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Functioning of the international oil markets and security implications

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Introduction

Energy security is primarily a function of investment. If investment in new capacity, logistics and transmission, and emergency preparedness is timely and adequate, energy security will be guaranteed.

Investment in a market economy is a function of the expected revenue stream, which in turn is a function of prices. Reliable and predictable price signals are a prerequisite of adequate investment. If prices are very volatile and/or unpredictable, enterprises will not be confident enough to invest. Energy security will be imperilled.

A well-functioning market is therefore a key component of security. Ideally the market should generate stable and predictable prices, i.e. prices that can be modelled on the basis of structural factors within a sufficiently narrow band to allow enterprises to have a reasonably good vision of the revenue stream that their investment might generate.

The main obstacle to oil and gas security of supply is the growing volatility of prices and their fundamental unpredictability. This leaves enterprises exposed to very high risk, and will discourage some of them. In these circumstances, it is to be expected that enterprises will tend to be conservative, and underinvest.

Security itself is also dependent on prices. Customers feel secure if they can buy all the energy they need at prices that they can afford. A purely physical concept of security (meaning availability of the quantities of energy that are in demand at any moment in time) has little meaning, because demand varies with price. There always is a price at which demand will exactly equal supply – it may be a very high price, however, at which some final customers may not be able to satisfy their “essential needs”. Oil, specifically, has a global market and any supply interruption that one can think of is quickly translated into higher prices, this being the key mechanism for rationing demand and redistributing supplies among different bidders. In the end, oil is almost never physically unavailable.

But even "essential needs" are a function of prices, in the sense that in the long run customers will adjust their consumption habits to the expected cost of energy and their disposable income. In the short term, such adjustments may be difficult, and what creates insecurity is the experience of price volatility, the fact of being surprised by sudden jumps in prices – especially of course sudden price increases – which were not and could not be expected.

Hence energy security is as much a matter of perception as of objective availability. Consumers make decisions on the basis of the historically prevailing level of prices: energy may be expensive or cheap – in the sense of absorbing a large or small share of their consumption basket – their lifestyles will adjust accordingly. Lifestyles and per capita energy consumption in Europe and Japan are quite different from those prevailing in North America, because for decades energy has been relatively expensive in the former, and considerably cheaper in the latter. Nevertheless, consumers in Europe and Japan are not insecure because they had to devote a larger share of their income to energy than their North American counterparts – their level of consumption has adjusted to the price environment.

Well functioning oil and gas markets therefore are not only a prerequisite of energy security through their influence on investment and future availability; they are a component of security, because volatile and unpredictable prices are part of the definition of insecurity.

This deliverable looks at the evolution of prevailing international oil price regimes over the past decades and at past attempts at stabilising prices, and reasons why they failed. This historical background in necessary to better understand the causes of today's growing volatility and potential remedies to the same. The current reference pricing regime will then be introduced, and the debate on the causes of increasing volatility and whether the market responds to fundamentals or is dominated by speculators will be summarised. This debate is very much underway.

Next, we shall discuss structural causes of volatility in the oil and gas markets. It is normally accepted that, even if the current market is reformed, and its functioning improved, volatility can be contained but not eliminated. What institutional

arrangements can we envisage which will create enough long-term convergence in prices whereby investment will be sufficient to meeting future demand?

In a concluding section, we shall discuss how this relates to other aspects of out analysis of oil security, notably the geopolitical aspects and policies for strategic storage and cooperation with the exporting countries.

A short history of oil price regimes

Chart 1 is a very well known and widely quoted representation of oil prices in nominal and real terms since the inception of the oil industry. The chart shows that oil prices were extremely volatile in the early days of the industry, because output increased suddenly whenever there was a new discovery, then declined rapidly as fields were uncontrolled due to the law of capture in the US and poor technological understanding of petroleum geology.

The industry experienced one long stretch of stable oil prices, from the early 1920s to the early 1970s: a 50-year period of progressive expansion with slowly declining prices, which was made possible by very large discoveries in the Middle East coupled with oligopolistic control on supplies by the famous seven (or eight) sisters, the major international oil companies of the time. This control - albeit slowly yet systematically eroded by “oil independents” and other newcomers - succeeded in guaranteeing the “orderly” development of capacity, in line with the rapid growth of demand. Oil supply security was guaranteed by the seven sisters, although not necessarily at the lowest possible price to the final consumer, nor with the fairest possible distribution of financial benefits between the various parties involved.

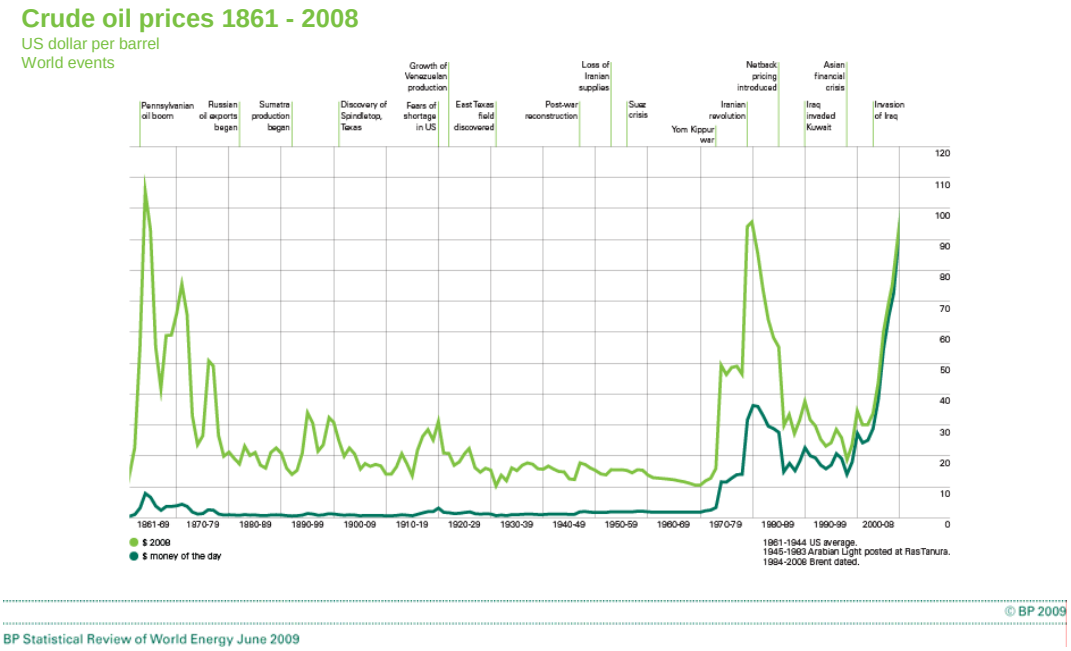
The seven sisters lost control of the oil market between 1969 and 1973. In 1969, Muammar Qaddafi seized power in Libya in a bloodless coup, overturning the Sanusi monarchy. Very soon, he nationalised some of the companies operating in the country and asked significant concessions from the others. The nationalized companies called for a boycott of Libyan oil, as they had resorted successfully to a boycott of Iranian oil in 1950-53. But the boycott failed: Iran joined Libya in challenging the companies, and the so-called Tehran-Tripoli agreements were arrived at. But the latter were not destined to last for long: it had been proved that companies could not resist the demands of major

oil exporters, and the balance of power in the industry shifted from the major international oil companies to the major exporting countries.

The companies had unilaterally "posted" a price for the crude they were producing. The role of the posted price was primarily to calculate taxes due to the host governments, avoiding the controversies that would have arisen had "market prices" being used instead. There was, in fact, no transparent and easily observed international oil market at the time.

In 1973, the power of fixing posted prices shifted from the companies to the exporting countries. This opened the door to a period of intense instability in prices, which went from 1973 to 1985. Prices grew rapidly until 1980 and collapsed thereafter.

Chart of crude oil process since 1981



Prices increased in the first subperiod because of political events: the Yom Kippur war of 1973, the Iranian Revolution of 1978-79, the beginning of the Iraq-Iran war in 1980. Prices were pushed to historical highs and OPEC just simply sanctioned the level that was generated by short-term panic buying and supply disruptions. Notwithstanding the

opposition of some of its members, notably Saudi Arabia, a longer-term vision of OPEC's interests did not prevail: no consideration was given to the danger of demand destruction and growing non-OPEC supplies – although it was rather clear at that time that significant volumes of oil would be made available to the market from new producing provinces, notably the North Sea, Alaska and the Mexico.

OPEC attempted to defend its posted price by cutting back on production and enforcing quotas on its members. Non-compliance eroded OPEC's solidarity, already badly challenged by multiple conflicts between its Middle Eastern members.

In 1985, Saudi Arabia abandoned the posted price system and resorted to netback pricing. The netback price regime was short lived, lasting only about two years. It led to a collapse in crude oil prices, partly because OPEC quota discipline broke down and production increased, partly because netback pricing tends to guarantee refiners' margin and encourages refineries to run at full capacity, flooding the market with products, and eventually drawing down the netback value of the barrel.

Hence was inaugurated the era of reference pricing, which is the prevailing regime to this date. Reference pricing means that the price of a crude oil which is not freely traded is indexed to the price of a crude oil which is freely traded, plus or minus an adjustment factor which is periodically reviewed by the producing country depending on market conditions. In this system, the producing country can manipulate the adjustment factor, but by far the major influence on the price of any non-traded crude comes from variations in the price of the benchmark crude, to which it is tied.

Two markets have emerged as benchmark for all other crude oils - that is Brent in the UK and WTI in the US. This regime has proven more resilient in the face of political disturbances, but volatility has monotonously increased, and has exploded since 2007. The reason for increased volatility has been the progressive shift from referencing physical oil prices to referencing futures.

"Initially, writes Robert Mabro, the marker prices were spot WTI, dated Brent, or spot ANS. The logic is that a marker price must be generated in a physical market where the transactions are sales and purchases of barrels of oil. Thus 'market-related' meant a

relationship to prices arising at the *margin* of the physical market. This conforms to a fundamental economics principle that prices are determined at the margin."[1]

However, physical oil transactions became increasingly unreliable because of dwindling physical volumes and the ease with which the market could be influenced. As futures trading developed, originally as an appendix of the physical market intended to provide liquidity, but subsequently to attract trading many times in excess of that of the physical market, the balance of price discovery has shifted from physical oil to futures.

We are now in the midst of a major controversy concerning whether "speculation" is "excessive" or "investors" are simply providers of badly needed liquidity and better equipped to judge collectively of longer term trends. Do nowadays oil prices respond to fundamentals or to speculation?

According to some, prices respond to fundamentals and indeed "investors" or "speculators" are better judges of long term trends than "commercial" traders, i.e. the oil companies. Throughout the 1990s and well into the early years of this century, major international oil companies maintained that the price of oil at $18 per barrel (on average in the 1990s) was too high and would prove untenable. This opinion, it should be added, shaped the major companies' investment policies, leading to very conservative investment decisions, and a preference for mergers and acquisitions over greenfield development of new projects.

Against this view, a current of opinion insisted that oil is finite, and production will inevitably peak. Various versions of the peak oil theory have been proposed at different times, and heated controversy has characterized this debate.

The futures market signalled a tendency to an increase already in 2002 and early 2003. Prices had increase already in 2000, but this spike had been deemed untenable by a majority of experts. And in early 2003 the expectation was that prices would again fall, following the US and allies' intervention for regime change in Iraq, which would lead to an increase in Iraqi production and exercise pressure on OPEC.

[1] Robert Mabro "The International Oil Price Regime - Origins, Rationale and Assessment" The Journal of Energy Literature, Volume XI, No1, June 2005, pp3-20

Instead, 2004 saw an unexpected increase in demand and further price increases. The futures market signalled a tendency towards higher prices through a persistent contango, which at the time was deemed unjustified. The market was signalling its fundamental belief that oil would become relatively scarce, due to demand increasing faster than supplies. This is not the same as necessarily expecting a peak: all that is required is an expectation that supply will grow more slowly than demand. Today, most experts would agree that the market was right, and preachers of low oil prices had been wrong.

However, in 2007 and even more so in 2008 the market was shaken by such violent swings that it is impossible to find a rational justification in fundamentals' shifts. There was no dramatic demand increase or supply restriction to justify the doubling of prices between the beginning of 2008 and July of the same year, followed by a dramatic collapse in the latter part of the year. Such swings can only be understood as part of the turbulence which hit financial markets, of which today's futures oil market is part and parcel. The price of oil is therefore highly exposed to financial markets vagaries and disequilibria, and has ceased to send a useful signal to corporate decision makers for the purpose of sanctioning long term investment.

From the point of view of security of supply, if all that a major disruption can cause is a major swing in oil prices; but the same kind of swing can happen also in the absence of a major physical disruption: then what is the point of worrying about disruptions?

Obviously, it is necessary to address the issue of price stability, and especially of convergence of prices towards a long term value which may be credibly used for investment decisions.

Structural causes of oil price instability

Oil prices, like the prices of most commodities, are unstable because of well understood structural causes.

Firstly, up front investment is the key cost component, while direct costs are relatively less important. This means that once the investment is made and the capacity created, it will be utilised even if prices fall well below the break-even point. It is only if prices fall below direct costs that the producer will consider shutting capacity, and even then it

may be costly (in terms of immediate costs or forfeited long term revenue) to shut in capacity.

Secondly, investment gestation times are very long. For a while, the industry boasted that it was able to go from discovery to early production in a much shorter time than in the past, but a few exceptional examples in the offshore of the Gulf of Guinea have since been overshadowed by numerous disaster stories – from the Gulf of Mexico to Sakhalin passing through Kashagan. Whether it is field development, pipeline construction, or refinery construction, this is an industry in which five to ten years easily pass from the moment the investment is sanctioned to the moment it becomes operational. For all practical purposes, this means that investment is made with little or no knowledge of the returns it will bring when it becomes operational. True, the futures market can mitigate this risk and offers contracts and derivatives several years into the future, but liquidity at such distant maturities is thin and the feasibility of massive hedging of investment is problematic. In line of fact, very few major projects are financed with risk mitigation from the futures market.

Thirdly, and most importantly, both demand and supply are rigid in the short term. Exhibit 2 reproduces a slide used by Christopher Allsopp and Bassam Fattouh in a presentation given to the Bank of England in June 2008[2]. It summarizes different measures of price elasticity of oil demand estimated by various authors at different times. Short-term price elasticity has consistently been found to be very low, in fact very close to zero. Long-term elasticity is more significant, being estimated in a range of .5-.6 for the OECD countries, much lower for the developing countries. Finally, authors that have repeated the estimation over time have found that price elasticity is declining – a consequence of the fact that oil has been largely substituted by other fuels in uses in which substitution was easy.

Exhibit 3 shows that the income elasticity of oil demand is higher than the price elasticity, meaning that oil demand can effectively be curbed only by reducing disposable income, i.e. through a recession. The very high income elasticity of demand

[2] Christopher Allsopp and Bassam Fattouh "Oil prices: fundamentals or speculation?" presentation at the Bank of England, June 13th 2008.

in the developing countries means demand for oil tends to grow more rapidly than GDP in those countries.

Finally Exhibit 3 indicates that price elasticity of non-Opec oil supply is also low – a reflection of the points mentioned above about investment being the main cost component and requiring long gestation. OPEC supply is of course considered a political variable, and it is expanded or contracted depending on the Organisation's price target and perception of market conditions – no structural elasticity can be measured.

Oil Demand Price Elasticity

- Oil demand price elasticity is close to zero in short run
- Price elasticity of demand is higher in long run due to substitution and energy conservation but elasticity still quite low
- Declining over time
  - Hughes, Knittel and Sperling (2008): US short-run price elasticity has declined
    - 0.21 to 0.34 over 1975-1980
    - 0.034 to 0.077 for 2001-2006

Studies	Short run	Long run	Sample
Dahl, 1993	−0.05 to −0.09	−0.13 to −0.26	Developing countries
Pesaran *et al.*, 1998	−0.03	0.0 to −0.48	Asian countries
Gately and Huntington, 2002	−0.05 −0.03	−0.64 −0.18 −0.12	OECD Non-OECD Fast growing non-OECD
Cooper, 2003	0.001 to −0.11	0.038 to −0.56	23 countries
Brook *et al.*, 2004		−0.6 −0.2 −0.2	OECD China Rest of World
Griffin and Schulman, 2005		−0.36	OECD
Krichene, 2006	−0.02 to −0.03	−0.03 to −0.08	Various countries

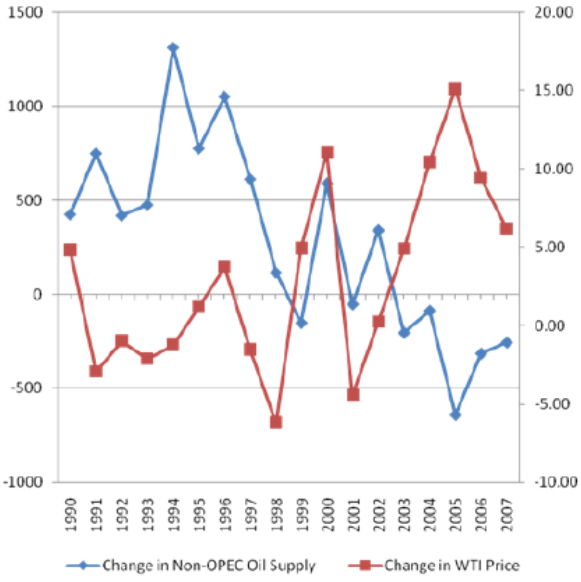
Oil Demand Income Elasticity

- Oil demand more responsive to income than prices
- Responsiveness of oil demand to income been declining over time in OECD
- Developing countries exhibit higher income elasticity than OECD
  - Do not expect income elasticity of oil demand to fall in developing countries very soon

Studies	Long run income elasticity	Sample
Ibrahim and Hurst, 1990	> 1.0	Developing countries
Dahl, 1993	0.79 to 1.40	Developing countries
Pesaran *et al.*, 1998	1.0 to 1.2	Asian countries
Gately and Huntington, 2002	0.56 0.53 0.95	OECD Non-OECD Fast growing non-OECD
Brook *et al.*, 2004	0.4 0.7 0.6	OECD China Rest of World
Krichene, 2006	0.54 to 0.90	Various countries

Supply Response

- Response of non-OPEC production to oil prices low
  - Producers do not increase production in face of a price rise
  - A reduction in oil prices does not induce producers to reduce production
  - Krichene (2006): long run price elasticity of 0.08
  - Gately (2004) reports a wide band of price elasticity varying from 0.15 to 0.58 by 2020
- Other factors affect investment and supply
  - Sanctions (Iran, Libya, Sudan)
  - Political instability (Iraq, Nigeria)
  - Access to reserves and hardening of contractual terms (Venezuela, Algeria, Russia)
  - Uncertainty and the option to wait
  - Rising costs
  - Shortage of human capital



The combination of rigid demand and rigid supply means that price signals generated by the market are not very effective in balancing demand and supply. Or, conversely, it means that even very small shifts in the balance between demand and supply will provoke large changes in prices. In essence, this market can truly be balanced only

through income and investment adjustments, which are slow and generally considered unwelcome. After all, the purpose of energy security is to maintain income and consumption levels, and concluding that demand and supply can only be balanced through declining income levels defeats the purpose.

Any discussion of the functioning of the international oil market in view of fostering security must therefore acknowledge that in the short term demand and supply are unlikely to be exactly in balance, and this will cause wide swings in prices. The challenge is to aim at achieving a better balance of demand and supply in the longer term, so that short term price swings may be understood as oscillations around a central value which is the long term equilibrium price.

The search for a long term equilibrium price is further complicated by our poor understanding of the dynamics of both demand and supply. Concerning supply, the most frequent procedure is attempting to estimate non-Opec supply and calculating the requirement for Opec supply as the difference between projected global demand and projected non-Opec supplies. However, estimates of non-Opec supplies turn out to be significantly off the mark even at very short horizons, such as one year or less. This is all the more surprising since at such short time horizons we know very well which fields are in production and how they behave, and precious few surprises would seem to be possible. Instead, estimates of non-Opec supplies are almost invariably off the mark, and for the past few years they have been systematically in excess of recorded production.

The lack of success in predicting demand is in a sense even more surprising – because here we deal with literally billions of decisions makers, whose aggregate behaviour should be statistically predictable. In contrast, demand forecasts for any one year are constantly adjusted and by significant margins as the year progresses, and in the end the distance from the original expectation to the recorded result can easily be of the order of 1 to 2 per cent. With .05 price elasticity of demand, this alone justifies a 20% swing in prices…

Thus at any point in time we really have very little confidence about future demand and supply, and such lack of confidence fundamentally contributes to the perception of insecurity about energy supply. Today, the International Energy Agency estimates that

investment is insufficient, and as soon as the global economy recovers the price of oil will again tend to increase rapidly. Fatih Birol has gone on record asserting that this will limit global growth unless investment is increased promptly. In turn, this expectation is influencing "investors" (or "speculators") and justifies the high prices in the back end of the futures curve, which in turn are believed to be the reason why even front end future prices are relatively high, notwithstanding the market is flush with oil. In this world, expectations become reality and have greater influence on prices than actual demand and supply. But corporate decision makers are not convinced that prices may stay high: they see that supply is abundant, and read that the recovery will be slow – so is this the right time to invest?

Structural changes in the supply of liquid fuels

In the search for a longer term equilibrium price for investment we may have our task facilitated by some important changes which are occurring in the international oil industry.

Conventional crude oil is no longer the sole source of liquid fuels. Non conventional sources will become increasingly important, and the common feature of non conventional sources is that they are primarily industrial processes in which output is much more easily predictable as a function of investment. The timing and production profile over time also are much more easily predictable.

Conventional oil is the realm of uncertainty. Exploration may or may not be successful, and a discovery may be a giant or a small field. Resources in place are never exactly known, and reserves estimates are constantly updated, generally towards an increase, but sometimes in the direction of a decrease. The time required for developing a field and the development cost per barrel of added capacity vary widely across the spectrum and are not always exactly predictable (Kashagan will serve as reminder for a long time). Finally, production from a field generally reaches a plateau rather quickly, but it is not easy to know for how long the plateau will last and how rapid might the decline be thereafter.

In contrast, most unconventional projects are relatively much more predictable. The availability of the resource is not in question, be it oil sands, Orinoco bitumen or oil

shale: in fact the available resource is so much greater than what is used, as to be practically infinite. The difficulty is in the cost of the investment, with relatively minor operational issues involved – even the technology is not very demanding. At the time the investment is sanctioned, the investor knows with considerable precision what output he will get from the project, and this output will be sustained for the life of the equipment. In this sense, non conventional oil projects are much closer to a factory than to a mining operation, although they are a combination of the two. The limiting factor is the transformation capacity, not the availability of the raw material.

This is all the more true for gas to liquids or coal to liquids projects, which are essentially petrochemical ventures.

The incremental capacity obtained through investment in non conventional oil projects is relatively small relative to the investment – and relative to global supply of crude oil. There is little danger that a sudden rush of non conventional projects will cause an unexpected increase in supply and a collapse in prices, which may undermine investment. Output increases from non conventional projects will be gradual and very predictable.

As for conventional oil, predictability may also increase because the frequency of very large discoveries has dwindled to almost zero, while the number of declining provinces is increasing. The probability of a sudden increase in capacity is therefore very low.

As declining fields become a growing share of total oil reserves, the importance of enhanced oil recovery (EOR) will increase. The effects of implementing EOR on declining fields cannot exactly be predicted, but the connection between investment and increased capacity is much tighter than with conventional methods. Also, as EOR methods are more widely adopted, the weight of direct costs over investment costs may increase (this depends on the specific EOR technology adopted) and investment and production may become more responsive to prices.

From the demand side, it is not clear whether the development of alternatives to the use of fossil liquid fuels may increase or decrease price elasticity. As mentioned earlier, the evidence appears to be that concentration of oil in those uses in which it is most difficult to substitute for has further decreased elasticity. However, the appearance of alternatives

in the transportation sector may generate greater responsiveness in demand, if the consumer has - directly or indirectly - the possibility of switching from one fuel or source of energy (or mode of transportation) to a different one.

Containing price volatility

In the light of extreme price fluctuations since 2007, the attention of politicians and experts has been drawn on the need to dampen short term fluctuations and achieve greater reliability of prices.

The pendulum has swung back from the extreme position that advocated exclusive reliance on unregulated markets as optimal, to a position advocating reining in of speculators and pursuit of a "fair for all" price.[3]

The experience of the oil price yo-yo of 2007-2009 has been sufficiently traumatic to lead to the emergence of a degree of political consensus on the need to dampen volatility and agree on a price that may be acceptable to all sides. Expressions of concern have been voiced not only by the major OPEC exporters, but also by leaders of the major industrialised countries, notably Prime Minister Brown, President Sarkozy[4] and President Obama. It has been said that a consensus may be emerging to the extent that a "fair" price might be in the region of 65-80$/b.

On the basis of this impression, the proposal has been put forward to establish an international committee that would decide on prices[5] or a price band[6], similarly to what happens with interest rates (at the national level, though). But how would such a consensus be implemented and enforced? How could producers and major consumers

[3] The Oxford Institute for Energy Studies held a conference on oil price volatility in October 2009 at St. Catherine's College. A summary of the discussion, which was held under Chatham House rules, was published in the Oxford Energy Forum #79 of November 2009.
[4] Gordon Brown and Nicholas Sarkozy "Oil Prices Need Government Supervision" Wall Street Journal, July 8th 2009.
[5] Robert Mabro has proposed the creation of an independent commission backed by significant research capability and an international convention that would be expected to set a reference price for oil once a month. ENI has proposed the creation of a global energy agency "which might possess the tools to implement concrete initiatives as needed to stabilise the price of oil" (my translation of Scaroni's original speech, available in Italian from http://www.eni.com/en_IT/attachments/media/speeches-interviews/italian-version-speech-scaroni-G8-energia-25-maggio-2009.pdf).
[6] In particular: Bassam Fattouh and Christopher Allsopp "The Price Band and Oil Price Dynamics", *Oxford Energy Comment* July 2009.

agree on sharing the burden of implementation (which presumably would require active market intervention)?

Finally, Giacomo Luciani has proposed that the major oil producing countries – notably Saudi Arabia – take a more active role in the price discovery process and engage in direct sales of their crude oil through auctions of forward contracts for physical delivery and acceptance of a secondary market.[7]

Relying on longer term pricing

Even if speculation is curbed and short-term volatility is successfully dampened, it would be advisable to rely on price signals from longer term maturities rather than on spot or front month prices. Prices for longer maturities (3 or 6 or 12 months) always fluctuated less than front month prices and are inherently more stable, because they are not influenced by short term inconsistencies of demand and supply.

There is no overwhelming reason why prices to the final consumer should reflect the spot or front month market. Refiners and retailers have the option of hedging forward and could very well be asked to guarantee a price to their customers or give significant advance notice of any variation. The market will not spontaneously generate such behaviour: no oil products retailer has conceived of competing on the basis of guaranteeing a price to its customers for a given period of time. The reason is simple: customers cannot be tied to a specific supplier: they would prefer the supplier that guarantees a price in the longer run for as long as that price is lower than the competition, and switch to the competition as soon as it becomes higher. However, if regulations were adopted imposing on all suppliers to guarantee prices for a given period of time and/or announcing changes with sufficient advance notice, the final consumer could not take advantage of prices that may be lower in the short term.

It is normally considered that oil products markets are either free or administered, and the latter frequently means prices that are kept artificially low, because governments are reluctant to pass on to the final consumers price increases for crude oil. Indeed, the extensive reliance on administered prices in developing countries, notably in the fast

[7] Giacomo Luciani "From Price Taker to Price Maker? Saudi Arabia and the World Oil Market" Rahmania Occasional Paper, forthcoming.

growing Asian countries, has been singled out as one reason of the rigidity of demand relative to prices: demand is simply shielded from higher prices.

What is proposed here is not a system of administered prices, but a set of regulations which would in essence encourage refiners and retailers to hedge on the futures market and lock in prices which they offer to their clients. Requesting retailers to "post" prices which can only be changed with, say, three months' advance notice would probably yield the best results: competitors would be able to decide whether to follow the moves of the price leader and price competition would still be possible. If prices need to be guaranteed over a set period of time, adjustments will be more difficult and competition will be discouraged. In all cases, coordination in view of price fixing needs to be repressed.

The combination of advance notice and limits to the frequency of price changes would represent an increase of energy security for the final consumer per se. In theory, the final consumer could use the futures market and derivatives to reduce his risk and enhance his own security even in today's conditions, but in practice this is beyond the means of most consumers. Only large consumers, such as airlines or shipping companies, have done so, and they too are vulnerable to the threat of consumer infidelity whenever their final prices are higher than the competition. Regulations for encouraging systematic hedging would contribute to energy security overall.

Price bands

The concept of a price band has been around for some time as a way to dampen volatility through a maximum and minimum price target which would trigger action on the part of producers and/or consumers as the market price approaches or crosses the extremes of the band. OPEC has had a notional price band between 2000 and 2005. Robert Mabro, Christopher Allsopp and Bassam Fattouh of the Oxford Institute of Energy Studies have all argued in favour of a band. Behrooz Baik Alizadeh of the Iranian Ministry of Petroleum has written "In its 109th ordinary meeting in March 2000, OPEC unofficially introduced its price band mechanism to the market. Within this mechanism, in the case of the average OPEC Basket crude price falling under $22/B for more than 10 successive working days, OPEC member states would be obligated to cut their daily production by 500,000 b/d, and in the case of the price exceeding $28/B for

20 successive working days, OPEC would increase production by 500,000 b/d. Although OPEC took advantage of this mechanism only once, increasing production by 500,000 b/d beginning on 31 October 2000, and gave up the whole idea in January 2005, introduction of this mechanism affected the market psychologically and stabilized prices during the period that OPEC was not inclined to change prices beyond specific limits."[8]

The problem with any price band concept is the instrumentation of intervention as the price approaches the limits. In the absence of appropriate instrumentation, it is not at all clear that the market psychology will be affected – indeed the market may be tempted to challenge the band and test the will of governments trying to enforce the same.

A price band may be effective if it is agreed upon by both importing and exporting countries. It is not clear that such an agreement would ever be possible, although at present it appears that the target prices of both sides are very close. The interests of exporters and importers are in structural opposition, and the current convergence is likely to be an exception. However, it may not be excluded that the industrial countries' concern for climate change and their desire to diversify their energy balances away from fossil fuels and specifically oil; and the exporting countries' fear that oil might be penalised as a consequence have indeed created a new order of priorities in the two sides, such that the importers no longer wish to minimise, and the exporters no longer wish to maximise the price.

Secondly, for the band to be a useful concept it would be necessary to enforce supply restraint on all exporters, not just OPEC. It may be argued that the threat of unrestrained expansion of non-OPEC supplies is fading away, because non-OPEC countries are unable to very much expand their production, and in fact non-OPEC production has already peaked or plateau-ed according to some interpretations. Nevertheless, the importing countries should be ready to defend the lower limit of the band by imposing limitations on imports of oil from non-OPEC countries, if necessary.

In the opposite case of prices reaching the upper limit of the band, OPEC countries would obviously be called to use all of their available capacity to supply a tight market. However, if OPEC reached the limit to its capacity and the market remained tight, then

[8] MEES 9 February 2009.

the importing countries should be ready to ration domestic consumption, or use "strategic" stocks (more on stocks later). In theory, this would also require concerted action on the part of all importers – something which is guaranteed to be very contentious and difficult to achieve. In the absence of concerted action, free riding on the part of some would prevail.

A further difficulty has to do with revisions or adjustments to the band. If the band is adjusted very frequently – à la limite, in response to any price movement - it ends up being no restraint at all on volatility. At the same time, a band that is never adjusted is bound to become obsolete and untenable. Finding the optimal middle-of-the-road solution is highly subjective and controversial. If we add that this middle-of-the-road compromise would need to be collectively endorsed by both oil exporters and importers, we conclude that the task is very difficult indeed.

A price band might be useful if it is intended to limit price volatility only within a specified period of time, and involves a market-responsive automatic adjustment mechanism. For example, it may be envisaged that the price band would extend x% above and below a central price equal to the average of observed prices in the previous year. In this way, if the price remains consistently close to the upper or lower limit of the band, the central price for the following year will be adjusted and the band moved up or down. The frequency of adjustment of the central price should be inversely proportional to the scope of the band. A system of very frequent adjustments (e.g. weekly adjustments of the central price to a moving average of the observed price over the previous x months) might be compatible with a relatively narrow band (say 10% above or below the central price). This would serve the purpose of dampening very short term volatility.

However, if the objective is creating a more reliable investment environment, priority should be given to less frequent adjustments and a wider band. The beneficial effect on investment decisions of a broadly based agreement on a central price is likely to outweigh the uncertainty intrinsic in a relatively broader band.

Finally, as mentioned, the effectiveness of a band depends on its instrumentation. Supply restraint may take the form of output limits or the accumulation of stocks, which in turn could be used to counter excessive price increases. This leads us to the

possibility of using intervention stocks in addition to strategic stocks, or some hybrid formula of strategic/intervention stocks.

Managing stocks.

Strategic stocks are discussed in deliverable 5.1.4b. The discussion evidences the ambiguity of strategic stocks and the rules concerning their use, especially with respect to containing price variations.

In theory, strategic stocks are clearly distinct from commercial or intervention stocks. Strategic stocks are meant to be used in case of supply emergencies, and to serve the purpose of guaranteeing energy security. Intervention stocks are meant to maintain prices at a fixed level or within a band. In practice, as explained in D 5.1.4b, the distinction is blurred, because the concept of energy security incorporates the notion of affordability, therefore some notion of a maximum acceptable price. Furthermore, as discussed in deliverables 5.1.1 and 5.1.2, emergencies or disturbances arising from geopolitical events such as wars or revolutions tend to be reflected in price levels more than in physically available supplies: in the end, demand always is matched by supply. Consequently, strategic stocks whose utilization is based on a strict quantitative criterion (such as is the case for the IEA emergency response mechanism) tend never to be used.

Intervention stocks are normally not very well regarded because in all cases in which the defence of a rigid price through the use of an intervention stock has been attempted, the stock facility eventually went bust. A rigid price regime invites speculation, and eventually market forces overwhelm any stock that might be accumulated.

At the same time, it stands to reason that stocks should be accumulated at times when the price is declining or low, and liquidated at times when prices are high or increasing. Accumulating stocks even at times when prices are increasing, as the Bush administration has done in the US, appears intuitively irrational.

What this means is that institutions and facilities should be established to manage stocks in a flexible way and in the absence of a fixed price regime. If a band is broadly agreed, as discussed in the previous paragraph, then institutions managing stocks will feel encouraged to sell when the price approaches the top of the band, and buy when it

approaches the bottom, but it might be dangerous to impose a rigid rule on the stock managers.

Should governments establish intervention stocks? In theory, managing stocks in a way which is functional to maintaining prices within a band is a profitable operation, which might very well be undertaken by private investors. Investors may choose to buy and sell purely paper barrels or they may decide to hold physical barrels: the latter option is likely to have a beneficial effect on price stability. The objective of government regulations should therefore be to encourage private investors to hold physical stocks. Today, individual investors (the doctors and dentists of Chicago fame) and large financial investors shy away from physical barrels, and only want to deal in paper.

Encouraging holding physical stocks requires passing legislation that will make it easier to build and maintain storage. This is partly an issue of environmental and fiscal rules, partly an issue of market organisation. Physical storage operators (who shall be separate legal entities from the owners of the stored oil) should be empowered to issue certificates convertible in physical barrels: oil deposited into the storage would be exchanged for such certificates, and certificates could be used to withdraw oil from storage. There is nothing exotic about this, but such a facility and a market for the certificates that it might issue does not exist.

Governments may well decide to facilitate this development by establishing an agency to build and manage the storage facility[9] – this can be established at the national or regional level or both - and issue certificates to oil depositors. The possibility of depositing oil would be open to all, including national oil companies of oil exporting countries. Storage facilities could be established in all appropriate locations, not necessarily in the territory of the country or group of countries establishing the same. In fact, it might be very interesting to establish large storage facilities at critical logistical junctures, such as the Suez Canal or the Malacca Strait, or in conjunction with pipeline projects to bypass the same.

[9] Japan, Abu Dhabi and Saudi Arabia have an agreement along these lines. Japan has built storage in Japan itself that is offered to Abu Dhabi and Saudi Arabia free of charge to store its oil. The stored oil belongs to the producer but obviously Japan gains a degree of security because of this. See “Saudi Arabia to store oil in Japan” Reuters December 23 2009.

Major trading companies, such as Vitol, maintain storage facilities already today, but the phenomenon is limited[10] and not sufficient to influence crude oil prices. Much larger storage facilities are needed, and private sector initiative may not be attracted to doing so. Nevertheless, per se the business of operating storage facilities may very well be profitable if investment in physical stocks develops as envisaged here.

Stored oil certificates should be designed and regulated in such a way that they will be accepted as collateral by financial institutions. This would open the possibility for oil exporting countries of "depositing" oil that they cannot sell at prices which they deem convenient, and borrow funds to make up for the temporary shortfall in revenue. Of course, if assumptions about future prices are unrealistic, they may end up defaulting – but this should be a concern of the banks, as is the case for any credit issued against real collateral.

Demand security

In discussions of energy security, the producing countries have frequently stated that they are willing to engage in the investment which is required to meet expected future demand, but they need some demand security, i.e. assurance that the demand will be there as expected. In other words, security of supply begs security of demand.

In a free market environment, there can of course be no assurance of future demand. Importing countries are at a loss in responding to the request for demand security, because they possess no tools to guarantee demand. How can this problem be approached?

The establishment of storage facilities where oil could be deposited against certificates that may be discounted at financial intermediaries is of course already a step in the right direction. An agreement to consult and coordinate in the accumulation/decumulation of strategic stocks may also be of help. But neither is likely to be viewed as providing sufficient security of demand.

[10] In May 2010 Vitol sold 50% of its global storage business to Malaysia's MISC, a subsidiary of Petronas, the purpose being to attract additional equity to expand the business. Vitol being a privately held company owned by its employees, it faces difficulty in tapping the equity market and finance expansion. FT May 17, 2010.

The gas industry historically solved the problem through take or pay contracts. These were said to place the burden of the volume risk on the buyer and leave the burden of the price risk on the seller. There is no denying that this arrangement, unpopular as it might have become, has allowed the implementation of some very ambitious investment projects, and significant improvement in Europe's energy supplies. But these arrangements only were possible because prices were exogenously generated: gas prices were indexed to oil and oil products prices, to guarantee the competitiveness of gas in marginal uses.

In the case of oil, we cannot think in terms of take or pay contracts because the price needs to be internally generated. However, individual countries, including large ones, could conceivably conclude take or pay contracts and index the price to signals generated elsewhere in the world. For example, China or India could put in place take or pay contracts for volumes of Gulf oil, and index the price to Brent or WTI or some other traded market (e.g. the DME Oman contract).This would provide the Gulf producers with significant demand certainty, and probably would be viewed with considerable anxiety by importers in the US, Japan and Europe. We are not quite there yet, it should be said, although the intensification of relations between the Gulf and the emerging countries in Asia does point in this direction.

The drawback of this arrangement is that it would divide the oil market in a price making and a price taking segments; it is to be expected that volatility on the price making segment would be relatively higher the smaller the price making segment is relative to the price taking segment. This is the same as saying that oil may be sold on the basis of long-term evergreen contracts or on a short-term basis: price is generated on the short-term market, and this is where all potential demand/supply imbalances will be felt. Such imbalances may be minor when related to global demand and supply, but large when related to short term trading only.

Today, we have a system which is very close to this: prices are indexed to traded markets that are a very small component of global physical supply and demand. The difference is that there are no proper take or pay contracts, only evergreen contracts which envisage neither an obligation to supply on the part of the seller nor an obligation to lift on the part of the buyer. In addition, the price directly reflects all the volatility of

short term markets. But an evolution towards take or pay contracts closer to those familiar in the gas industry is conceivable.

Vertical integration

Another potential step in the direction of a longer term perspective to investment in the industry is facilitating vertical integration. In the current downturn, the large, vertically integrated international oil companies have claimed that their investments plans are unaffected by the downturn and based on their long-term strategy.

This may or may not be true, of course. In past years, these same companies have frequently been criticised for allocating larger funds to purchasing their own stock and propping up the value of their shares than in industrial projects proper. They have also extensively engaged in mergers and acquisitions, leading to the disappearance of several independent corporations – a loss of diversity which can only negatively affect the vitality of the species.

At the same time, it is true that large integrated companies "own" their market thanks to their presence at the retail level and the oligopolistic nature of the business. They therefore enjoy a considerable degree of demand security, although they face the price risk and are exposed to price volatility as any other player in the industry. Large integrated companies also have a broader capital base and may be better able to continue funding investment projects out of internally generated resources than smaller independents.

Nevertheless, the "old" large integrated companies remain vulnerable to the pressure from financial analysts and investors, who are typically only interested in "returning value" to the shareholders in the short run. The functioning of financial markets does not encourage strategic thinking, as investors can enter and exit a stock at any time, and are mostly interested in short term appreciation. This is a problem for all industrial corporations, but is an especially difficult problem for the oil companies, whose outlook is structurally long-term.

It is typical of the distorting signals that management receives from the financial market that all attention in recent years has been focussed on cutting costs rather than guaranteeing the long term growth of the company.

Thus, let it be noted that security of energy supply is also dependent on the functioning of financial markets and the kind of signals that originate from them – however we cannot here enter in a discussion of how financial markets might be reformed to encourage longer-term thinking on the part of management.

In any case, the problem which affects the behaviour of the "old" large integrated companies does not affect the "new" integrated companies: these are the national companies of the major importers which are venturing internationally in order to improve their security of supply, as well as the national oil companies of the exporting countries which are investing downstream in order to gain better control of their markets. In both cases, ownership remains either entirely or to a large extent in the hands of strategic investors, frequently the State itself, and strategic thinking is encouraged rather than short-term profitability.

The growing role of these companies is a factor increasing energy security, because they will invest with a long-term perspective. The activism (or shall we say "aggressive" approach) of Chinese companies to acquiring reserves internationally has frequently been portrayed as being threat to importers in the OECD – while it should be more properly understood as an example to imitate. Equally, the drive of some national oil companies to integrate downstream, acquiring refining and retailing assets in the importing countries, has frequently been viewed as a threat, as if it entailed a further degree of dependence and loss of control, while in fact it should be viewed as improving security of supply, reinforcing the commitment of the supplier to service his own assets and keeping the market supplied.

Hence, vertical integration is important and it is good for energy security. The OECD countries should look into ways in which they may encourage more of a strategic behaviour on the part of the "old" integrated majors, and preserve the species by putting a limit to the cannibalism represented by mergers and acquisitions. And they should welcome the downstream integration of the national oil companies of major producers, interpreting the will to invest as a commitment to supply.

Conclusion

This deliverable has argued that the functioning of markets is a key determinant of energy security. Geopolitical and other threats to physical supply may cause price shocks, but, based on historical experience, are unlikely to cause any significant physical shortage. Therefore, insecurity is manifested by price shocks and price shocks are insecurity. But price shocks may very well originate in the absence of major disturbances to physical supplies, simply as runs originated by investors, or "speculators", which the market does not correct because both demand and supply are rigid relative to prices.

Price volatility is therefore a threat per se, in many ways more important and more devastating than potential threats to physical supplies. The cost of price volatility is very high, much higher than the potential cost of possible disruption to physical supply; and it is significant not just in the immediate, but even more so in the long run, because of the depressive effect it has on energy investment generally.

Thus addressing price volatility is a key component of energy security policy.

Unfortunately, there is no easy recipe to dampen price volatility: this paper has reviewed several approaches that may reduce volatility, notably:

- Encourage the freer trading of major crude oil streams, notably those from the Gulf
- Increase reliance on long term pricing
- Enforce an internationally agreed price band
- Manage stocks
- Offer demand security through take or pay contracts
- Encourage vertical integration

None of these approaches is sufficient to stabilise prices, but collectively they may very well succeed in reducing the extreme volatility that was experienced since 2004. Volatility will never be eliminated, because it is a structural feature of the oil industry,

but it may be contained, and energy supply would be perceived as being much more secure.

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