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Oil Price Differentials: Markets in Disarray

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The purpose of this series of eight papers is to analyse a number of oil issues - political, economic and industrial - which have always been important but which have acquired additional significance during the current Gulf crisis.

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The series extends significantly the work presented at a very early stage of the crisis (mid-August) in the Institute's study *The First Oil War.* Many new topics have been researched, and those addressed in *The First Oil War* developed in greater depth.

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All price data used in this paper are Platt's Prices. We have used the following definitions.

Europe ARA are prices for Cargoes NW Europe c.i.f. basis Amsterdam-Rotterdam-Antwerp.

Europe Mediterranean are prices for Cargoes f.o.b. Mediterranean basis Italy.

US East Coast are prices for New York Harbour Barge.

US Gulf Coast are prices for Gulf Coast pipeline, naphtha and heavy fuel oil are waterbourne.

US West Coast are prices for San Francisco Pipeline.

Japan are prices for C&F Japan.

Heavy fuel oil prices are for fuel oil with one per cent sulphur content, and for Japan high sulphur fuel oil 180cst.

As nomenclatures vary, we have used the generic term kerosene to represent that slice of the distillation cut comprised of Jet Kerosene, Jet Fuel and Kerosene.

Gasoline prices, unless stated, refer to regular unleaded gasoline, except for the Mediterranean where leaded 0.4 per cent is used.

The latest prices used in our calculations are those for 12 October 1990.

EXECUTIVE SUMMARY

OIL PRICE DIFFERENTIALS : MARKETS IN DISARRAY

The conventional wisdom about the current behaviour of oil prices is essentially very simple. It is comprised of two assertions and then an inference. It runs as follows. First, there is no physical shortage in oil markets. Secondly, there is no stockbuilding (or "hoarding") at least not by the important oil companies. The price rises in oil markets since the Iraqi invasion of Kuwait can then only be due to "psychology" and "sentiment". These latter terms have dismissive connotations. They suggest that oil prices are being pushed up either by speculation or by factors which are not easily amenable to "rational" analysis.

This conventional wisdom is being fostered by OECD governments and oil companies. It is expedient, serves a variety of vested interests well, and has a politically appealing ring to it. It is also wrong.

We record in this paper a disintegration of world markets (in Europe, Japan and the USA), so great that for nearly all oil products there is no meaningful world price, just a series of local prices. The process of arbitrage that binds markets together has collapsed in a spectacular fashion. Enormous price differentials have opened up across markets which in normal times would have disappeared very quickly. For example the price of gasoline for Japanese delivery has remained 25 per cent higher than prices on the US West Coast for over a month. This suggests the presence of an overwhelming desire to hold physical stocks.

Many oil markets have few sellers although prices are in some cases three times the level of July. It is clear that those needing physical supplies are preferring to buy from the open market rather than run down their stocks. All the evidence is that there is an increased demand for holding physical and immediate stocks.

The markets are being driven by physical factors, most evidently in Japan and Europe. They are not being driven by speculation which has merely added sharp fluctuations to the rising price level. The underlying level of prices is symptomatic of severe physical imbalances.

Markets have not proved efficient and distortions have been caused creating problems that require considerable subtlety of action on the part of the major participants in the industry. By way of example in the paper we detail two such problems, the use of the Rotterdam market for pricing purposes and decisions concerning refinery utilization.

To maintain the view that all is normal bar the actions of a few fearful speculators is to be rather economical with the truth. To continue to insist that there are no physical imbalances is a misrepresentation which may lead governments and oil companies either to make incorrect and damaging decisions or to abstain from adopting the necessary remedial actions in time. It is important to be clear about what is driving prices because if the conventional wisdom is doggedly maintained we may be running straight into severe problems.

O.I.E.S.

OIL PRICE DIFFERENTIALS : MARKETS IN DISARRAY

1. Introduction

"The American people want to know why oil companies are making soaring profits at a time when the government contends that only costs of production are allowed to be passed through to the consumer. The American people want to know if this so-called energy crisis is only a pretext, a cover to eliminate the major source of price competition - the independents - to raise prices, to repeal environmental laws, and to force adoption of new tax subsidies."

These are not the words of a member of the US Congress speaking in 1990 (although many have reused parts of the full litany from which the quotation is drawn), but Senator Henry Jackson addressing US oil companies in January 1974. Jackson was speaking in the aftermath of the US energy crisis that began in the winter of 1972 and continued to worsen throughout the 1973 gasoline season, well before the Yom Kippur war of October 1973 and the oil embargo. If the International Energy Agency had existed in the summer of 1973 their summary of the world crude oil situation would have added to Senator Jackson's avowed perplexity. They would have found that in aggregate there was no crude oil shortage. In fact a crude oil shortage is neither a necessary nor a sufficient condition for an oil crisis to occur. Before the embargo the 1973 crisis in the USA was caused by severe distortions in US domestic pricing policy, the absence of an open market and a highly inflexible supply system that proved unable to cope when stressed.

Markets played a more powerful role during the second oil shock, but reacted to expected not to realized shortages. The only period of actual shortage over this period was immediately following the shut-down of Iranian production at the beginning of November 1978. Markets did not in this case react to a 4 mb/d shortfall either before or immediately consequent to it.

The loss of Iranian production was swiftly replaced with Saudi Arabian, and full Iranian production was restored in March 1979. Thus when prices began a significant upward movement in February, and over the period before they reached their 1979 peak in November, there was no shortage. However the Iranian crisis had sensitized oil markets to the possibility of cut-backs in Middle East production, and markets reacted to expectations of shortage. Hence political volatility was reflected in oil prices, with spot prices consistently leading changes in official OPEC prices. In particular, the markets reacted in turn to, in particular, the aftermath of Camp David, developments in Tehran, and the siege at the Grand Mosque in Mecca. In each case there was no immediately resultant change in the oil supply situation, but in each case the perceived probability of a major shortage occurring was revised upwards. As oil market participants tend to be risk averse, even relatively small changes in this subjective probability can lead to dramatic increases in price.

Hence the observation that supply has not fallen, even if true, does not rule out the occurrence of an oil crisis. Prices can be driven by an increased demand for precautionary stocks, and hence a supply gap can arise not because supply has fallen, but because demand, though not necessarily consumption, has risen. Stockholdings need not even actually rise, if the first resort is always the market rather than stocks, i.e. no price will release stocks, prices can be bid sharply upwards without any change in the level of actual consumption or physical supply. This would hold even if production from all countries remained the same and the oil supply system had developed no logistical problems.

However this is not the only factor which has been behind the general increase in the level of crude oil prices. Following the cessation of production from one area, even if it is completely replaced by other production, a process akin to a game of musical chairs ensues. The immediately displaced importing countries seek replacement supplies, which (either because of logistical reasons or because of the timing and uncertainty attached to extra production), are most unlikely to be made up wholly of the incremental production from other sources. Consequently, a further set of consumers are displaced from supplies as the original crude short countries bid up prices, and the process continues. Prices are increased by dislocation in the market, and adjustment is neither rapid nor frictionless enough for this process not to increase prices over what can be an extended period.

Thus the IEA's repeated claims, over the first two months of the crisis and beyond, that the supply of crude oil was equal to the level of expected demand does not automatically lead to the conclusion that there was no reason for prices to have increased. It is the failure to understand the processes by which arithmetical equality does not lead to price constancy that has led to political and public incomprehension on a scale at least as great as Senator Jackson's. In such circumstances a politician, armed with only one supply curve and one demand curve and who believes that neither has moved, will begin to look for villains.

The process of explaining price increases to the public and to governments has not been helped when even seasoned oil market participants and observers display a lack of awareness. One experienced oil market commentator has even described crude oil prices as representing $22 per barrel of economics, the rest attributable to human nature and in particular oil companies.

The presence of general uncertainty and dislocations in the process of obtaining supplies would be enough to explain oil price increases and fall well within the province of economics. However there are also other processes at work. These relate to the mechanisms by which markets process information, and the fact that there is not just one supply and one demand curve for oil markets, but a whole multiplicity. The oil market is not defined by one price, but a whole range of interrelationships deriving a complex set of relative prices and absolute price differentials. The creation of a distortion in any one of these relationships, caused for example by frictional or informational problems, will create further distortions in every other relationship.

The results of these distortions may often appear perverse. For example we will show that in the primarily product led price explosion during the Gulf crisis, it is highly conceivable that many refineries working under particular commercial, technological and political constraints, have every incentive to curtail their operations. It is the development of the dislocations in oil market relations that lead to such outcomes which is our focus in this paper.

The 1990 crisis differs from the experience of 1978 to 1980 in the pace of price increases. In Table 1 we show prices for five products (Platt's upper range prices c.i.f. Amsterdam-Rotterdam-Antwerp), for both crises. The start of crisis prices are taken one month before the respective political catalysts, i.e. they represent prices for the beginning of October 1978 and July 1990.

Table 1 : Product Prices 1978-80 and 1990

($ per tonne c.i.f. basis ARA)

		Start	Peak	Date of Peak
Leaded Gasoline	1978-80	194	430	29 May 79
	1990	232	455	24 Sep 90
Naphtha	1978-80	164	398	12 Dec 79
	1990	146	403	10 Oct 90
Kerosene	1978-80	151	420	7 Nov 79
	1990	159	520	12 Oct 90
Gasoil	1978-80	133	396	30 May 79
	1990	144	356	9 Oct 90
HFO (1%S)	1978-80	82	216	9 Jan 80
	1990	82	169	28 Sep 90

The peak prices to date for naphtha and kerosene represent increases, in both absolute and percentage terms, that exceed those experienced during the second oil crisis. Gasoline, naptha and kerosene prices have reached their highest ever levels. Whereas the peaks of 1979 were the result of respectively eight and thirteen months of

rising prices, they were first breached within two months of the Iraqi invasion.

For the lighter products the Gulf crisis has then already represented a price shock greater then the second oil crisis. While prices are lower than their previous peaks in real terms, this does nothing to reduce the psychological impact of the shock. Behaviour and psychology are conditioned on changes from the absolute levels of July 1990, not from the real terms levels of 1979. When falling from the twentieth floor of a building, it is little comfort to remember that, as the building has no thirteenth floor, you are only falling nineteen floors in real terms. This is not to say that the demand side effects of this crisis are necessarily a repeat of the experience of 1978 to 1980. As the sixth paper in this series details, there are some important differences.

2. Markets and Relative Prices

As markets develop and their mechanisms evolve they can become highly efficient processors of information, in particular short-term information. The markets for crude oil and petroleum products have been no exception. These markets have developed a voracious appetite for information of all types, and have an ability to swiftly fathom the consequences of each new set of indicators and to adjust prices accordingly. This can be largely a process of experience. A judgement on how a given piece of information will affect the market can be gained by the assimilation of knowledge of the market's past behaviour. Hence the existence of an efficient oil market does not imply that every, or even any, participant in that market knows the details and scale of the mechanisms by which each action leads to the result.

Thus information can become a convenient shorthand. Once participants have a feel for the quantitative effects of information as diverse as heating degree days, inventory levels and changes in production policy, it is only surprises in the details of the information itself, not its effects, that can cause market fluctuations. There is then rarely ever a need to review old information and markets only react to the information once, having no need to reassess its implications at a later date. The most successful traders are then those who get or process information faster than the others, since the understanding of the implications of that information is, at least in the longer term, common to all.

While market conditions are normal, no one market can move too far out of line from any other. If too large a differential arises a process of arbitrage will return markets to a state where they move within narrow relative price bands. Further, there is substantial cross hedging between markets, such that, say, a rise in gasoline prices in Singapore can be instantly transmitted to the price of heavy fuel oil in Rotterdam. Hence even highly localized supply problems or demand surges can be felt in all markets. Often physical arbitrage need not even take place, in normal times the certainty that it will happen is enough to immediately bring prices in different areas closer together.

The above typography of an efficient oil market holds as long as the underlying relationships change, at the very most, only gradually, and even then always perceptively. It does not hold when the underlying relationships and patterns of behaviour are disturbed, as has now happened, or if there is a sudden and unforeseen structural change. The Iraqi invasion immediately put a premium on holding physical supplies. Under such circumstances few will wait for arbitrage to work. Buyers in the market are in effect using very high discount rates, and hence the differential in prices between locations necessary for them to prefer to purchase supply from a more distant but cheaper location can become very large. For this reason the impact of the markets' most effective cohesive force is greatly reduced, and the bands within which markets move together become considerably wider.

When the underlying relationships are disturbed, market participants lose the knowledge of how each piece of information affects the market quantitatively, even when

the information is of a type within the market's experience, for example degree day indicators for heating oil demand. The relationships that had been observed before are no longer precise, and hence greater volatility is introduced into prices. Whereas under normal circumstances only information can cause surprises, in a crisis so can its results. Old information needs to be continually reassessed because its impact may prove to be different from the market's first opinions, and thus the market will tend to continually either undershoot or overshoot. Even more destabilizing are cases when the relationship has changed qualitatively. In such cases the market can, for example, react bearishly to information when the effect of that information will later prove to be bullish. Established and observed relationships may now work in a totally different direction.

Not only will markets have difficulty in assessing the effects of information of a familiar type to them, they also have to learn to react to information of types outside their normal experience. They will absorb political and military information, not only unsure of its real effects but also unsure of the validity of the information itself, and they become prone to rumours. When events are highly volatile there is an even greater premium on getting information first. In the case of rumours the greatest advantage is in hearing them first and finding out they are incorrect first. Rumours can add significantly to intra-day price movements both upwards and downwards. On 10 October markets first reacted to a rumour that US troops had entered Kuwait. Prices shot upwards. Later the same day they reacted to a rumour that Saddam Hussein had been assassinated, and crude oil prices immediately fell more than $2. The suspicion has to be that not all rumours are innocent misunderstandings. After all the person who hears a rumour first and knows it is false first is its originator. Hence, whether the information is of a familiar or an unfamiliar type, market reaction adds to the volatility of prices, and the presence of rumours reinforces this.

The above implies that there will be considerable price instability even if there is only one market which is trying to find the correct level of only one price. However there are many oil markets trying to find many prices, all potentially processing information differently. When the loss in the efficiency of arbitrage is added to this it is not too surprising that relative prices and price differentials will move very erratically. Volatility in the levels can lead to magnified volatility in relative prices and price differentials.

There are four main varieties of relative petroleum prices and price differentials of interest. First, there are the relative prices between each pair of products in the production slate. Secondly, there are intra-crude and intra-product relative prices. The differentials between different grades of crude may and do change, just as the relative prices of differentiated forms of the same generic product group, for example heavy fuel oil of differing sulphur content. Further, prices for exactly the same product may vary even in the same location due to the differential between futures and physical markets, or in the time profile of prices in futures markets.

Thirdly, there is that set of relative prices between crude oil and any given product slate that will determine refining margins. Finally, while relative prices in separate trading locations are in the longer term constrained by arbitrage, the swings across markets can be marked for significant periods of time, even for completely

homogenous commodities. While markets are highly interrelated and a shock in one location will be swiftly transmitted to others, this transmission is normally less than perfect.

Any change in either supply or demand conditions will have repercussions for all varieties of relative prices and price differentials. The underlying trends are the result of normally gradual evolutions on both the supply and demand side. However when these relationships are disturbed by a shock, the dynamics of relative prices can be violent. Further, markets will rarely be able to find the correct pattern of relative prices immediately, thus increasing the volatility of prices.

Following a shock, given the information costs involved the immediate reaction of many market participants will be to attempt to achieve any possible long position, which will not necessarily be the best available. Quite simply markets cannot absorb and process the amount of information necessary to solve for the correct new set of relative prices of all descriptions, when every relationship within the system is pulled sharply out of equilibrium at the same time. Given the time lags involved before the full implications of a supply side shock become apparent, the markets can be wildly incorrect in their appraisal of relative prices throughout a considerable period. In such circumstances the relationships within the system that have been observed by gradual evolution and observation are unlikely still to hold.

The shock to the market represented by the Iraqi invasion of Kuwait and the unravelling of its consequences, has led to changes in the patterns of both supply and demand for both crude oil and petroleum products. We now detail these changes before considering their implications for price differentials.

3. Changes in the Patterns of Supply and Demand

On the supply side the primary and most obvious change has been the loss of Iraqi and Kuwaiti crude oil exports combined with attempts to achieve their replacement from other sources. While there would still be, as we show below, enormous implications for demand which would have greatly affected markets, under certain strict conditions there need not have been any change in the supply situation. First, the lost crude oil production would have to have been completely replaced by marginal production elsewhere with precisely the same characteristics. Secondly, the lost refinery capacity in Kuwait would need to have been replaced by previously unused capacity of the same sophistication, and thus able to produce the same product slate composition from the same crude oil input. Finally, there would need to be no time lags involved in the replacement, nor any logistical problems with replacement crude oil or products being far removed from the markets facing the supply loss. Given the strictness of these conditions it is hardly surprising that none have been met, and it is from this failure that the supply side implications for relative prices arise.

The change in the supply of crude oil has been one of both quantity and also quality. Almost a whole month's exports from Kuwait and Iraq were lost before any expansion was possible elsewhere. After this a supply gap of nearly 2 million b/d is still left, which would be even greater if the alternate incremental suppliers were to produce at sustainable rather than surge capacities. Furthermore, within this picture the incremental supplies are around 3 degrees API heavier than the lost production. The fall in crude gravity is not evenly spread, much of it is due to Venezuelan incremental production. According to the Venezuelan government, their aim is to maintain an increase of some 500,000 b/d with a gravity ranging from 18 to 20 degrees API. The lost Iraqi and Kuwaiti production was about 33 degrees API. Such falls in gravity cause severe problems for refiners. Given the tightness in cracking capacity they imply that to produce the same quantities of the lighter products as before the crisis, more crude oil input is needed and more heavy fuel oil will be produced.

As was shown in the previous paper in this series, the loss of Kuwaiti refinery capacity is not a trivial consequence of the crisis. The lost refinery capacity was sophisticated and complex producing a slate heavily biased towards the lighter end of the barrel. The invasion of Kuwait removed 7.4 per cent of the world's hydrocracking capacity. This is irreplaceable. Refinery capacity is especially tight in the USA, UK and Germany, and what spare capacity there is, mainly in Italy and some rapidly disappearing capacity in Japan, is not cracking capacity. The same applies to decommissioned capacity that might be brought back on stream. Hence to produce the same quantities of lighter products that Kuwait exported requires yet more crude oil input, and will therefore produce yet more heavy fuel oil. Thus the loss of the Kuwaiti refineries reinforces the effects of the fall in crude oil gravity. The combined effect will be to produce, *ceteris paribus*, a significant increase in the relative supply of heavier compared to lighter products.

Changes in demand patterns arise due to differing price elasticities through the product barrel, regular seasonal changes, military requirements and most importantly an

increased demand for holding physical stocks. Short-run price elasticities of demand for petroleum products vary considerably. At one extreme heavy fuel oil demand is highly price sensitive. Demand for straight run fuel oil as input to cracking capacity will remain buoyant as long as differentials between straight run prices and lighter products increase in absolute terms, subject to the constraints on cracking capacity. Demand from this source may increase as more owners of complex capacity find it even more profitable to back out crude and use straight run fuel oil as input. However the demand for fuel oil for electricity generation by utilities responds to the absolute price. The growth in the amount of dual-fired generating capacity over the last decade has meant that many countries can almost instantly switch from heavy fuel oil to alternative inputs. For example UK power generating utilities have reduced purchases of heavy fuel oil by 86 per cent, from 228,000 b/d in July to just 31,000 b/d in September.

Hence the demand for cracked fuel oil becomes confined to countries without sufficient flexibility in power generation, either in terms of dual-fired or spare capacity, to substitute away from heavy fuel oil. However the demand for lighter products is relatively price inelastic. This is reinforced by the presence of substantial tax cushions embedded in retail prices, which lead to changes in world prices translating to less than proportionate increases to the final consumer.

Current non-Iraqi military demand for oil products represents about 170,000 b/d. However as the build-up of forces continues and manoeuvres increase, this is likely to constitute a continually mounting drain on world supplies. James Schlesinger has expressed the view that if the military presence becomes prolonged, military demand could reach 1 million b/d. Even if the amount was only half this figure, it still represents a considerable drain since virtually all of it is incremental demand compared to normal circumstances. The problem is that this is of course not demand for crude oil, but for particular products. The only major military demand for heavier products is bunker fuel for naval requirements. Other than this, demand is concentrated on lighter gasoils (i.e. diesel), and also aviation fuel which comes from the slice of the distillation cut we have termed as kerosene for the purposes of this paper. Aviation fuel requirements alone represent a large increase in the world demand for this class of product. Hence each barrel of military oil products demand requires considerably more than one barrel of crude oil input, and on the supply side leads to a very significant diversion of refinery capacity.

The role of oil inventories is considered in the next paper in this series. For present purposes it suffices to say that uncertainty not only greatly increases the implicit discount rate used by market participants, but increases the premium for holding physical stocks. This constitutes normal risk averse behaviour, and reflects a desire for supply security. It does not necessarily imply large-scale speculative behaviour. Pure speculators have no need to hold physical oil when they can trade in paper barrels, and as the last section of this paper shows, price increases for paper barrels have not outpaced their physical counterparts.

4. Refining Margins

Refining represents the interface between crude oil and product markets, and hence any perverse effects caused by the disintegration of traditional relationships are likely to appear in refining first, and then create the dynamic for further distortions.

The refiner's art is, subject to the technological constraints in refinery setup, to attempt to maximize production of the higher value lighter products and to minimize the production of heavy fuel oil. Heavy fuel oil tends to almost always trade at a discount to an equal volume of crude input, whereas the lighter products all tend to trade at a premium. Hence the implicit loss made in the production of heavy fuel oil must be made up by the lighter products for refining to be profitable.

Gross refining margins can be thought of as the weighted sum of the differential between the prices of each output and the value of an equal volume of crude oil input, the weights being the refinery yields obtained. Weekly averages for these differentials, expressed in dollars per tonne, are shown in Table 2 on the basis of prices in the Mediterranean, the US Gulf Coast and Japan, using respectively Brent, West Texas Intermediate and Dubai as crude oil input. We also show, based on these figures, sample gross refining margins in dollars per tonne of crude oil input, for simple distillation technology and also complex cracking capacity producing a slate more biased to the lighter end of the barrel but using more input as fuel or loss.

In Europe over the course of August gross margins increased substantially for the production of gasoline, naphtha and kerosene. While the differential for heavy fuel oil worsened, overall improved margins were achieved by refiners with cracking capacity, and in the latter half of the month also by simple distillation units. However since August gasoline margins in particular have fallen away, and heavy fuel oil has produced negative margins of an unprecedented magnitude. Meanwhile kerosene has become by far the most profitable slice of the distillation cut. In total this has led gross margins for simple refining to plunge while complex capacity margins have held up considerably better. The refining margins shown are not necessarily upper and lower bounds. In particular, complex hydrocrackers will have achieved considerably higher gross margins than catalytic crackers, mainly due to the dramatic increase in kerosene margins. Kerosene is produced by straight run distillation, with incremental production achievable by hydrocracking but not catalytic cracking. At the other end of the scale, older and more inefficient distillation units using heavier crude input may have produced far worse gross margins than those shown for simple refining.

The collapse in distillation capacity margins, both in Europe and as Table 2 shows also in the USA, presents a dilemma for integrated oil companies. They predominantly hold the cracking capacity, while the independents have capacity more biased to simple distillation. Thus they are making greater unit margins in refining than the independents. They could of course quote a negative margin for simple distillation and imply that they are making losses in the refining stage. However governments see cross-subsidization between company activities as essentially anti-competitive and predatory to non-integrated companies. The same logic that does not allow upstream gains to subsidize

Table 2 : Product Price Differentials from Crude Prices; Weekly Averages $s per Tonne

Mediterranean Basis Italy

Differentials From Brent

Week Ending	Gasoline	Naphtha	Kero-sene	Gasoil	HFO	Margins Simple	Margins Complex
6 Jul	82.3	9.0	23.1	8.4	-42.5	-3.6	18.5
3 Aug	94.0	12.9	37.3	21.5	-53.9	-3.1	25.0
10 Aug	92.1	39.8	33.5	13.3	-75.2	-14.3	20.3
17 Aug	105.7	55.2	54.6	20.4	-80.7	-10.6	29.1
24 Aug	152.0	76.9	85.7	38.0	-84.0	2.5	51.2
31 Aug	157.7	63.7	95.4	30.7	-64.3	11.6	54.9
7 Sep	150.3	47.3	82.0	20.0	-88.3	-5.3	41.9
14 Sep	153.7	52.7	81.5	16.4	-88.5	-5.3	42.3
21 Sep	119.2	48.6	85.5	6.9	-126.8	-30.6	23.9
28 Sep	105.3	60.5	152.5	28.8	-145.5	-30.0	33.3
5 Oct	107.0	79.5	186.8	34.9	-125.8	-14.7	46.3
12 Oct	79.3	70.1	193.5	37.2	-144.2	-27.0	36.3

Gulf Coast USA

Differentials From WTI

Week Ending	Gasoline	Naphtha	Kero-sene	Gasoil	HFO	Margins Simple	Margins Complex
6 Jul	79.0	36.4	34.7	19.4	-37.0	3.2	26.5
3 Aug	69.6	49.1	31.2	18.7	-55.8	-7.0	20.5
10 Aug	86.9	73.4	31.5	17.1	-60.9	-5.9	25.9
17 Aug	107.4	86.7	48.8	24.7	-58.5	2.2	37.3
24 Aug	136.2	117.2	81.3	45.5	-60.1	14.7	57.3
31 Aug	108.5	94.8	61.7	29.7	-40.7	13.6	45.1
7 Sep	117.1	97.1	65.0	29.8	-64.4	4.0	43.3
14 Sep	102.9	79.4	66.8	21.4	-72.7	-4.6	34.5
21 Sep	67.7	54.6	65.1	16.3	-103.7	-27.1	15.5
28 Sep	58.6	50.7	101.4	23.2	-107.0	-25.2	19.3
5 Oct	48.8	47.4	133.4	27.4	-88.0	-13.8	26.2
12 Oct	38.3	38.6	151.8	19.0	-120.7	-31.3	16.8

Japan

Differentials From Dubai

Week Ending	Gasoline	Naphtha	Kero-sene	Gasoil	HFO	Margins Simple	Margins Complex
6 Jul	125.5	47.4	71.1	58.7	-27.3	26.9	56.0
3 Aug	131.9	49.3	71.6	47.1	-28.4	25.2	54.7
10 Aug	164.1	81.5	108.6	82.5	-31.1	41.1	79.9
17 Aug	191.3	101.8	110.0	75.5	-38.3	41.5	85.7
24 Aug	217.9	115.7	120.6	79.6	-48.8	43.0	94.3
31 Aug	241.4	111.6	150.1	106.0	-39.1	59.2	112.7
7 Sep	231.4	116.0	140.2	97.7	-51.4	49.4	104.6
14 Sep	232.8	118.8	152.9	99.5	-62.1	46.3	105.5
21 Sep	239.5	129.3	151.8	87.6	-73.3	39.9	102.8
28 Sep	208.2	148.2	213.1	118.2	-92.2	39.3	110.0
5 Oct	218.2	164.1	258.0	139.5	-77.0	57.7	129.1
12 Oct	201.8	147.7	302.2	127.3	-88.1	51.1	124.8

downstream operations and thus dictates that increases in world gasoline prices should be passed onto the consumer also implies that simple refining operations should be cut when margins become heavily negative. What holds for the pricing of refinery output should also hold for refinery input, with all crude, including equity crude, being priced as input to a company's refineries at world prices. Not to do so would represent the same form of cross-subsidization as would artificially holding down retailing margins. It would immediately destroy the arguments behind companies' retail pricing policies. This would clearly be disastrous for companies, particularly in the gasoline market. To maintain simple distillation operations when making losses implies that production cutting would be solely carried out by independent refiners.

While an increased perception of the value of product stocks may lead to independent refiners maintaining output longer than they would under normal circumstances, eventually they must cut runs. Continued maximum capacity operation by integrated companies in such circumstances results in a market pricing distortion that puts crude prices too high compared to product prices. Further, while in a competitive market the bulk of run cuts should be borne by independents due to their lower capital investment, it might be rather difficult to explain the distinction to governments.

However cutting runs from simple distillation capacity does not appear to be an attractive option for companies either. Normal adjustment implies that refining margins can only be restored by cutting crude runs. Nevertheless it is very hard to explain to the public and governments that in a time of crisis refinery output should be cut, the result of which will be an increase in product prices. Even if that is precisely what refining economics implies should happen, outsider reaction will be to see this as a profiteering measure. Further, if supply crunches such as those of the winter of 1989-90 reoccur, as is more than possible, the inquiries into the crunch would indubitably conclude that refinery run cuts in October when the annual distillate stockbuild should have been completed, were a major contributory factor. Such inquiries, following onto the plethora of tribunals at both US Federal and State level over the course of 1990 after the heating oil price spikes of last year, would be highly detrimental to the interests of the oil industry. In short, integrated companies may be storing up political problems whether crude runs are maintained or whether they are cut. Unless markets can correct the distortion, the only choice left open to companies is equivalent to the choice of holing your boat on Scylla or on Charybdis. You either declare positive margins and attract suspicion when comparisons are made with the plight of some independents, or you claim negative margins and then have the dilemma of whether to maintain or cut runs.

This is the most clear-cut case where pricing distortions have led to a direct conflict between supply security of products and refinery economics, as well as creating a political minefield for oil companies. Both producers and consumers of petroleum products have an increased demand for supply security. This is immediately transmitted to the price. However higher prices and gross margins for individual slices of the distillation cut, in this case the lighter products, do not imply that increased refinery profits will lead to greater production, because of the dramatic collapse in residual fuel oil margins. The only way to satisfy the demand for supply security is for product prices to rise higher, and when the most affected product constitutes even on maximum yield a small proportion of the product slate, such as kerosene, its price increases can be

startling yet still fail to produce refining profits.

With products still representing the Achilles' heel of the supply system, especially as winter approaches, it may be optimal from the economy wide perspective to keep refineries working at a maximum. Nevertheless while the benefit of increasing product stocks is common to all, some refiners would have to incur losses to achieve this. While integrated companies can, at the cost of later being accused of cross-subsidization, absorb any losses (and in fact will be making profits on their refining operations as a whole), independent refiners without complex capacity can not.

When some are calling for the imposition of taxes on the oil industry it might seem most perverse to suggest that in fact subsidization of certain areas is necessary. However, the combination of price distortions and the realities of competition policy are beginning to create a significant market failure. Unless the markets correct price differentials so as to keep independent owners of simple distillation capacity in profit, refinery utilization in the USA and in Northern Europe will fall from their recent maxima. To allow this to happen may be a recipe for disaster over the winter period. To prevent this market distortion from cutting crude runs it may be necessary to provide compensation for independent refiners who hit negative margins. It may also be necessary to have some behind-the-scenes talks with majors, because the tangles they face over refinery operations have a very strong political element. The refining system is already highly stressed in both the USA and Europe, to allow capacity to become idle would be very dangerous indeed.

A further dimension is added by the position of East European refineries. These tend to be old and inefficient with very little upgraded capacity. They are already insufficient to meet current demand, let alone the increases expected over the next decade which are likely to be heavily biased to the lighter end of the barrel. In current circumstances such refineries would on a commercial basis be making gross margins far worse than those shown in Table 2 due to their high heavy fuel oil yields. Given that they operate under foreign exchange constraints there is every incentive to cut runs. It would prove cheaper in foreign exchange terms to cut production, import lighter products and in particular gasoline, and even to export some refinery crude stocks to minimize the foreign exchange burden. This has already begun to happen, particularly in, as was, East Germany, Poland and Romania. Thus some available capacity in the European market is cut, and Western European refiners face a further call on supplies.

The situation in Japan is very different. As the next two sections detail, Japanese refiners face both higher output prices and lower crude oil input prices, and hence margins have remained relatively buoyant. MITI, which regulates Japanese refinery throughputs first approved an increase in crude runs of 215,000 b/d for the period 17 August to 30 November. It has now effectively allowed Japanese refiners to decide their own throughput levels, in what is an unprecedented liberalization of the Japanese refining industry. While refiners have been asked to reduce their output later to keep within the year to end March 1991 guidelines, these guidelines have also been raised.

The major problem for Japan has been to replace their imports of naphtha and kerosene previously produced by Kuwaiti hydrocrackers, from a combination of spot

market purchases and increases in refinery throughputs. However, there is a severe shortage of complex refinery capacity in Japan (there is between 15 and 20 per cent upgrading capacity, which is now running at a maximum), and indeed this is true for the Far East in general. Very few Japanese refiners will be able to achieve gross margins of the magnitude shown for Japanese cracking capacity in Table 2. On the other hand, compared to their American and European counterparts, very few Japanese refiners will be making losses.

MITI's policy response has been swift and flexible. They have implicitly acknowledged the danger of leaving refinery capacity idle, and realizing that a glut of fuel oil will result, the easing of export restrictions has been considered. This should take refinery utilization in Japan measured against nameplate capacity to above 80 per cent, which, while well below the rates achieved in Europe and the USA, represents an historically high level for Japan. Given that nameplate capacity may be at least half a million b/d too high as an estimate of immediately usable capacity, utilization rates in Japan are in reality over 90 per cent. The major concern in MITI is kerosene supplies. As the next section shows this, combined with military demands, has contributed to a severe squeeze in the kerosene market.

5. Product Prices

It is in the markets for oil products that arbitrage has most seriously broken down and markets have been left to move untethered. In Table 3 we show the percentage changes in relative prices between six locations (Japan, North and South Europe, and the US East, West and Gulf Coasts), for four products between the start of July and October 1990. The figures shown are the percentage change in the ratio of the price in the region shown in the row compared to the price of the location shown in the column. Thus, for instance, the first figure in the table shows that the ratio of the price of unleaded gasoline in Japan to that in NW Europe basis ARA has risen by 10.7 per cent. For each product, the area with the slowest growth in prices would have a positive number in every column it appears, and a negative number in each row it appears. Hence the table shows that gasoline prices have risen fastest in Japan, kerosene and gasoil prices in the Mediterranean, and heavy fuel oil prices on the US West Coast.

The changes in relative prices shown in Table 3 are in some cases extreme, and translate to absolute differentials of a large magnitude, which arbitrage has had little effect on. To illustrate we will consider the gasoline markets. Trade flows are possible, especially between Europe and the US East and Gulf Coasts, and between the US West Coast and Japan. While exports of domestic crude oil are prohibited in the USA, exports of oil products are not. Thus, at least in theory, US exports can play an arbitraging role when US prices are relatively low.

Table 3 shows that European ARA prices relative to the US East Coast have risen 14.1 per cent, and Japanese prices relative to the US West Coast have risen by a phenomenal 40.2 per cent. These convert to the absolute differentials shown in the two left hand side graphs in Figure 1, which demonstrate that the extreme relative price changes shown in Table 3 are not merely the result of a temporary aberration in prices. Gasoline prices are usually higher in the USA than in Europe allowing European imports to move across the Atlantic. This was the pattern during July and held until the Iraqi invasion. In early August European prices increased rapidly, until a differential of nearly $90 per tonne was opened up over US prices. While US markets caught up, since the beginning of September the differential has increased steadily to move between $20 and $50 per tonne. Even though freight rates have increased, the price differential is still far more than the cost of transport, and yet it has shown few signs of narrowing.

This then is the scale of profitable arbitrage opportunity that is opened up by a relative price change of 14.1 per cent. Table 3 shows no less than 25 relative price changes greater than this level. For instance Japanese gasoline prices, which as is shown in Figure 1 began July $20 per tonne below the US West Coast, at one point reached $170 above (a $210 swing since the beginning of August), and have maintained a differential of over $100 a tonne since early September. This equates to about thirty cents per gallon, again a huge premium over transport costs. The discount rate effectively being used by anyone who buys supplies in Japan rather than waiting for purchases made on the US West Coast to arrive, is over 4000 per cent a year. The need for immediate physical supplies then parallels the behaviour of someone so desperate for immediate cash that they would take out a loan carrying 4000 per cent annual interest.

Table 3 : Changes in Relative Prices July to 12 October 1990
% Change in Relative Price of Row to Column

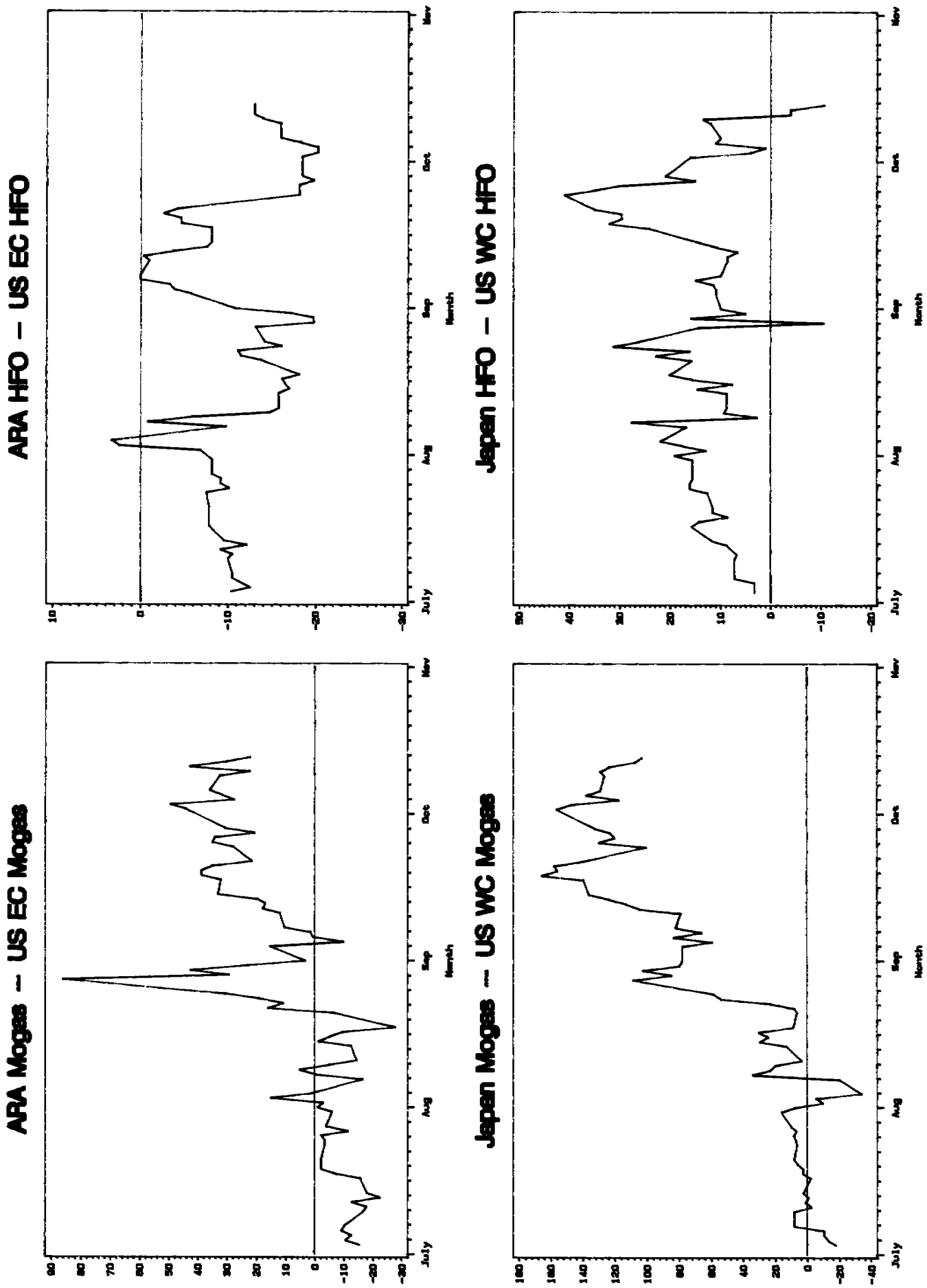
	Unleaded Gasoline				
	Europe ARA	Europe Med	USA East	USA Gulf	USA West
Japan	10.7	7.4	26.3	19.7	40.2
Europe ARA		-2.9	14.1	8.2	26.7
Europe Med			17.6	11.5	30.5
USA East				-5.2	11.0
USA Gulf					17.1

	Kerosene				
	Europe ARA	Europe Med	USA East	USA Gulf	USA West
Japan	1.0	-6.9	19.4	13.3	39.8
Europe ARA		-7.8	18.3	12.2	38.4
Europe Med			28.3	21.7	50.2
USA East				-5.2	17.0
USA Gulf					23.4

	Gasoil				
	Europe ARA	Europe Med	USA East	USA Gulf	USA West
Japan	-0.8	-7.4	12.3	7.9	5.3
Europe ARA		-6.7	13.2	8.7	6.1
Europe Med			21.2	16.5	13.7
USA East				-3.9	-6.2
USA Gulf					-2.4

	Residual Fuel Oil				
	Europe ARA	Europe Med	USA East	USA Gulf	USA West
Japan	16.1	13.2	21.3	17.7	-10.2
Europe ARA		-2.5	4.5	1.4	-22.7
Europe Med			7.2	4.0	-20.7
USA East				-3.0	-26.0
USA Gulf					-23.7

Figure 1


ARA HFO – US EC HFO
Japan HFO – US WC HFO
ARA Mogas – US EC Mogas
Japan Mogas – US WC Mogas
July
Aug
Sep
Oct
Nov
Month

The immediate question then is why when so many profitable trading opportunities exist, differentials should have been maintained at such high levels. Some have suggested that US oil companies are uncomfortable with the reversal of trading patterns and find it politically awkward to increase exports up to the level necessary to guarantee price convergence. The premise may perhaps be correct, but this is not the reason for the price differentials. As explained in section 2, arbitrage simply does not work during a crisis, there may in fact be no level of US exports sufficient to cause price convergence in an upward and volatile market.

Consider how arbitrage works in normal circumstances. Imagine a localized supply side shock which is expected to be a discrete event, i.e. it is not the product of any evolving situation such as a crisis. An example might be a week of bad weather on the US East Coast. The market will react and East Coast prices be driven above European prices. However they cannot be maintained at this higher level. An arbitrage possibility has opened up and, with no extra shock foreseen, all participants know that exports from Europe will enter the market in a few weeks and equalize prices. As everyone in the market then expects prices to fall, prices will be adjusted downwards long before any extra cargoes arrive. Thus price spikes are short lived in normal circumstances, just knowing that a higher relative price will eventually increase supply means that arbitrage works before extra physical supplies are transferred.

However, a crisis is not a series of single independent events with long lags between them. The appearance of price spikes in normal times is precisely that. In a crisis nobody is prepared to wait for arbitrage and market participants work with incredibly short time horizons. Even when supplies do move, this can have little to do with price. Japan is certainly not buying in the USA because it finds Far East prices too high, it is buying because it wants extra physical supplies. Imagine a new piece of information hits the market. Prices move differentially because different locations may interpret it differently, or because they have varying degrees of concern about supply security. Opportunities for arbitrage open up, but before any supplies can change location, another piece of information arrives causing another set of wild gyrations in prices.

When information able to cause price changes of large magnitudes is hitting the market on a daily basis, nobody is going to bid prices down to levels of other areas in the belief that price driven international trade will physically equalize prices at a later stage unless the markets do so immediately. The markets and events are too volatile, and the time lags in international trade too long for this to happen. Ultimately arbitrage ceases to work because everybody realizes that it cannot lead to price convergence under such circumstances. Until events take on a more regular pattern price differentials may gyrate wildly either up or down, but there will be no systematic tendency for convergence to be achieved and to hold. Market prices become determined by local demand patterns that do not take other international markets in distant locations into any account. Markets may appear to move up and down together, but this is due to them receiving the same information and to a degree of cross-hedging between markets. It is not due to any power of arbitrage, since, as we have seen, price differentials can be large and persistent.

Arbitrage has then collapsed in a spectacular manner. Markets are now using such large discount rates that the opening up of arbitrage possibilities is no longer self-correcting. While insensitive to possible international trade patterns, they are however highly sensitive to the appearance of new players in the market. Not only have European markets had to cope with the increased demand from Eastern Europe for lighter products referred to in the last section (even the Soviet Union most unusually has sought to purchase gasoline on open markets), there has also been an influx of Japanese demand. While, as the next section details, Japan has shown great restraint in the market for crude oil compared to other market participants, they have apparently shown little restraint in the market for oil products. Tanker rates have begun to climb as Japan seeks supplies. These are coming primarily from the Mediterranean and have had the greatest impact on demand in Europe, but they have also come from the Caribbean and there have even been reports that to date over 3 million barrels of gasoil cargoes have gone to the Far East from the US East Coast.

Table 3 demonstrates that there is no longer any efficient and unified world market for oil products in which the markets are bound together by the operation of arbitrage. Product markets have splintered into several distinct geographical markets. That is, there is in the conventional sense no world price for oil products, just a range of local prices. From this arises another minefield for oil companies, particularly those operating in, or on the basis of, the Rotterdam oil products market.

Most European retail prices are in some way linked to the Rotterdam market. Rotterdam prices are used as transfer prices between refinery and retail operations. The justification for this in normal times runs as follows. Rotterdam prices represent the level of world prices, since world markets are efficiently bound together. They represent the replacement cost of supplies, since most refiners at some stage may go to the Rotterdam market for supplies. Rotterdam prices also represent the opportunity cost of supplies since marginal production could be sold on the Rotterdam market. Replacement cost is a minimum price concept, the price at which oil companies would buy. However opportunity cost is a maximum price concept, the price at which oil companies could sell. In normal times all is fine since as long as Rotterdam never becomes decoupled from other world markets, opportunity costs equate to replacement costs.

However in a crisis world markets do become decoupled for long periods and the concept of the world price becomes meaningless. Worse still a gap opens up between replacement and opportunity costs. While US prices remain so much lower than European prices, the replacement cost becomes the US price plus transport costs. However the opportunity cost remains the higher European price. It is at this point that the lack in transparency of the volumes traded by major companies becomes a liability. To use the UK gasoline market as an example, volumes obtained from Rotterdam in normal times are small compared to total production. Likewise the volumes imported from the USA over the course of the crisis are also small compared to total production. But which source is currently the most important?

In normal times it made no difference since prices in both the USA and Rotterdam reflected world prices, and in any case the normal pattern of trade was always

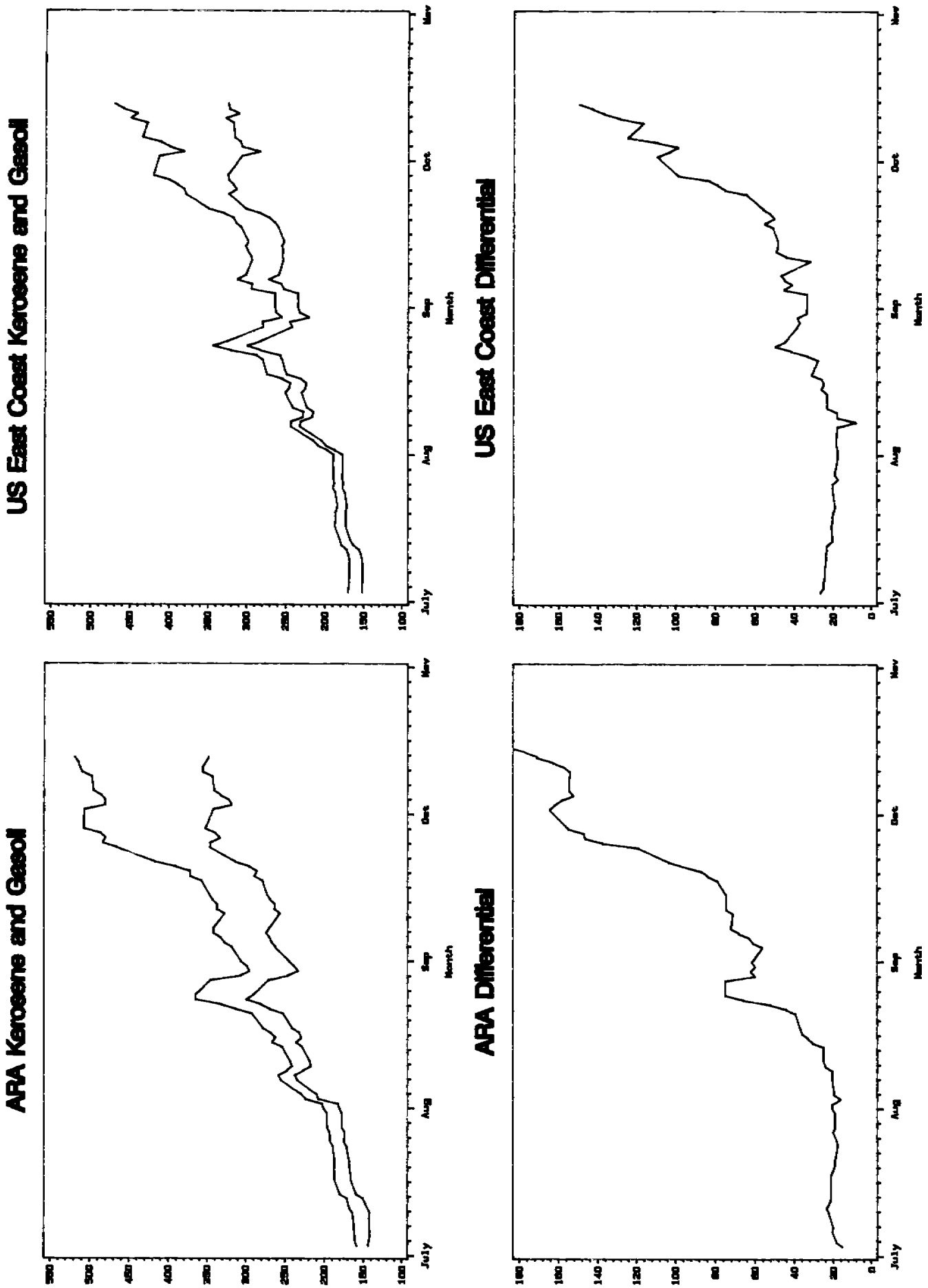
from Europe to the USA. However this has now been reversed, and neither market reflects world prices because there are no world prices. Hence the choice of whether to justify pricing on the replacement cost or the opportunity cost principle becomes critical as they now imply different prices. If companies are seen to be importing marginal supplies from the US market but pricing on the basis of the Rotterdam market they need to make a very good presentation of the case for using opportunity cost pricing as opposed to replacement cost pricing. Currently they have been using replacement cost pricing as an argument. Given the lack of transparency in market volumes traded, as the above shows this may be a highly dangerous strategy. This will not be the only case where the lack of detailed information publicly available on the operations of the European oil industry, compared to the accessibility of information on the US oil industry, will prove to have been a very serious mistake. For example, unless dealings with and in the Rotterdam market are made more transparent, it is absolutely inevitable that some political body will force them to become transparent, with the ever present threat of regulation. The window of opportunity for self-regulation and self-enforced market transparency is now narrowing very quickly. There is no suggestion that the Rotterdam market is being rigged. However nobody can claim that Rotterdam prices represent world market prices since those prices are not definable for oil products during a crisis, and this creates a whole set of new problems.

The squeezes and widening differentials between markets are likely to hit different portions of the barrel at different times, and may never affect the market for heavy fuel oil. As Figure 1 shows, heavy fuel oil differentials, even those between markets that have such large differentials for gasoline, have been trendless.

The major squeeze to date has been on that slice of the distillation cut we have referred to as kerosene. As detailed in section 3 this has been hit by a large supply loss from Kuwaiti refineries, together with increased military use for aviation grades. Furthermore kerosene is the major fuel used in Japanese space heating, and it is as politically sensitive in Japan as gasoline is in the USA. The crisis has coincided with the time when the annual Japanese seasonal stockbuild should have been completed. Increased security fears have led to a further increase in Japanese demand, regardless of the absolute level of their kerosene stocks. Put together this implies that a relatively small slice of the product barrel faces an enormous squeeze. The result has been the first major price spike within the general pattern of rising prices during the crisis. It may not be the last.

Kerosene and gasoil prices for NW Europe basis ARA and for the US East Coast together with the kerosene to jet differential are shown in Figure 2 (all data expressed in dollars per tonne). Normally kerosene trades at a premium of between $10 and $20 per tonne over gasoil (the normal pattern is illustrated in the second paper in this series). Beginning in mid-August the differential widened dramatically, reaching over $180 per tonne in ARA, and $130 per tonne on the US East Coast. Within this picture a differential of over $60 per tonne has opened up between the kerosene price in the two locations. This is another failure of arbitrage, and another problem for European oil companies in their internal transfer pricing. As the difference will not be automatically self-correcting the choice is non-trivial.

Figure 2


US East Coast Kerosene and Gasoil
US East Coast Differential
ARA Kerosene and Gasoil
ARA Differential
July
Aug
Sep
Oct
Nov
Month

6. Crude Oil Prices

We have already seen that when a large premium is put on holding immediate physical supplies, arbitrage becomes largely ineffective. This process has been very evident in the market for crude oil. This market is a set of markets for crude oils with non-homogenous characteristics, differentiated by the characteristics of the crude itself as well as its location. It is a market with long delivery lags, and hence with the consistent failure of arbitrage, differing perceptions of the situation across the world will tend to destroy even long-standing relationships. We consider two main aggregate markets in this section, the market for internationally tradable crude oils and the market for domestic crude oils in the USA. Exports of domestic US crude oil are prohibited and hence they are internationally non-tradable, at least until they are converted into tradable products.

The price differential between different grades of crude oil is comprised of two main elements. First, there are transport costs as crude oils are quoted for sale at different locations. Most internationally tradable grades are quoted f.o.b. at their export terminal, for example Brent at Sullom Voe and Iran Heavy at Kharg Island. The only major exception is Urals which is quoted c.i.f. Europe (in the Mediterranean by Platt's and NW Europe by Petroleum Argus). As Table 2 demonstrated, lighter products have increased their gross margins relative to crude oil, while heavy fuel oil margins have worsened dramatically. For purposes of illustration consider a crude oil which produces a yield of heavy fuel oil 4 per cent greater than Brent with the fall in lighter product yields equally distributed. Then, abstracting from transport costs and any differences in sulphur content, such a crude oil would have traded at a discount to Brent of below $3 per tonne in July, (about 40 cents per barrel), if the gross margins of simple distillation units facing European prices were to be equalized between the grades. By the first week of October the differential would have had to be over $9 per tonne, (about $1.25 per barrel), to achieve the same result.

Changes in prices for grades of crude oil are shown in Table 4 (all price differentials in this table are shown as dollars per barrel). One could have two theories about how crude oil differentials should have moved during the crisis. They could have responded to changes in product prices, in other words the market might lead to a tendency for the margins obtained from different crude oils to be equalized. If that were the case Brent should have increased its absolute differentials compared to the other international crude oils shown in Table 4. Brent is the lightest tradable crude oil shown in Table 4 (i.e. it has the highest API degrees of gravity), and as it will also incur the lowest additional transport costs for major world refining centres outside the Far East, barring Urals for the European market which is quoted c.i.f., the relative increase in its product value can not have been offset by increases in tanker rates.

The other view of the crude market runs as follows. The failure of arbitrage will lead to differentials between grades that are predominantly used in a particular refining centre overwhelmingly reflecting only the differences in demand and perceptions across centres. Prices for crude oils used in regions that are the most worried about security of supply, will then tend to outpace those for crude oil used in other regions. Further,

Table 4 : Crude Oil Markets from July to 12 October 1990

International Crude Oils

			$ Differential above Brent		
	% Change	Gravity	2 July	12 Oct	change
Iran Heavy	199.0	31.0	-4.00	-1.87	+2.13
Urals (USSR)	181.1	32.0	-2.59	-0.17	+2.42
Es Sider (Libya)	166.2	36.7	-1.55	0.53	+2.08
Forcados (Nigeria)	161.1	29.7	-1.12	0.88	+2.00
Forties (UK)	155.5	36.6	-1.00	0.33	+1.33
BBQ (Nigeria)	153.6	37.0	-0.53	1.22	+1.75
Dubai	151.3	31.1	-2.79	-4.83	-2.04
Oman	147.5	36.3	-2.33	-4.22	-1.89
Suez Blend (Egypt)	141.9	31.9	-1.24	-2.37	-1.13
Brent	138.1	38.0	.	.	.

US Domestic Crude Oils

			$ Differential above Brent		
	% Change	Gravity	2 July	12 Oct	change
Line 63	157.2	24.0	-3.56	-5.98	-2.42
ANS California	149.7	26.8	-2.85	-5.20	-2.35
ANS	144.1	26.8	-2.23	-4.45	-2.22
HLS	141.9	34.0	0.04	0.74	+0.70
LLS	138.8	38.0	0.29	0.81	+0.52
W. Texas Sour	138.6	33.0	-1.28	-2.98	-1.70
Wyoming Sweet	136.7	38.0	0.17	0.17	0.00
WTI Mid	136.1	44.0	0.14	0.01	-0.13
WTI	132.7	44.0	0.39	0.02	-0.37

Brent, Dubai, Oman, WTI and ANS shown are for the next month. Others are ;

			$ Differential above Brent		
	% Change	Gravity	2 July	12 Oct	change
Dated Brent	154.5	38.0	-0.90	0.42	+1.32
2nd Month Dubai	135.2	31.1	-2.38	-6.08	-3.70
2nd Month Brent	131.5	38.0	-0.38	-1.95	-1.57
2nd Month ANS	128.7	26.8	-1.53	-5.05	-3.52
2nd Month WTI	114.4	44.0	1.09	-1.58	-2.67
3rd Month Dubai	120.5	31.1	-2.00	-7.33	-5.33
3rd Month Brent	116.6	38.0	-0.07	-3.70	-3.63

when prices show considerable volatility, even intra-day volatility, considerations of crude oil quality become irrelevant. If supplies are available they will find a market. While, say, a lighter crude oil may appear better value at a particular moment, it could still be rational to buy a heavier crude if it is immediately available. Any difference in the gross margins achievable may be a minor concern compared with the possibility of paying a higher price when supplies of the lighter crude oil become available. Further, given the time lag between purchase and the realization of the product value of the crude oil after refining, the considerable degree of price risk in product markets increases the differentials necessary to trigger quality considerations at the point of purchase of crude oil. The premium then becomes one for holding crude oil virtually of any type, and if necessary hoping to arrange a swap at a later date for a grade closer to that which was originally required.

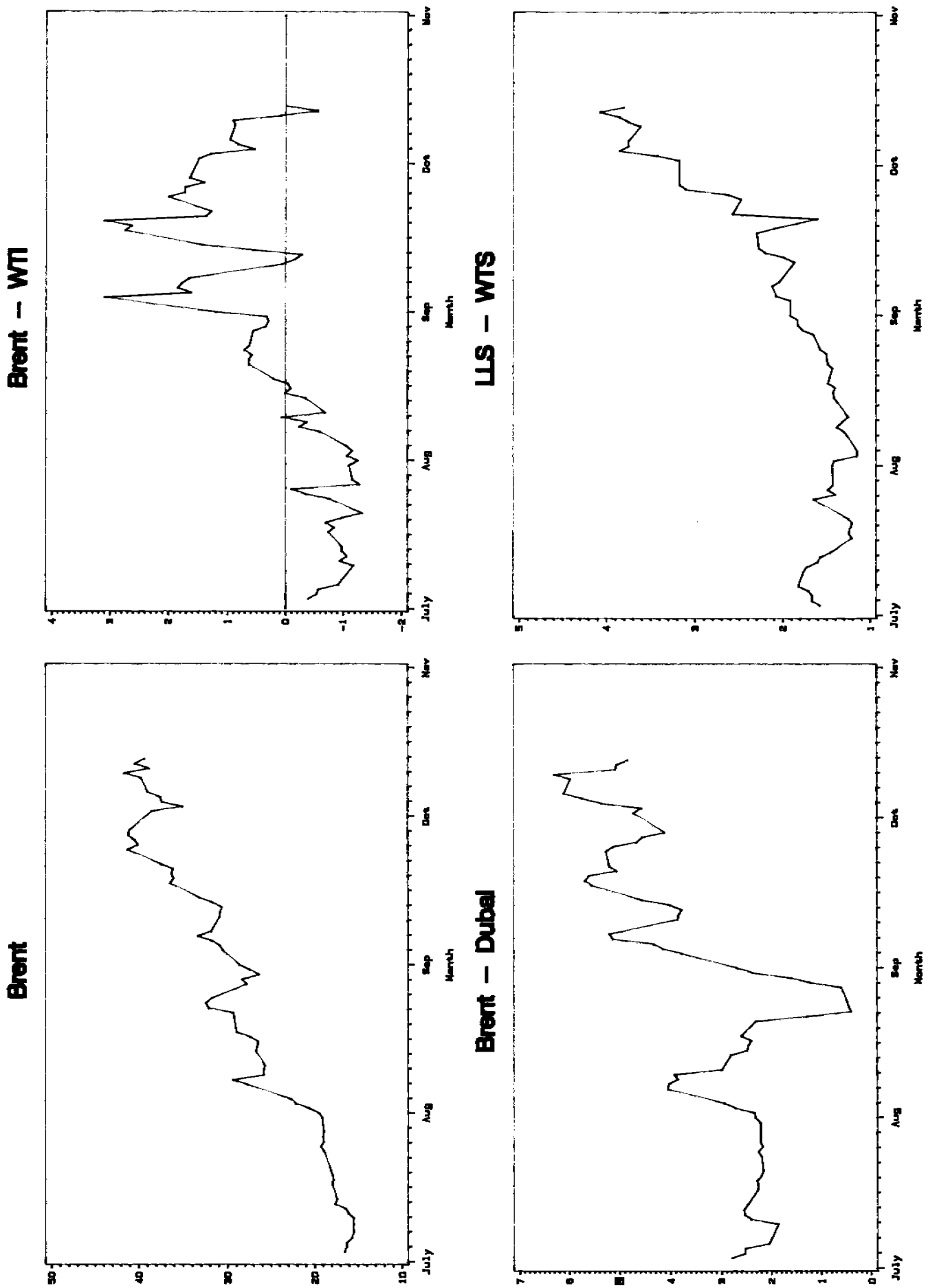
If this second view were correct, then not only should differences between the marker crudes for different areas, in particular Brent, Dubai and WTI, reflect differences in perceptions across those areas, but also absolute differentials within areas should move closer to zero, since quality concerns have been foregone. Table 4 suggests that it is this view that best explains the behaviour of the crude oil market, rather than the equalization of product values minus crude oil and transport costs.

Consider first differentials between the key marker crude oils. Table 4 presents crude oil price differentials from Brent at the start of July and during October. From this it can be seen that while the price of Dubai (which tends to be followed by Oman and Suez Blend prices), has increased faster than Brent in percentage terms, the absolute differential has widened. Meanwhile WTI has lost its usual size of premium to Brent and the rest of the US domestic market has been pulled down with it, although as we explain below WTI has proved to be a most inappropriate marker for the US market. This snapshot does not however paint the full picture of the dynamics of these two key differentials.

Figure 3 shows the price of Brent and its differentials over the prices of Dubai and WTI. Dubai is the key crude oil for the Japanese market, and thus if differential prices do reflect varying demand and perceptions, the Brent-Dubai differential should reflect differences in the behaviour of European and Japanese oil market participants. Japan was the country most immediately affected by the first round effects of the embargo. After a brief period of assessing the situation, during which the Brent-Dubai differential cleared $4 per barrel, the Japanese were in pole position to begin the game of musical chairs in obtaining replacement supplies explained in the introduction of this paper.

In the first three weeks of August there was heavy Japanese demand for crude oil as they sought to achieve replacement supplies and forge new contracts. Japanese crude oil imports in August increased by 16 per cent compared to July, despite the direct effects of the embargo. Imports from Abu Dhabi were just over 950,000 b/d, an increase of more than 50 per cent. As a result of this, the differential of Dubai from Brent narrowed at one stage to as little as 20 cents. By late August Japanese crude supplies were assured until the end of the year. While not necessarily having the correct crude mix, in particular a surfeit of heavy and sour grades which they have attempted to swap,

Figure 3


Brent
Brent – WTI
Brent – Dubai
LLS – WTS
July
Aug
Sep
Oct
Nov
Month

after August the Japanese have shown considerable restraint in the crude market. The perception of crude oil security in Japan then moved from the extreme worry caused by the original cessation of supplies, to a relatively calm attitude. They have attempted no stockbuilding of crude oil, and while Japanese supply security fears are now confined to oil products, not crude oil, European markets remain concerned over both. Thus the Dubai market has lost most of its liquidity, and the differential from Brent has widened from 20 cents to over $6.

Hence, after August, Dubai together with Oman and Suez Blend have slipped back against Brent. However the other internationally tradable crude oils shown in Table 5 have closed their differentials from Brent, indeed over the course of the crisis they have all, except Iran Heavy, traded at a premium to Brent at various points in time. Their behaviour is not consistent with product value changes, which implies an increasing differential with Brent. It is however consistent with price differentials tending to zero in a given market if quality considerations are abandoned. Whereas in normal times a movement in a price differential of 10 cents either way will be a matter of important consideration, if you are paying more than $20 extra compared to July, and perhaps $3 more or less than the previous day, considerations of differentials between grades become minor compared to considerations of the general level and its volatility.

The performance of WTI relative to Brent demonstrates both the differences in supply security perceptions between the USA and Europe, and also the distortions caused by the logistics of crude oil supply in the USA. Brent normally trades about one to two dollars below WTI, a much lighter crude oil. The 39 cents WTI premium at the start of July, as shown in Table 5, was in itself an oddity. A more normal level of WTI premium over Brent of more than a dollar was re-established in mid-July and held at the time of the Iraqi invasion. However, since then Brent has been on a rising trend relative to WTI, at one point trading on a premium of over $3. We have made the comparison on the basis of the next forward month traded, not contracts with equivalent timing. When a need to obtain supplies as quickly as possible is felt participants enter the nearest available month. Hence the comparison of second traded month Brent with first traded month WTI, if those contracts happen to be equivalent at a given time of the month, would totally miss the immediate price pressures. A demand surge for WTI transmits to first month WTI, a demand surge for Brent also hits the first month forward market, (and also the much less liquid Dated Brent market if any cargoes are available), it is felt far less in the second month forward market.

Even when WTI has managed to reassert at least parity, as happened in early September, the next round of changes has pushed Brent further ahead. Hence WTI has become decoupled from the world market, and the usual trade patterns stalled as evidenced by a considerable fall in US crude oil imports. As is detailed in the next paper in this series, this has resulted in a large supply gap which has had to be met by stock withdrawls and will later need to be met by refinery run cuts. While Brent can profitably cross the Atlantic at a dollar discount to WTI, it can not, in terms of opportunity cost, do so when at a premium. Differentials based on comparable trading months also show that Brent has been on a rising trend compared to WTI, and even on the comparable month basis Brent has obtained premia over WTI. However, given the very different structures of the Brent and WTI market both logistically and in terms in

contract timing, the comparison of temporally equivalent months, while being the most usual comparison, is inferior to that of next traded month, (even when contracts overlap), when the object of comparison is relative demand pressures. The opportunity cost to holders of Brent or Brent linked crude oils that potential American purchasers have to bid against is represented by first month forward Brent whether that or not that represents the same month as first month forward WTI.

It is only within the last two to three years that Brent has completely supplanted WTI as the key marker crude for world spot markets. It always seemed rather peculiar to base the entire world market on a totally non-tradable isolated US mid-continent crude oil with production of about 1 mb/d. However, during the Gulf crisis WTI has begun to look an inappropriate reference point even for domestic crude oil pricing in the USA. The reasons for this are essentially logistical.

The major basing point for WTI is at Cushing Oklahoma, the same point being used for futures market quotations of WTI as discussed in the next section. From Cushing WTI can flow North to mid-Western and Great Lakes refineries. It can not flow south to US Gulf Coast refineries following pipeline reversals over the last two years. The US Gulf Coast receives WTI through a pipeline connection at Midland Texas, from where pipelines also go north to Cushing. While Great Lakes and Gulf Coast demand patterns move in tandem this configuration need not produce distortions. However when demand moves differentially between the two areas, WTI quotes at Cushing are to a great extent insulated from developments in the main US refining region. Hence they are also insulated from product demand changes not only in the South, but also on the East Coast which receives most of its product supplies from the US Gulf Coast refineries through the Colonial and Plantation pipeline systems. Indeed the entire pipeline system in the US Gulf Coast has become so inflexible that imported crude oil essentially carries a convenience premium. It can be rational for some Southern refiners to buy imports rather than domestic production, even when domestic production is at a discount.

Over the course of the crisis US Gulf Coast demand has increased relative to the Great Lakes area for two main reasons. First, perceptions of supply security differ, with the US Gulf Coast having less crude oil stocks in terms of refinery throughput. Secondly, the direct effects of the import curtailment from Iraq (US imports of Iraqi crude oil in July 1990 were 1.12 mb/d, only 0.12 mb/d away from making Iraq the largest exporter of crude oil to the USA in the month), together with any diversion of supplies from elsewhere due to higher prices in other centres, have been felt and observed far more on the Gulf Coast. This has led to WTI at Midland gaining a premium over WTI at Cushing, at its peak of nearly a full dollar per barrel.

Apart from the problems caused by WTI distortions, the major feature of the US domestic crude oil market has been the growing difference between sweet and sour crude oil prices. WTI has in absolute terms gained relative to all the sour grades, but fallen back against sweeter grades. The key US sweet grade when the WTI market becomes disconnected from US Gulf Coast demand, is Light Louisiana Sweet (LLS). It is the most direct competitor with Brent type crude oil imports, and as such its price normally should reflect the availability of waterborne sweet crudes on the US Gulf Coast. The key sour grades are West Texas Sour (WTS), and waterborne Alaska North Slope (ANS).

With the problem of getting substantial quantities of WTI to Gulf refineries, any tightness of light sweet imports should push LLS prices upwards. Further, with the bulk of the incremental production entering the USA being Venezuelan and Saudi Arabian heavy crude oils competing with ANS and WTS, their prices should be pushed further down relative to LLS. This is a trend that should be reinforced by the extreme tightness of desulphurization unit capacity. In fact this is precisely what has happened, as the pattern of the LLS-WTS differential shown in Figure 3 demonstrates.

Hence, while patterns in European markets are consistent with a general scramble for supplies, US markets are calmer, and, especially in the Gulf Coast area, responding to sweet/sour differentials. There is then some effect from arbitrage, but in an indirect manner. It can not legally be achieved by exports of US crude oil, but the slow-down in transatlantic trade into the USA does at least transmit to LLS. While mid-Continent customers maintain their relatively more secure perception of supply security, the only effect on WTI prices is through diversions south of WTI at Midland of supplies that might have continued to Cushing. This is a very indirect and relatively inefficient method of linking WTI and Brent in the case where Brent carries a premium. While WTI remains the main US marker crude oil, such distortions are likely to reoccur. In the past distortions were due to high WTI premiums which could not be quickly arbitraged because pipeline connections made it difficult for imported crude oil to reach Cushing. In correcting this, the reverse problem has been caused - WTI has a problem reaching the US Gulf Coast. While current conditions prevail there may scope for a greater role for a grade such as LLS in US domestic price formulation, especially as the current problem is not any overpricing in the Brent market, but rather a relative underpricing of WTI.

7. Futures Markets

As futures markets for crude oil and petroleum products developed over the last decade, their potential behaviour under crisis conditions was often put forward as a cause for concern. It was thought that futures markets might completely destabilize the system, leading the physical markets upwards in something equating to a dance of death. These worries, at least in some political circles, have persisted over the course of the Gulf crisis. However, to date futures markets have been mere bit players in the unravelling of events.

At the meeting of the International Energy Agency on 28 September, the USA was urged by some European governments to suspend dealings in oil futures on the New York Mercantile Exchange (NYMEX). The reaction from the US government seemed to be one of surprise, at least judging from the words of Deputy Energy Secretary Henson Moore. "I don't know if we even have the power to do that, the Department of Energy certainly doesn't". In fact President Bush can order the Commodity Futures Trading Commission to close NYMEX, although from Moore's remarks it appears as if this has received little consideration to date.

If speculation were to be the main dynamic forcing prices higher, futures market prices would be expected to lead the physical markets. Speculation on the physical markets is a much more involved procedure, speculators would need to incur carrying charges. A pure speculator would be drawn to NYMEX or its London and Singaporean equivalents, the International Petroleum Exchange (IPE), and the Singapore Mercantile Exchange (SIMEX). A futures market based on Rotterdam (ROEFEX), announced in September that it would cease trading, not in any way due to the crisis but as a result of the lack of liquidity in the market which had plagued it from its inception. Other markets have not suffered from liquidity problems, indeed new volume records have been set.

The NYMEX crude contract is based on WTI with provisions being made for physical delivery. Delivery may either take place in WTI at Cushing Oklahoma through the standard contract terms, or Alternative Delivery Procedures (ADPs), in which NYMEX itself matches up buyers and sellers. Physical transference can also be achieved by the use of Exchange for Physicals (EFPs), in any crude deliverable at any location. Hence EFPs are not necessarily costless as they will reflect differences in the crude oil actually delivered and the location of delivery as compared to the defaults. For NYMEX crude contracts that result in a physical transference of crude oil, EFPs are by far the dominant delivery method. In 1989, 7.1 million physical barrels changed hands as standard deliveries, 8.2 million barrels through ADPs, and 663.7 million barrels through EFPs. While total deliveries only represent a very small proportion of the total paper contract trading volume, which equated to 20.7 billion barrels in 1989 alone, they still represent a volume on a yearly basis equal to more than forty days of US crude oil demand. Thus, while most NYMEX trading floor activity is in paper barrels, there is still a link with physical oil which will tend to bond the movement of NYMEX prices with those of physical WTI.

The IPE is by contrast purely a cash market, which, while being a Brent contract, contains no links with physical Brent embedded in contracts that would parallel those in NYMEX WTI contracts. Therefore while NYMEX can act, not only as a hedging tool, but also as a source of supply, the IPE can perform no such role. Contracts are settled solely by cash. Nevertheless as the IPE is used as a hedging tool by traders of physical Brent, EFPs do exist in the Brent market essentially to match up those who are long in physical Brent with those who are short in paper Brent. As such they should in normal times be costless as there is no difference between the IPE specifications for its Brent contract and the characteristics of physical Brent.

As the Gulf crisis has progressed these differences between NYMEX and IPE contracts have resulted in completely different behaviour patterns. In short, even though as noted above WTI has become decoupled at prices below those of international crudes, the NYMEX contract has followed the behaviour of WTI. However the IPE paper Brent market has become completely removed from the physical Brent market. The most obvious manifestation of this is that EFPs have begun to carry a cost, thus reducing its potency as a hedging tool. It has also created an unexpected trading possibility. Playing the spreads between the IPE and the fifteen day Brent market would have been considered a rather futile occupation in July. It now constitutes a valid trading game, but not one that it would be wise for major companies to be observed playing.

IPE officials have described the current state of affairs as a short-term aberration, and expressed the belief that convergence will soon be re-established. However the case of the IPE demonstrates that the role of futures markets in a crisis may have been misjudged, a purely paper based market can in fact become increasingly irrelevant in the setting of physical prices, not a motive force behind any upwards spiral in physical crude oil prices. Developments have undermined some of the credibility of the IPE as well as seriously disrupting its expansion. The proposed unleaded gasoline and naphtha IPE contracts will clearly have to be postponed indefinitely while crisis conditions prevail.

The behaviour of NYMEX and IPE crude oil contracts over the course of the crisis is shown in Figures 4 and 5 (both sets of figures drawn on the same scale). In Figure 4 it can be seen that the most obvious impact of the crisis has been to send futures markets into a state of backwardation (prices for more distant months trading at a discount to the more immediate months), compared to the contango which had prevailed for much of 1990. The IPE, based on the difference between first and third month contracts, went into backwardation on 1 August, NYMEX on 2 August. Since then the move into backwardation has been deeper and more committed on the IPE, reflecting the differing perceptions between the USA and Europe about crude security that have been behind some of the movements in differentials between physical crude oils. Indeed NYMEX even achieved a brief period of contango during August. However it is not clear quite what the degree of backwardation or any transitory contango actually imply about expectations under crisis conditions, other than a concentration of trading in the next month's contract. For later contracts there are limits on daily movements. Since late August these limits have been hit roughly one day out of each three days trading. Later month NYMEX trading is therefore even riskier.

Figure 4

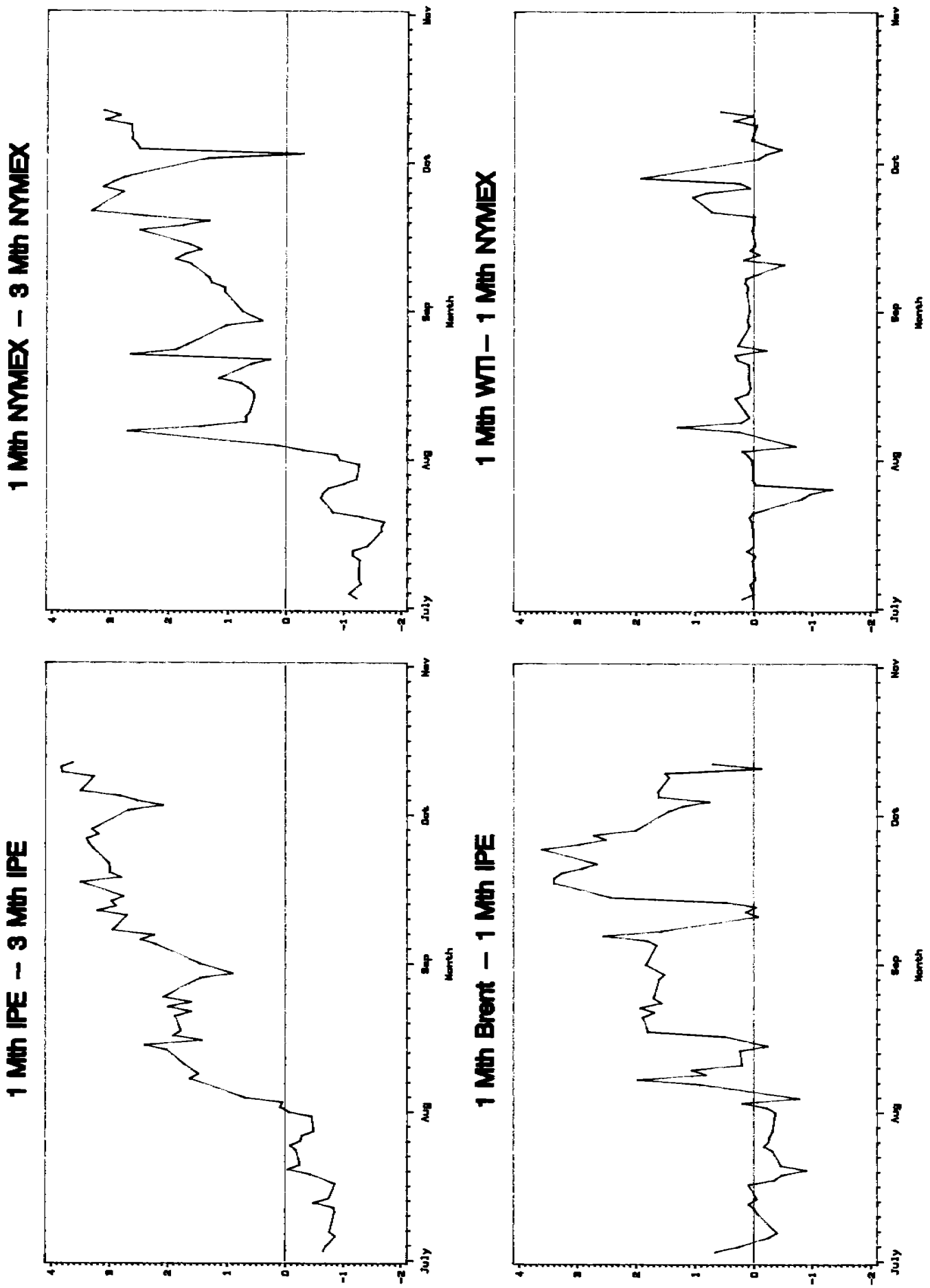
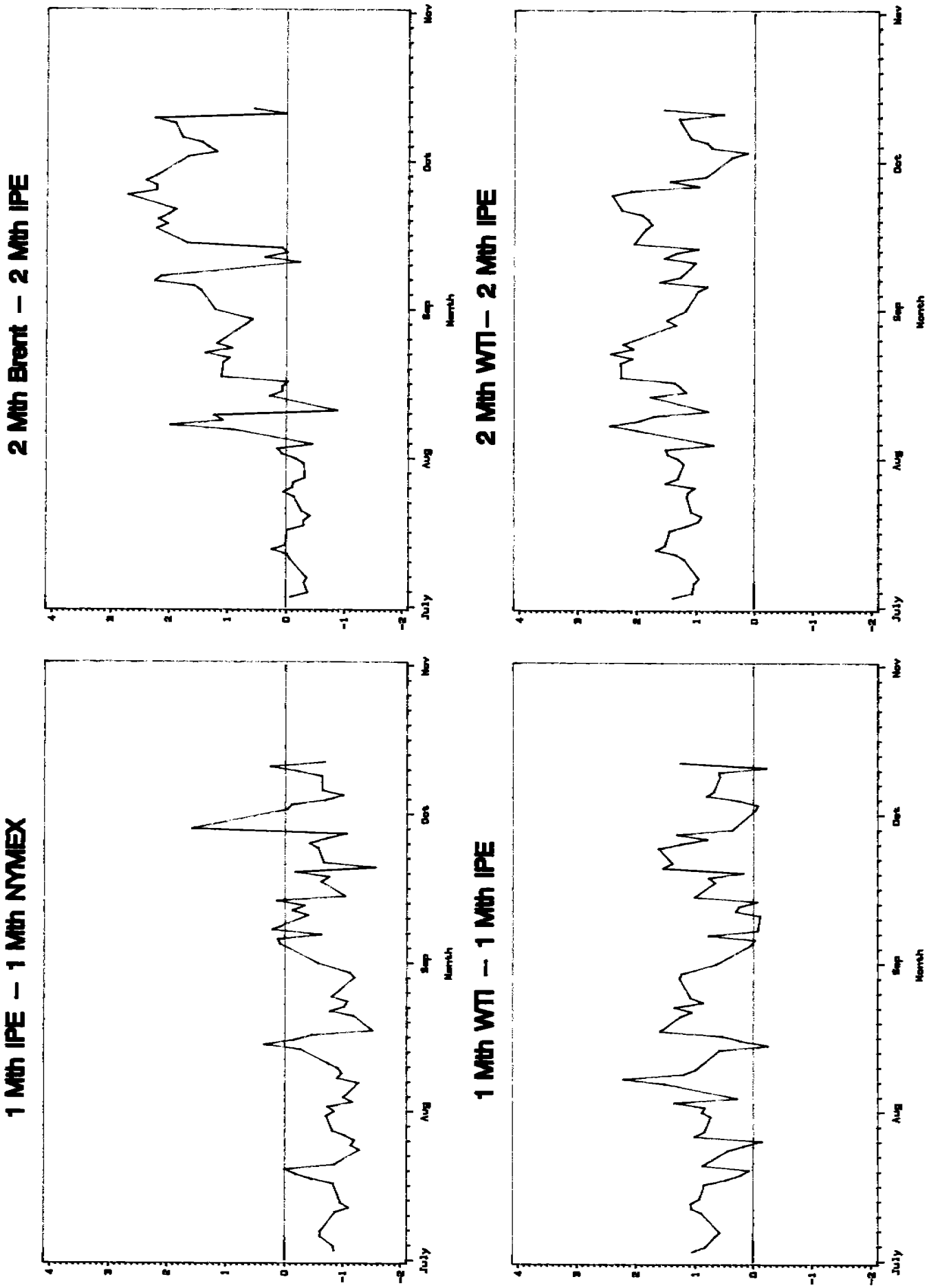

1 Mth NYMEX – 3 Mth NYMEX
1 Mth WTI – 1 Mth NYMEX
1 Mth IPE – 3 Mth IPE
1 Mth Brent – 1 Mth IPE
4
3
2
1
0
-1
-2
July
Aug
Sep
Month
Oct
Nov

Figure 5


2 Mth Brent – 2 Mth IPE
2 Mth WTI – 2 Mth IPE
1 Mth IPE – 1 Mth NYMEX
1 Mth WTI – 1 Mth IPE
4
3
2
1
0
-1
-2
July
Aug
Sep
Oct
Nov
Month

However, the major difference between NYMEX and IPE prices has been, as is shown in Figure 4, their very different behaviour compared to their respective marker crude oils. NYMEX, because of the contractual physical links explained above, has only moved away from the price of physical WTI for brief periods, and this has normally only been due to the later closing time in the WTI forward market compared to NYMEX. The largest swings on the WTI forward market after NYMEX closing have to date been 70 cents up and 50 cents down. However, IPE Brent has been disconnected from first month physical Brent for extended periods, sometimes trading more than $3 per barrel below physical Brent. The figure demonstrates that the pressure has been primarily in the forward market which, due to differing contract terminations, for much of a month does not even have an IPE futures counterpart. If the major price pressures occur on markets without any futures market equivalent the reason for the pressure cannot be speculation in future markets but rather the pressure on immediate supplies in physical markets. It is the differential between the most immediate forward and future contract which best illustrates this pressure, not comparably timed contracts. Markets participants in the physical market who wish to secure supplies rush into the first month and dated Brent markets, not the nearest Brent contract with an IPE equivalent. However, it should be noted that the closest month IPE Brent crude contract has traded as much as $1 below the comparable forward price, and, as noted above, EFPs have often carried a cost.

Hedging immediate supplies during a crisis on such terms becomes a very hazardous enterprise when an exactly equivalent futures market contract does not exist. For anyone attempting to do so, the IPE Brent contract has shown a much closer relationship to NYMEX prices and hence to WTI, than it has to physical Brent. As shown in Figure 5 while physical Brent has moved to trade at a premium to WTI, IPE prices have rarely exceeded NYMEX prices. Indeed much of the fluctuation in the difference between the IPE and the NYMEX first month crude oil price is due to the different closing times in the two exchanges. The difference between first month physical WTI and the IPE price has shown more constancy than difference between physical Brent prices and the IPE shown in Figure 4. This pattern is confirmed by the second month price differentials shown in Figure 5. Thus an IPE+X price formula would have actually represented a better hedge for WTI than the IPE price acted as a hedge for immediate physical Brent. For those hedging further ahead there are of course fewer problems. It would perhaps be in the IPE's interests to consider a closer alignment of the timing of the trading of their contracts with those in the forward markets.

There appears therefore to be no evidence that futures markets have either led or destabilized the level of international crude oil prices. It is far too simplistic to believe that price increases are due to speculative behaviour with scant regard to the fundamentals of supply and demand. To date, the major danger would appear to be any effort to corner the market that might be attempted, not any inherently destabilizing properties of futures markets. NYMEX is tied to the crude oil which, as was shown in Section 5, has in percentage terms risen less than any other major world crude oil. Unless the market is later seen to be prone to manipulation, cessation of NYMEX activities would merely destabilize and confuse the US domestic crude oil market. It would certainly not dampen price increases, because, as yet NYMEX is not leading those price increases.

8. Conclusions

We have seen that traditional relationships between and within oil markets have broken down spectacularly. Particularly in the market for oil products, the cement which bound markets together has been destroyed. The result of the failure of arbitrage is that there is no longer any integrated world market for oil products, nor is there likely to be while the crisis prevails. Every single relationship within the system has been put under stress, and many have collapsed entirely. The self-correcting mechanisms of normal times have all either become very weak or have completely disappeared.

The result is a set of markets behaving inefficiently, creating large distortions. It creates a political minefield for market participants. Policies that could be justified on the basis of how markets work under normal circumstances, suddenly begin to develop yawning holes. Markets simply do not behave in the same way in a crisis, and it is unwise to base any strategy on textbook trading programmes, or any policies on textbook recapitulations of the workings of efficient markets. Neither hold much water in current circumstances. It is pure myth to believe that there are no problems associated with the operation of markets under these conditions.

This state of affairs will continue as long as events remain unpredictable and fast moving. The immediate resolution of the Kuwait crisis may not in itself be enough. The creation of longer-term instabilities in the Middle East could just as well trouble markets for as long a period as did the events starting in 1978.

We have not contended in this paper that the general level of prices is too high given the rationale behind the behaviour of market participants, nor that prices have been primarily driven by speculation in the political and journalistic sense. The political debate seems to have forgotten that while some speculators may indeed gamble on higher prices, others will do the reverse. In the final analysis pure speculation is after all a zero-sum game. Markets can be driven down by speculation as easily as they can be driven up. It is too simplistic to view all recent price increases as pure speculation, and all periods during the crisis when prices have temporarily fallen back as being the partial reassertion of supply and demand fundamentals. When the premium is on holding physical supplies the reasoning could just as well be the other way round. After all there is no guarantee that the effects of a free market are necessarily always pleasant for those reliant on the market, nor any presumption that in times of uncertainty free markets cannot produce large-scale market failures when they become disconnected from one another.