Oil Market Dynamics through the Lens of the 2002-2009 Price Cycle[1]

Bassam Fattouh

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[1] This report was prepared while the author served as a member of an independent expert group established to provide recommendations to the 12th International Energy Forum (IEF) Ministerial Meeting in Cancun (29-31 March 2010) for strengthening the architecture of the producer-consumer dialogue through the IEF and reducing energy market volatility.

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During the period 2002 to 2008, the oil market experienced a sustained increase in prices with the annual average price rising year-on-year for seven consecutive years. This boom, however, ended with a spectacular collapse towards the end of 2008. These sharp price movements captured public and political attention and raised concerns within both major consumers and producers about the adverse economic, political and social consequences of such violent price movements.

In concert with recent debates over economic policy, the G20 and other bodies are considering policies designed to prevent a repeat of the recent swings in oil prices. An underlying theme in these discussions is that sharp price swings are undesirable since they increase uncertainty, hamper global economic growth, and undermine investment in both the oil and alternative energy sectors. Governments fear that speculative activity could cause oil prices to overshoot and choke off a burgeoning economic recovery.

The recent behaviour of prices has polarised views about the key drivers of oil prices. One view attributes the recent behaviour in oil prices to structural transformations in the fundamentals of the oil market. An alternative view considers that changes in fundamentals, or even expectations, have not been sufficiently dramatic to justify the extreme cycles in oil prices over the last two years and that oil markets have been distorted by substantial and volatile speculative financial flows. This dichotomy between fundamentals and speculation continues to dominate the current debate about the appropriate measures needed to reduce oil price volatility and to prevent a repeat of the latest price cycle.

While it is convenient for some policy makers and analysts that the issues are presented in terms of this dichotomy, it is too simplistic to be of use in formulating policy. The idea that the oil price can be sliced into various components reflecting fundamental and non-fundamental factors is difficult to implement theoretically and empirically.

This report instead follows a more inclusive framework that emphasises the interactions among the various oil price determinants and the various players in the oil market. Specifically, it emphasises the dual nature of crude oil as a physical commodity and as a financial asset, and focuses on the role of expectations in the formation of the oil price. As a physical commodity, the price of oil is influenced by current market fundamentals, such as the supply-demand balance, the level of inventories and the availability of spare capacity. As a financial asset, the price of oil is influenced by expectations of market fundamentals, as well as other macroeconomic news that influences those expectations.

During the 1980s and the 1990s, expectations about short-term oil price behaviour rested on the assumption that changes in oil prices would induce a response or feedback from supply, demand or policy, or a combination of these, which would prevent prices from rising above a certain ceiling or falling below a certain floor. The perception of strong feedbacks stabilised long term expectations

about oil prices. One of the major features of the oil market was the relative stability of the expected price for oil in the long term.

As oil prices rose sharply during the boom years in the 2000s, uncertainty about the existence of and timing of feedbacks from prices to oil supply and demand increased markedly. The perception of strong feedbacks in the oil market was replaced by the perception of limited feedbacks. Key feedbacks absent during this period were a) the perception that high oil prices would trigger a rise in global inflation rates and a subsequent recession, tempering growth in the demand for oil; b) that high oil prices would induce strong growth in non-OPEC supply; and c) that OPEC would increase its oil supply to prevent oil prices from rising to high levels as high and volatile oil prices may result in the long-term destruction of oil demand.

In parallel with developments on the physical side of the market, the related oil derivatives markets witnessed major transformations that would eventually consolidate the role of the futures and over-the-counter (OTC) markets in the process of oil price discovery. In theory, one could distinguish between two main layers for price discovery. One layer is based on the price assessments made by oil reporting agencies and, more recently, by bids and offers on partial cargoes. These prices play a key role in the oil market since most of the oil traded is based on contracts that include assessed prices in the pricing formula. These prices are derived from relatively illiquid physical markets which lack transparency and are dominated by a few players. Furthermore, some have argued that thin markets increase the crude market's vulnerability to manipulation, distortions and squeezes.

Another layer of price formation is the futures market which is more transparent, highly liquid and characterised by a large number of players with diverse expectations. By collecting and aggregating market participants' views and expectations, and disseminating regular flow of information about prices and liquidity, futures markets can improve the price formation process in the spot market. Due to limited data and information, the nature of the relationship between these two layers is not well understood and requires further analysis. An important question that demands deeper research is whether greater transparency in the physical market, and the creation of multiple benchmarks based on more liquid markets, would help reduce volatility by revealing more accurate information about the fundamentals in the physical market.

The last few years have seen a large inflow of funds into the oil market and the entry of a wide range of financial players. The growing importance of financial investors in the oil market should not, however, be thought of as an external event that occurred in isolation. It was interlinked with the tightening of the physical market. It also represents the consolidation of a trend that began with the collapse of the administered pricing system in 1986 and the adoption of the market related system which became, and remains, the primary method for pricing crude oil in international trade. The

market related system is based on formula pricing where the marker, or reference price, is derived from the futures market and physical benchmarks.

While the last two decades have seen the development of elegant theoretical models that analyse the role of financial players in asset price booms and busts, the empirical literature has struggled to offer much in the way of firm conclusions. Currently there is a wide range of views about the role of financial markets in the oil price formation process, but little consensus.

Designing effective policies to prevent a repeat of the sharp swings in oil prices requires a comprehensive understanding of the underlying causes of these swings, a thorough analysis of recent developments in oil markets, as well as their likely future evolution.

In the first half of 2008, doubts about the existence and timing of feedbacks from prices to oil supply and demand became pervasive. This development destabilised short-term expectations and allowed for a wider range within which the oil price oscillated. Within this implicit band, price changes were influenced by a very wide variety of public signals about current fundamentals and information and news which affected expectations about the future evolution of these fundamentals. Prices also depended on market players' expectations of other players' expectations, creating the grounds for herding behaviour. Since public signals can affect a player's guess about other players' guesses, public information or signals could have a disproportionate impact on the oil price. This is the case even if these public signals do not necessarily reflect material changes in the underlying fundamentals or provide new information to the market. Furthermore, while there is an abundance of public news and information, market participants often limit their attention to a few signals which they consider most important as it is impossible to synthesise and coordinate on a large number of signals.

Limited feedbacks also led market participants to revise their longer-term expectations and the prevailing consensus on long-term prices broke down. As a result, during the boom years, prices in the short and long run became jointly determined and the whole futures curve became subject to a series of roughly parallel shifts.

The sharp reversal in oil prices from July 2008 through to February 2009 came in two distinct phases. The first was a cooling off of prices from their peaks, brought on primarily by the combination of a supply side response from the key marginal producer, Saudi Arabia, following the Jeddah meeting in June 2008, and by mounting evidence in the rear-view mirror that OECD oil demand had weakened far more than initial expectations and provisional data had suggested. The second phase was more directly associated with the intensification of the global financial crisis, and the associated expectation of a collapse in global economic growth. Only when expectations about the global economy began to stabilise, there was a recovery in oil prices.

In the second quarter of 2009, the powerful shocks that affected global oil demand were counteracted by the perception of a quick global economic recovery, and the prediction of tight future market

fundamentals, or supply crunch, a prediction driven by increasing concerns that the credit crunch and low oil prices would limit investment in the oil sector and alternative energy. Analysis and commentary by influential financial players seemed to affect these long-term expectations. The consolidation of expectations over tight future fundamentals placed a limit on how much the market was willing to discount the spot price in relation to the long term price. On the one hand, the spot price was high relative to the market fundamentals at that time. On the other hand, the spot price was low relative to the expected long term prices. In the second quarter of 2009, the oil market reached a point at which either the long term price had to adjust downward or the spot price had to adjust upward. Throughout most of 2009, it was the spot price that carried most of the adjustment; longer dated contracts in 2009 were relatively stable in comparison to the shorter dated contracts at the front of the curve.

From a policy point of view, the above analysis raises key issues of how expectations are formed and whether consumers and producers can play a role in stabilising market participants' expectations about a preferred price range.

Clearly, expectations are formed on the basis of data and information and the analysis surrounding these data. Poor data can contribute to the volatility of oil markets by allowing inaccurate information to filter into investors' expectations and by increasing uncertainty. Thus, extending the coverage of data and improving the quality of information about crude oil market fundamentals can help stabilise expectations and oil prices.

Beyond this, there have been many calls to establish a price band with an oil stabilisation fund designed to dampen volatility and prevent sharp swings in oil prices. A fundamental weakness of these proposals is that such a system would have to be managed by parties with very divergent interests. Furthermore, it would be hard to design the institutional mechanisms that could generate feedbacks to prevent the price from straying outside the band.

Rather than adopting a price band, one of the main objectives of both oil importing and exporting governments should be to stabilise market participants' longer term expectations about a range of preferred oil prices. It has been long recognised that when individuals are confronted with considerable uncertainty, credible focal points may play an important role in the convergence of individual expectations.

Historically, producers and consumers have had very divergent interests, with producers favouring higher prices and consumers favouring lower ones, depending on what stage in the oil price cycle importers and exporters found themselves. At present, there is a realisation among both groups that oil prices that move too low or too high serve no one. Low oil prices constrain the flow of investment required by the industry to ensure stable oil supplies. High and volatile oil prices can damage the prospect of global growth and create worldwide imbalances with destabilising consequences.

The recent relative convergence of views by key players about a preferred oil price range according to statements from leaders in both camps has helped stabilise expectations and create a focal point in the oil market. However, this convergence of views does not necessarily ensure a stable equilibrium. For a preferred price range or focal points to be credible and sustainable, it is important that the price range be both dynamic and in line with changing market fundamentals. Furthermore, if key market players have different beliefs regarding oil market fundamentals, due to limited and imperfect information and uncertainty about the behaviour of other key players, it may not be possible to sustain a convergence of views, a necessary condition for attaining a credible focal point. Finally, if anticipated feedbacks are slow, or are perceived to be absent on either the demand or supply side, the market is likely to drift away from the preferred price range. This creates a reason for cooperation and dialogue between consumers and producers. For example, if the market believes that feedbacks do not exist, while in fact they do, then policy could play an important role in stabilising oil prices by increasing the visibility of these feedbacks and policy responses.

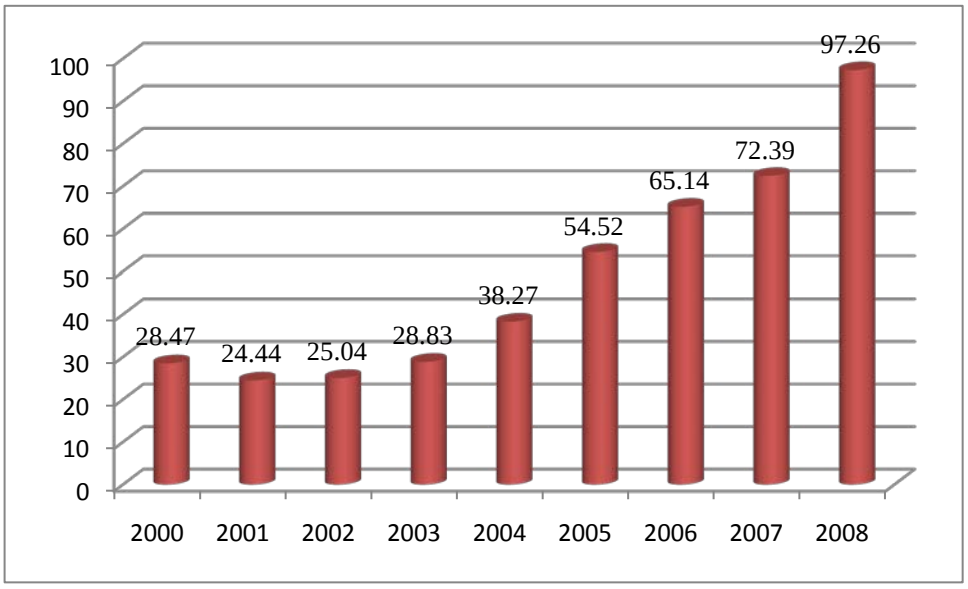
Concerns about excessive risk-taking and heightened commodity price volatility have brought the issue of regulation to the fore. In designing regulatory responses, policy makers should be clear on the behaviour that these regulations are designed to control. The financial crisis has led regulators all over the world to adopt or propose a new regulatory framework which, over time, is expected to increase the power of national regulatory authorities, increase global regulatory coordination, and expand the scope of regulation.

The emerging framework, however, has been primarily designed to address problems within financial institutions, particularly commercial and investment banks. In the case of banks, the main purpose of regulation is to avoid excessive risk taking and prevent future credit crunches. In commodity markets, on the other hand, the ultimate purpose of improved regulation is to limit volatility, or more accurately, price swings. Given that the regulatory issues relating to energy markets are different in nature and scope from those applying to financial institutions, there are concerns that the current reform efforts will not be appropriate for issues related to energy markets, especially those pertaining to the price discovery process in the physical market. Furthermore, if the main objective of proposed regulations is to tackle sharp rises in commodity prices, then authorities should widen the policy options to include the role of monetary policy (for instance by making asset price stability a target for monetary policy), prudential regulation, or even fiscal policy (by reducing overall demand).

Background

During the period 2002 to 2008, the oil market experienced a sustained increase in prices with the annual average price rising year-on-year for seven consecutive years (see Figure 1).

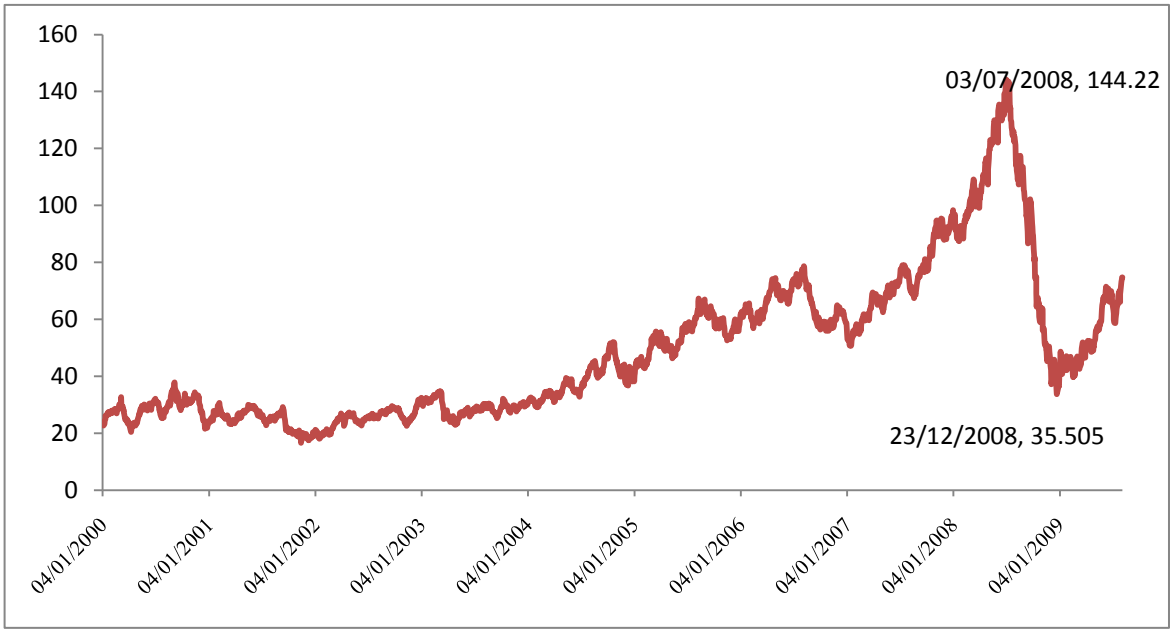
Figure 1: Annual average price for dated Brent for the period 2000-2008



Source: BP

The sustained rise in oil price paralleled that of the global commodity market boom, as well as an asset boom characterised by real estate bubbles in the US, UK and elsewhere. Considerable innovation in financial markets and global macro-economic imbalances also contributed to the economic tide. The oil price boom, however, ended with a spectacular collapse towards the end of 2008, which saw the price of dated Brent fall from its historic high of $144.22 per barrel at 3 July 2008 to a low of $35.5 per barrel by 23 December 2008 (see Figure 2).

Figure 2: Dated Brent ($/barrel)



Although the oil price did not spend much time near these extreme points, the sharp price movements captured public and political attention and raised concerns, particularly within major consuming country policy circles, about the adverse economic, political and social consequences of such violent price movements.

In concert with recent debates over economic policy, the G20 and other bodies are considering policies designed to prevent a repeat of the recent swings in oil prices. An underlying theme in these discussions is that sharp price swings are undesirable since they increase uncertainty, hamper global economic growth, and undermine investment in both the oil and alternative energy sectors. Governments fear that speculative activity could cause oil prices to overshoot and choke off a burgeoning economic recovery.

To determine whether such policy objectives are achievable, and whether policy interventions are necessary, requires an analysis of recent developments in oil markets and their likely future evolution. In particular, to assess possible policy innovations, we have to consider questions such as the following:

- Is the recent oil price behaviour due to fundamentals or to speculation?
- Could market stabilisation policies be effective?
- What effect do oil price fluctuations have on economic growth?

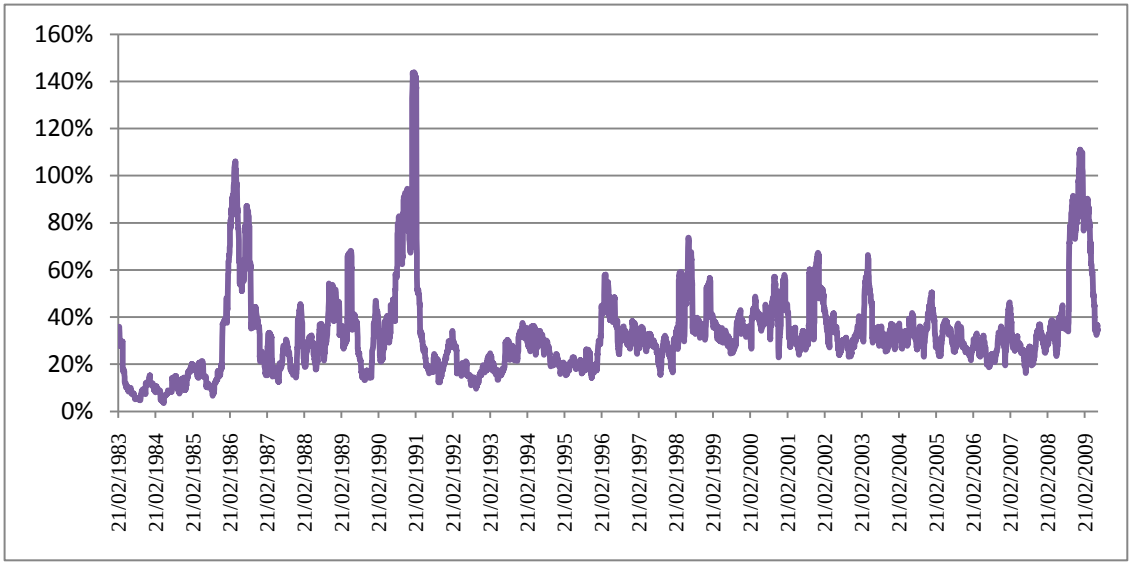
In this report, we focus mainly on the first two questions. The interaction between fundamentals and financial market is complex, and in recent years major changes in fundamentals have posed a

challenge to the conventional view of how oil markets operate, suggesting a revision which we elaborate in this report.

The Speculation/Fundamentals Dichotomy

The context for analysing the complex relationship between oil market fundamentals and speculation is the extremity of the boom and bust cycle noted in Figure 2. Within those broad movements, more minute changes, revealed by high frequency data, are also significant. In line with the sharp price cycle, the oil market witnessed a marked increase in price volatility, especially in the final phases of the boom-bust cycle. As Figure 3 shows, the annualised daily volatility rose sharply in 2008 between the months of April and December. While the oil market has witnessed many similar episodes of heightened volatility, these previous episodes have been associated with major structural transformations and geopolitical shocks, such as the abandonment of the administrated pricing system in 1986, the first Gulf War in 1990-1991, the Asian financial crisis in 1998 and the terrorist attacks on the US in 2001. In contrast, the increase in volatility in 2008 occurred at a time of relative political stability and without any major supply disruptions, although it coincided with increased fragility in major financial centres.

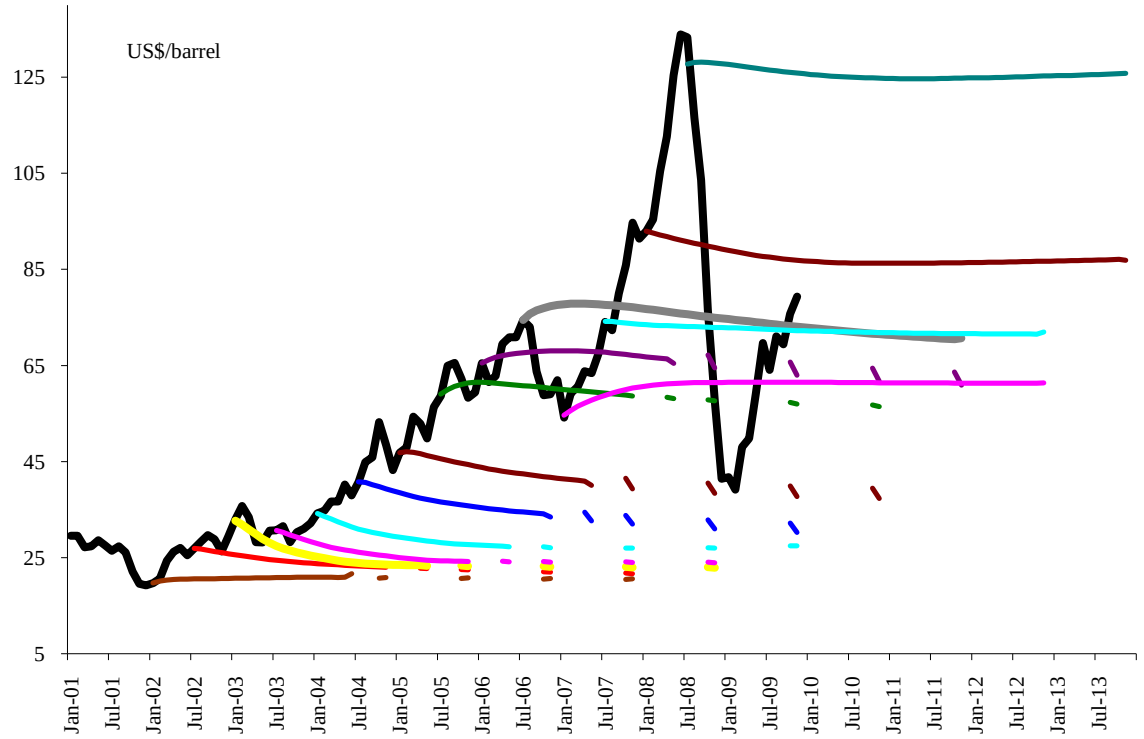
Figure 3: Annualised Daily Volatility (1 month rolling Average)



Source: Authors' Calculation

While the media's main focus has been on the behaviour of the spot price or prices of near-term contracts, the long-term oil price has also witnessed significant movement, indicating a breakdown of the existing consensus on long-term prices. While the price at the back end of the futures curve hovered around the $20-$22 range for most of the 1990s and early 2000s, in 2005 it broke out of its narrow band and fluctuations in the long-term price mirrored the sharp price movements at the front part of the futures curve (See Figure 4).

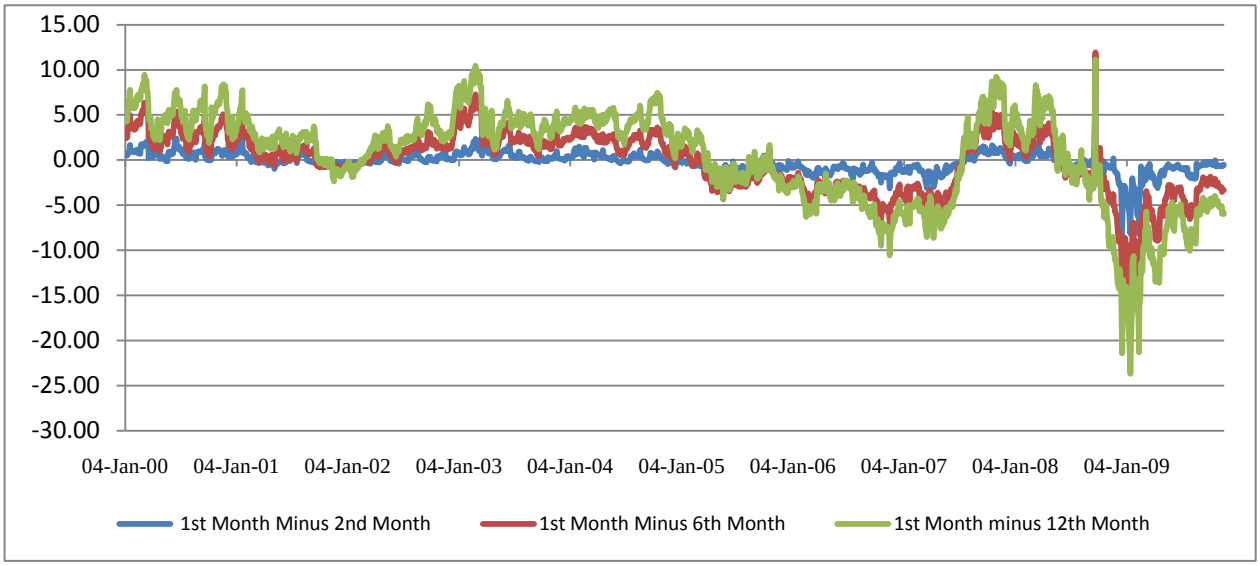
Figure 4: Nymex Light Sweet Crude Oil contract Front-Month Contract and Futures Curve



Source: Petrobras

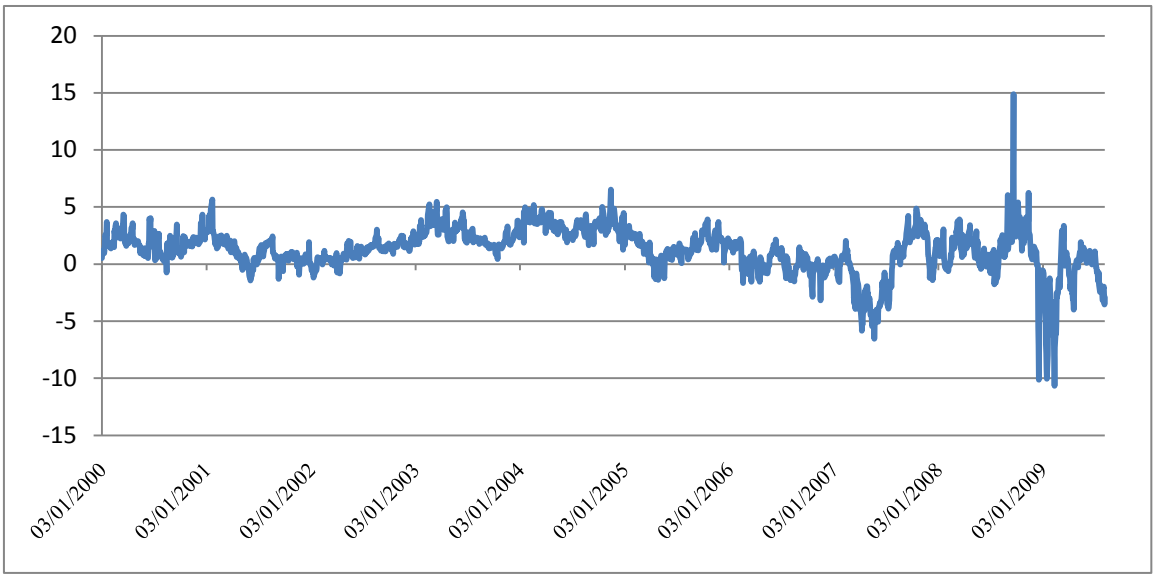
This latest oil price cycle has also been accompanied by volatile dynamics of time spreads. As seen in Figure 5, in early 2009, the time spread for Nymex Light Sweet Crude Oil contract reached very high levels, both in dollar terms and relative to the price level. The time spreads have also exhibited high volatility, rarely witnessed previously. These time spreads affected the dynamics of inventory accumulation and the behaviour of spot oil prices.

Figure 5: Time Spreads for Nymex Light Sweet Crude Oil contract ($/barrel)



Furthermore, the price differential between WTI and Brent, the main benchmarks of the current oil pricing system, has exhibited high volatility, reflecting serious dislocation between different segments of the oil market. As seen in Figure 6, the volatility in the WTI-Brent spread has increased in the last two years, with the price differential reaching very high levels in early 2009, both in the absolute level and as a proportion of the price level.

Figure 6: WTI-Brent Differential ($/barrel)



Notes: Light Crude Futures 1-month (Nymex, Closing price) minus Brent Crude Futures 1-month (ICE Closing price).

The recent behaviour of prices has polarised views about the functioning of the oil market and the key drivers of oil prices. On the one hand, some observers in the oil industry and in academic institutions attribute the recent behaviour in prices to structural transformations in the oil market. According to this view, the boom in oil prices can be explained in terms of tightened market fundamentals, rigidities in the oil industry due to long periods of underinvestment, and structural changes in the behaviour of key players such as non-OPEC suppliers, OPEC members, and non-OECD consumers. [2]

Another view is that the changes in fundamentals, or even in expectations, have not been sufficiently dramatic to justify the extreme cycles in oil prices over the last two years. The oil market is seen as having been distorted by substantial and volatile passive investments in deregulated or poorly regulated crude oil derivatives instruments.[3] This argument also sees a weakened or limited role for fundamental drivers in the rebound of prices in 2009, away from their sub-$35 lows and back towards

[2] See for instance, IMF (2008), *World Economic Outlook* (October), Washington: International Monetary Fund; Commodity Futures Trading Commission (2008), *Interagency Task Force on Commodity Markets Interim Report on Crude Oil*; Büyükşahin, B. Haigh, M.S., Harris, J.H., Overdahl, J.A. and Robe , M.A.(2008) 'Market Growth and Trader Participation in Futures Markets', *CFTC–Office of the Chief Economist Working Paper*, December.

[3] See the Testimony of Michael Greenberger before the Commodity Futures Trading Commission on Excessive Speculation: Position Limits and Exemptions, 5 August 2009. Greenberger provides an extensive list of studies that are in favour of the speculation view.

$80 per barrel. It is notable that differences in views over the movement of prices from lows in 2009 show a strong similarity with the differences over their movement towards their highs in 2008.

The discrepancy of views between those who ascribe increased volatility to changes in market fundamentals and those who fault speculation continues to dominate the debate over oil price behaviour. It also seems to inform most of the policy debate about measures designed to reduce oil price volatility and prevent a repeat of the latest cycle. An underlying theme to these discussions is that oil price volatility is undesirable since it increases uncertainty, hampers global economic growth, and undermines investment in the oil and alternative energy sectors. Governments fear that speculative activity could cause oil prices to overshoot and may choke off a burgeoning economic recovery.[4]

While it is convenient for some policymakers and analysts to present the issues in terms of this dichotomy, it is perhaps too simplistic to be of help in formulating policy. The idea that the oil price can be sliced into various components, reflecting fundamental and non-fundamental factors, is at best difficult to implement empirically without imposing the observer's own prior assumptions, and at worst, might be viewed as lacking any theoretical microeconomic justification. The price of oil reflects the market's aggregation of many participants' decisions based on various views and different information sets. It is almost impossible to isolate the different factors that enter into the process of price formation without imposing prior assumptions. This by no means suggests that the market always generates a 'correct' or efficient price. In fact, a broad basis of theory and empirics suggests that a wide sweep of financial, land and commodity prices could overshoot or undershoot their long run equilibrium levels, and asset prices can be subject to bubbles in markets operating with a significant surplus of liquidity. However, the danger remains that the above mentioned dichotomy may indicate to policymakers that financial players operate in isolation from the physical parameters of the oil market.

This report instead follows a more inclusive framework that analyses the interactions among the various oil price determinants and the various players in the oil market. Specifically, it emphasises the dual nature of crude oil as a physical commodity and as a financial asset. [5] It also emphasises the role of expectations in the formation of the oil price. Incorporating such features into our analysis helps provide a fresh and an encompassing perspective on oil market dynamics over the 2002-2009 price cycle.

[4] It is important to note that from the various announcements of government officials, governments are not concerned with volatility *per se* but rather with preventing sharp oscillations in oil prices. The two concepts are different. The former is simply a technical measure that characterises oil price movements. The latter is closely related to the sharp price swings and the overshooting or undershooting of oil prices.

[5] See for instance, Yergin, D. (2009) **'**It's Still the One**'**, *Foreign Policy*, Sept/October. Yergin argues that the "frenetic daily trading has helped turn oil into something new -- not only a physical commodity critical to the security and economic viability of nations but also a financial asset, part of that great instantaneous exchange of stocks, bonds, currencies, and everything else that makes up the world's financial portfolio.**"**

The Conventional Framework: Oil Prices and Feedbacks

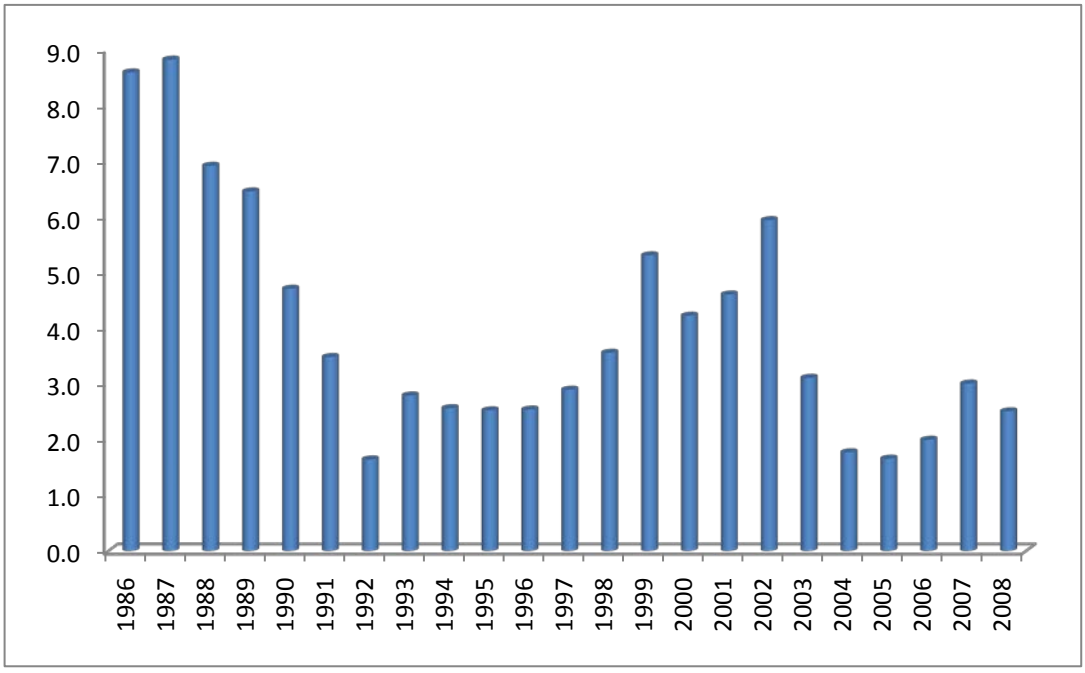
Until recently, expectations about short term oil price behaviour rested on the assumption that changes in oil prices would induce responses or feedbacks from supply, demand or policy, or a combination of all three, which would prevent prices from rising above a certain ceiling or falling below a certain floor. On the demand side, the feedbacks from high oil prices to demand operated through two main channels. High oil prices would have an adverse impact on oil demand through a price effect and an income effect.[6] Furthermore, high oil prices would eventually slow economic growth and induce recessionary pressures, with a detrimental effect on global oil demand. On the supply side, high oil prices encourage investment in the oil sector, inducing a supply response, but with a multi-year lag. High oil prices also encourage substitution at the margin by increasing the price of oil relative to other energy sources.

On the other hand, low oil prices can induce certain feedbacks which prevent prices from falling below a certain level. On the demand side, low oil prices encourage growth in oil demand. On the supply side, low oil prices discourage investment in the oil sector which causes a slowdown in the growth rate of oil supply, especially in non-OPEC countries. Furthermore, given the high relative costs associated with the development of alternative sources of energy, a low oil price environment can constrain investment in these alternative sources, reducing their role at the margin. Low oil prices can also induce OPEC to engage in production cuts in attempt to put a floor on the oil price.

One important factor which allowed the conventional framework to persist for a long period of time was the availability of large spare capacity in the system (see Figure 7).[7] Spare capacity effectively increased the elasticity of oil supply and generated strong feedbacks to the oil market, even when the market endured strong shocks that resulted in large supply disruptions.

[6] These effects will be discussed in detail later in this paper.
[7] Fattouh, B. (2006),'Spare capacity and oil price dynamics ', *Middle East Economic Survey*, Vol. XLIX No 5, January.

Figure 7: Spare Crude Oil Production Capacity



Source: CERA

These strong feedbacks have also featured in long term expectations about oil prices. One of the major features of the oil market during the 1980s and the 1990s was the stability of the long-term price for oil. While the spot and near term contracts sometimes exhibited high price volatility, that volatility was rarely transmitted to the back end of the futures curve. The back end of the oil price futures curve was anchored around the $20-$22 range. That price served almost as a cantilever; new information hit the front of the curve and caused volatility while the long-run price remained stable and anchored to the wall.[8] Oil importers, exporters, and participants in financial markets all thought in terms of that range for long-term sustainable prices. It is important to note that stability in long-term expectations affected short-term expectations. Specifically, it established a relationship between the spot oil price and expected change in prices. As oil prices drifted far from the long term price, the idea that prices would eventually revert towards that long-term oil price was built into participants' expectations.

Perception of Limited Feedbacks and Destabilised Expectations

As oil prices rose sharply during the boom years, uncertainty about the existence of and timing of feedbacks from prices to oil supply and demand increased markedly. The perception of strong feedbacks in the oil market was replaced by the perception of limited feedbacks. This led market participants to revise their expectations and the consensus on long-term prices broke down. As a

[8] See Gabillon, J.(1991), 'The Term Structures of Oil Futures Prices', *OIES WPM* 17, Oxford: Oxford Institute for Energy Studies.

result, prices in the short and long run became jointly determined and the whole futures curve became subject to a series of roughly parallel shifts (See Figure 4).

Structural Features of the Oil Market: Volatility and Elasticities

Central to the explanation of limited feedbacks in the oil market is the low, short-term responsiveness of both demand and supply to changes in oil prices. In economists' jargon, the global oil market is characterised by low short-term elasticity of demand and supply with respect to oil's price (own price elasticity of demand). In contrast, the income elasticity of oil demand is relatively high, especially in countries witnessing persistent high growth rates and improvements in income where each increase in GDP is associated with a more than proportional increase in demand for oil.

Oil demand is a function of a wide range of factors, including world economic activity, global demographical factors, demand-side technology, the relative price of competing energies, taxation policies, and of course, the price of oil itself. The bulk of the empirical literature however has focused on estimating the price elasticity, both in the short and long run. While there is a wide variation in estimates, it is possible to draw some general conclusions regarding the price elasticity of demand.[9] First, changes in wholesale oil prices tend to have a small (and often insignificant) effect on demand for crude oil, particularly in the short run. Second, the long-run price elasticity of demand is significantly higher than the short-run elasticity, due to substitution and energy conservation, although that elasticity often remains relatively low.

Third, oil demand may respond asymmetrically to changes in oil prices.[10] For instance, an increase in oil price would reduce demand for oil but it is not necessarily true that the decline in oil demand would be reversed by a decrease in oil price. The increase in price may, for example, induce investment and a shift towards more efficient equipment which reduces the demand for oil, and the decrease in price would not reverse the impact of the prior capital investment.

Fourth, the response of oil demand to an increase in the cyclical maximum price would not be the same as the demand response due to price recovery towards the trend from a cyclical low point. For instance, it is possible to deconstruct prices into price increases that lead to new historical prices, price increases that return to some previously observed price levels**,** and price decreases. Using this deconstruction, some studies have found that price elasticities are significantly different between price falls and prices increases, and that the most elastic price response of oil demand is due to new price maxima. [11] In lay terms, that effect is often characterised as 'sticker shock'.

[9] Fattouh, B. (2007), 'The Drivers of Oil Prices: The Usefulness and Limitations of Non-Structural model, the Demand–Supply Framework and Informal Approaches ', *OIES WPM* 32.
[10] See Gately, D. and Huntington, H. (2002), 'The Asymmetric Effects of Changes in Price and Income on Energy and Oil Demand', *The Energy Journal*, 23(1), pp. 19–58.
[11]See Gately, D. and Huntington, H. (2002), 'The Asymmetric Effects of Changes in Price and Income on Energy and Oil Demand' *The Energy Journal*, 23(1), pp. 19–58.

Finally, there might be threshold effects, so that below a certain price the demand response is very low but once the price exceeds the threshold, there is a strong demand response.

In sum, the impact of price is not always linear, not always reversible, and may often depend not only on current or expected price levels, but also on the past history of prices.

The relationship between oil demand and world economic activity is usually examined within the context of the income elasticity of demand, which measures the relationship between the change in quantity of oil demanded and the change in income or the growth rate in global GDP with higher economic activity being associated with higher oil demand. As in the case of price elasticity of demand, the estimates vary widely according to the method used, the period under study, and whether it is applied to developing countries or OECD. However, it is possible to draw the following general conclusions. First, oil demand is more responsive to income than to its price. Second, the long-run income elasticity for oil demand is higher than the short-run income elasticity for oil demand. Third, there is a large heterogeneity in estimated income elasticity across countries and regions, with developing countries exhibiting higher income elasticity than OECD countries. Finally, the responsiveness of oil demand to GDP has been declining over time in the OECD group. This reflects, in part, the relative decline in the oil intensity of OECD economies which has been associated with a structural shift in OECD countries' oil use.

Modelling oil supply is more complex due to reserves opacity and the behaviour of various suppliers. Concerning the latter, it is normal to distinguish between OPEC and non-OPEC dynamics. While it is widely assumed that non-OPEC suppliers behave competitively, modelling OPEC supply behaviour is more complex and there is a wide range of theories in the literature about its optimising behaviour. Outside OPEC, there are many diverse suppliers ranging from national oil companies, the large international oil companies and the smaller independents. However, empirical studies usually do not make the distinction between these various players and tend to aggregate non-OPEC oil production or aggregate production in individual countries. Studies of the estimated price elasticity for non-OPEC oil supply have shown that the response of non-OPEC production to oil prices, especially in the short run, is very low.[12] This is not surprising given that non-OPEC producers tend to run with minimal or no spare capacity, and that the development of further oil reserves is subject to long lags, as well as a host of other factors other than price, including access to reserves, availability of skilled labour, geopolitical shocks, changing fiscal terms, and the cost of field development.

The combination of a low short-term price elasticity of oil demand and supply, and the relatively high income elasticity of demand implies that small changes in supply and demand will induce large price swings, especially in tight market conditions. A recent report by the International Energy Agency

[12] See for instance, Krichene, N. (2006), 'World Crude Oil Markets: Monetary Policy and the Recent Oil Shock' *IMF Working Paper* No. 06/62, Washington: IMF; Gately, D. (2004), 'OPEC's Incentives for Faster Output Growth', *The Energy Journal*, 25(2), pp. 75–96.

(IEA) describes low elasticity as 'a clear recipe for high volatility' and tends to explain the large sharp swings in oil price in terms of low elasticity.[13]

However, what remains unclear is why perceptions or expectations of low price elasticity persist in the oil market even for the long term. Prices and income effects should affect supply and demand dynamics, which in turn should alter long-term expectations about market fundamentals. Thus, while low price elasticities and income effects can explain the behaviour of oil prices in the early phases of the boom, they cannot account for the subsequent sharp price swings both at the front end and the back of the futures curve. To tackle this issue, it is important to broaden our approach to analyse the key factors that created the perception of limited feedbacks, both in the short and the long run, as this change in perception helped destabilise expectations about oil market fundamentals.

Indeed, the sharp rise in oil prices has caused many market participants to reassess key relationships that formed the basis of their expectations about the functioning of the oil market. Among these are the relationships between oil prices and growth, the limited responsiveness of non-OPEC supply to the sharp rises in oil prices, and OPEC behaviour over the cycle.

Oil Prices and Economic Growth

There is a large body of theoretical and empirical literature that emphasises the inverse relationship between oil price changes and economic growth. The proponents of this view assert that the majority of recessions in the OECD were preceded by oil price shocks and that the 2008 financial crisis was no different.[14] Although its roots could be attributed to problems in credit markets, the impact of the 2008 financial crisis on growth would not have been so profound if it were not for the high oil prices. According to this view, a persistent rise in oil prices such as that experienced before the 2008 financial crisis has an adverse impact on key industries such as the motor industry; affects consumer sentiment and spending; makes some capital stock redundant; and, by increasing uncertainty, can lead to postponement of investment and consumption decisions with detrimental effects on key macroeconomic indicators such as output, growth and employment.[15]

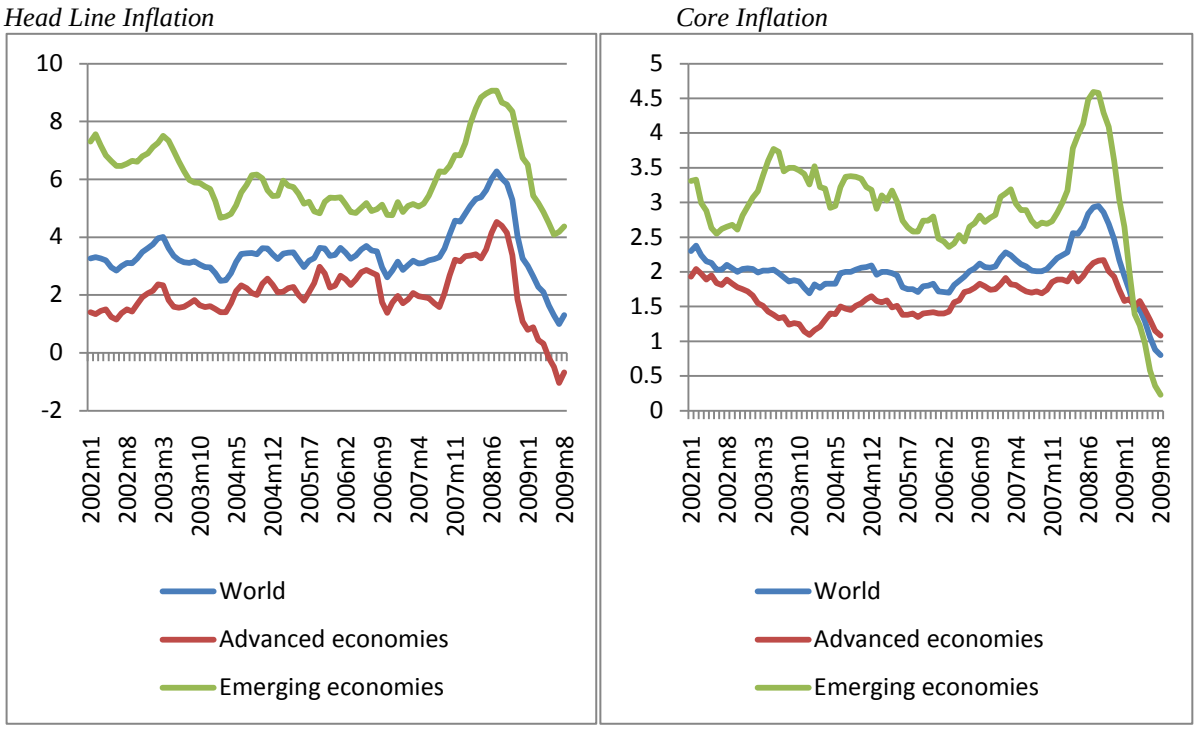
An alternative view is that oil price shocks are not special and are just like many other shocks that hit the economy.[16] In effect, the impact of an oil price rise is similar to that of an indirect tax and involves a transfer of income from oil importers to oil exporters. The ultimate impact on the global economy, however, depends on how oil exporters use the oil revenues and whether these are being saved or spent. This view submits that since oil price shocks have a deflationary effect on the economy through

[13] International Energy Agency (2009), *Medium Term Oil Market Report 2009 Edition*, June.
[14] Hamilton, J.D. (2009), 'Causes and Consequences of the Oil Shock of 2007-2008', *NBER Working Paper* 15002, May.
[15] Hamilton, J.D. (2009), 'Causes and Consequences of the Oil Shock of 2007-2008', *NBER Working Paper* 15002, May.
[16] Segal, P. (2007), 'Why Do Oil Shocks No Longer Shock?' *OIES WPM* 35.

the lowering of real disposable income and real consumption, fiscal and monetary authorities can engage in offsetting policy responses. For instance, if there is no change in inflationary expectations, monetary policy can lower interest rates to counteract the impact of oil price rises.

One of the most interesting features of the recent oil boom is the limited impact it had on inflationary expectations. Unlike previous episodes, this time, the impact of the oil price rise on inflation has been muted. While the increase in the oil price generated first round effects and led to an immediate rise in consumer price inflation, oil price rises did not generate wage inflationary expectations, especially in OECD countries, as Figure 8 shows. This has been attributed to a decline in the power of trade unions in OECD, a bigger pool of labour supply as India and China have become more integrated into the global economy, and the wide adoption of inflation-targeting by central banks. Regardless of the causes, the absence of wage inflation meant that monetary authorities did not have to pursue a contractionary monetary policy to combat inflation caused by higher food and energy prices. Another argument put forward in favour of this view is that since the oil intensity of GDP has been in decline in OECD countries these economies have become less sensitive to oil price fluctuations.

Figure 8: Global Inflation



Notes: Twelve-month change of the consumer price index
Source: IMF (2009), *World Economic Outlook: Sustaining the Recovery*, October

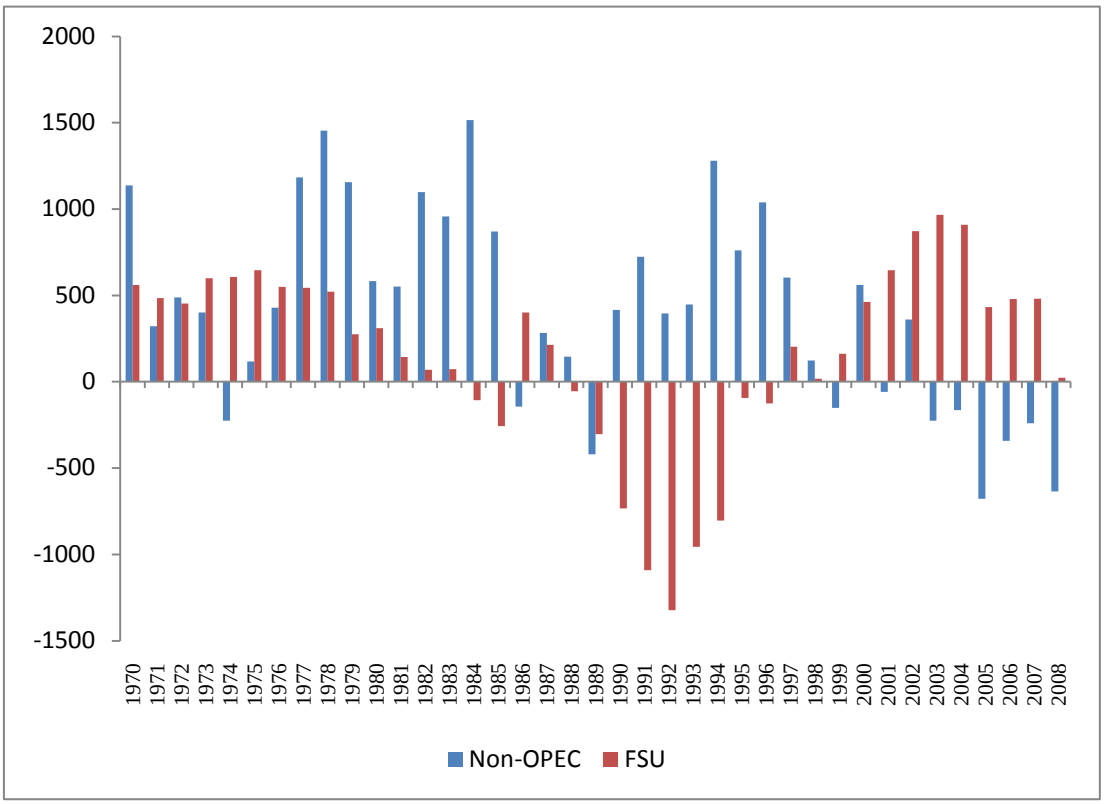
Those that subscribe to the above view posit that that the global economy can continue to grow in a high oil price environment. This view undermines a key element in the conventional wisdom on the

relationship between GDP growth and oil prices. In effect, it implies that oil prices have to rise to very high levels before they induce a serious feedback from economic growth. This belief was consistent with many economic reports that were predicting high growth rates while at the same time predicting a sharp rise in commodity prices.

Non-OPEC Supply and its New Features

Despite the rapid rise in oil prices between 2001 and 2008, the response of non-OPEC supply outside the Former Soviet Union (FSU) remained weak (see Figure 9). This poor performance reflects key structural changes manifested in high decline rates and the variability of non-OPEC supply growth. According to a recent OPEC report,[17] the weighted average annual observed decline rate over the period 2000-2008 stood at 4.6% per annum, implying that 1.8 mb/d of non-OPEC supply needs to be replaced to prevent it from declining.[18] Such high decline rates imply that special attention needs to be given to recovery rates. Furthermore, the main sources of non-OPEC supply growth have become more varied. In the next few years, the main sources of non-OPEC supply will be deep offshore in Brazil, ethanol in the US and tar sands in Canada.

Figure 9: Non-OPEC and FSU Supply Growth (Year-on Year, thousand barrels/day)



Source: *BP Statistical Review*

[17] OPEC (2009), *World Oil Market Outlook* 2009, Vienna: OPEC, Box 4.2.
[18] As expected, the highest decline rates are in OECD Pacific and Western Europe which witnessed annual decline rates of around 9.3% and 8.6% respectively over the period 2000-2008.

These changes have a number of important implications. In effect, the world has entered the phase of substituting a relatively cheap-to-extract barrel with a relatively expensive-to-extract one. On average, it has become more costly to develop oil reserves in non-OPEC countries. In addition, maintaining stable decline rates in mature fields requires the use of advanced and more costly technology. Furthermore, the scale and risk profile of non-OPEC suppliers are different from those of the past. It is now technically, financially, and managerially much more challenging to extract oil in these areas. This may cause delays in project completion inducing uncertainty about the timing of entry and the size of the increment. Sources such as tar sands and ethanol are more sensitive to lobbying groups and governmental policy. Finally, because of the different risk profile and the higher costs involved in development and production, non-OPEC supply has become more sensitive to oil price cycles. Specifically, there seems to be an asymmetric response to oil prices. A sharp rise in oil price induces a modest investment response in non-OPEC countries, while a decline in the oil price generates a sharp fall in investment and a period of underinvestment in oil sector , especially in those segments with relatively high marginal costs.

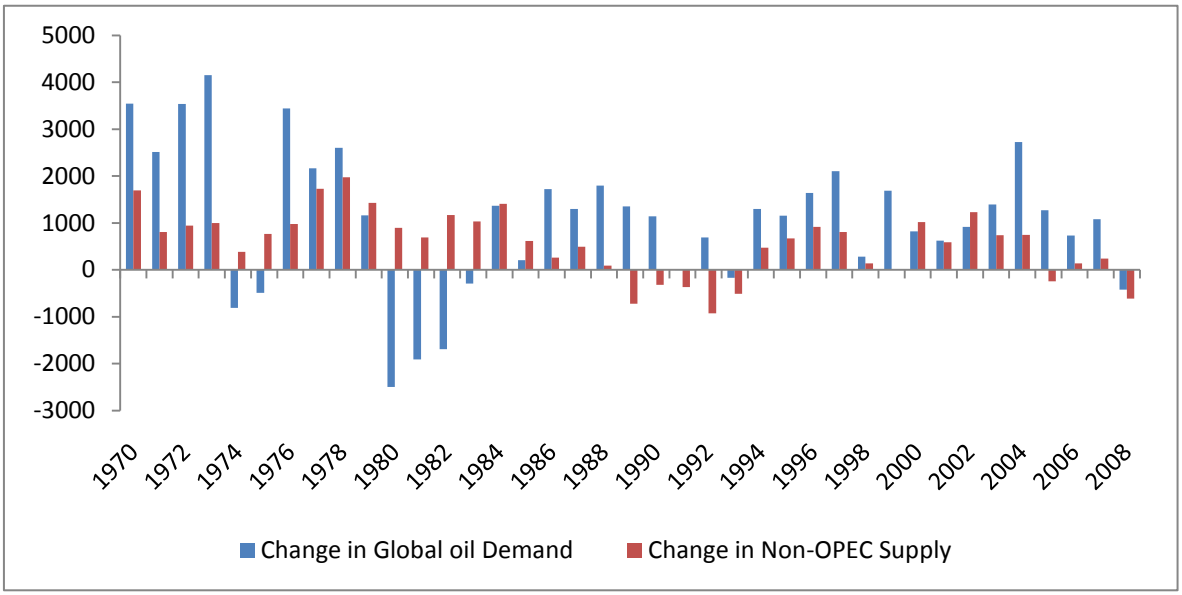
The weak response of non-OPEC supply to the sharp rises in oil prices, and the change in the risk profile of potential sources of non-OPEC supply, constitute major sources of uncertainty in the market. The uncertainty concerns both the magnitude of the year-on-year change in non-OPEC supply and the timing of any new supply's arrival to the market. This represents a major departure from the early 1980s, when non-OPEC supply response to high oil prices was positive and when supply was able to expand further in the face of lower prices, given the scope for aggressive cost reduction, significant application of technology, and sharp reductions in government taxation. During the boom years, the supply response from non-OPEC suppliers appeared to be more limited, and non-OPEC supply has struggled to keep pace even in a relatively high price environment.

Spare Capacity

As seen in Figure 10, for most of the current decade the year-on-year change in global oil demand has exceeded that of non-OPEC supply. Most of the incremental demand over these years has been met by OPEC. A relative lack of investment in the international oil industry has occurred with a backdrop of higher decline rates in mature fields. Most of the immediate increase in OPEC supply came from high utilisation of existing capacity rather the provision of new capacity, leading to a gradual decline in OPEC's spare capacity, which reached relatively thin levels as early as 2004 and 2005 (see Figure 7). When capacity constraints become the dominant force in the market, the following price dynamics are likely to emerge: an accelerated rise in the average level of prices; an increase in the volatility of prices and more frequent spikes in crude prices in face of shocks. In effect, the gradual erosion of spare capacity has had the effect of steepening an already highly inelastic supply curve. Given that oil demand in the short run is also highly inelastic, and that information on both curves is often opaque,

this combination yields volatility and price spikes. The market's ability to generate automatic supply and demand responses (feedbacks) that could put a ceiling on the oil price appeared to have been greatly weakened during the early phase of the oil price boom.

Figure 10: Change in Global Oil Demand and Change in Non-OPEC Supply (Year-on Year)



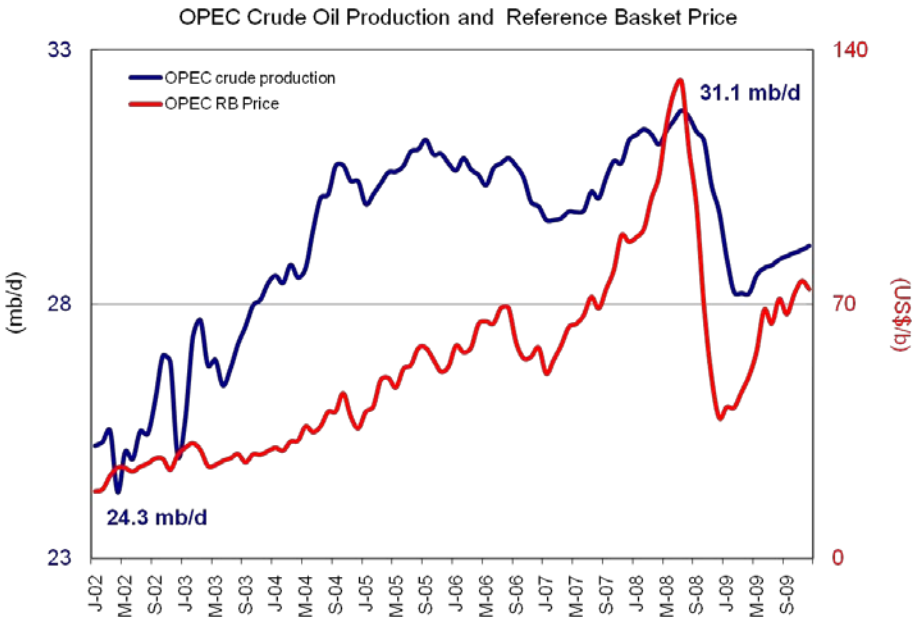
Source: *BP Statistical Review*

OPEC Cycles

An important part of the conventional wisdom that influenced the price formation process has been OPEC's behaviour. There was a common market belief that in the face of high and rising oil price, OPEC will respond by increasing supply to put a ceiling on the price. This would be in the long-term interest of OPEC members as such an action would help maintain healthy growth in global oil demand and limit the entry of substitutes such as tar sands and ethanol. This view was influenced by OPEC's decision to introduce a price band in 2000, which involved production adjustments when the OPEC basket price moved above $28 for 20 consecutive trading days or when the price moved below the $22 for 10 consecutive trading days. This was also reinforced by OPEC's official position that "extreme price levels, either too high or too low, are damaging for both producers and consumers".

In recent years, OPEC behaviour could be best described in terms of cycles as seen in Figure 11. These reflect the relative balance of demand net of non-OPEC supply balance, and a more proactive role in controlling the level of stocks.

Figure 11: OPEC Supply



Source: OPEC

An interesting lesson that emerged from the 2002-mid 2008 oil price boom is that OPEC's objective of securing stable supplies in case of physical disruptions or in case of increased demand and the objective of achieving fair oil prices are separate processes. The former provides a form of insurance; the latter is a continuing process of attempting to prevent prices from falling below the levels that would impact on longer-term capacity building and longer-term balance.

Another interesting lesson to be drawn from recent experience relates to the asymmetry of OPEC's responses to oil price movements. Specifically, the latest boom has shown that a key objective of OPEC is to avoid oil prices from falling below some level deemed unacceptable by its members. Its role is not to prevent oil prices from rising above certain levels or to set a price ceiling, when OPEC believes that the price is being driven by non-fundamental factors and that the oil market is well supplied.

Given the asymmetry in OPEC responses and the diversity of market players, OPEC's influence in the market is not straightforward. In a rising market, OPEC tends to satisfy demand at the available market-determined prices by using its spare capacity. In a falling market, OPEC sends a signal to the market about its preferred oil price. If the signal is successful in stabilising expectations about its preferred price, OPEC will not have to resort to output cuts. Instead, it will continue to meet demand at a price with which the Organisation is comfortable, given prevailing market conditions. However, OPEC signals are rarely successful in stabilising short-term expectations in a falling market. After all, OPEC signals are sometimes perceived by the market as not credible because it is costless to make them. In a falling market, financial players expect OPEC to implement output cuts to balance the market. If the expected output cuts are large, these players start to question whether OPEC will be able to implement them given the 'internal divisions', the different needs of its members, and the difficultly of sustaining a unanimous production decision in face of falling demand. However, OPEC usually succeeds in implementing the necessary production cuts, especially if oil prices fall to very

low levels deemed unacceptable by its members. These interactions with market players complicate the channels through which OPEC influences the market and create a time lag between the time OPEC announces an output cut and the time that market players respond to the OPEC signal.

In short, the perception that OPEC would respond by increasing supply to limit price rises has been important for anchoring short term expectations about oil prices. In this cycle, uncertainty as to whether OPEC would generate a strong feedback in a rising market has contributed to destabilising expectations and reinforced perceptions of limited feedbacks. When oil market conditions deteriorated towards the end of 2008, uncertainty as to whether OPEC could implement the cuts destabilised expectations and caused the oil price to under-shoot.

Perceptions of Limited Responses and Oil Price Behaviour

Doubts as to whether a rise in the oil price would induce meaningful changes in supply, in demand, in players' behaviour or in government responses, destabilised short-term expectations and resulted in a wide band within which the oil price could oscillate. Perception of limited feedbacks also affected the way in which long expectations were formed, with important implications for oil price determination. Since 2004 and until most of 2008, changes in the prices at the front end of the curve were normally associated with very similar changes in prices at the back end of the futures curve. This indicates that, during the boom, the oil market had entered into a phase of indeterminacy of expectations, where market participants (including oil companies and oil producers) did not know where to anchor the oil price that would balance supply and demand in the long run. The whole futures curve became subject to a series of shifts, sometimes parallel, sometimes weighted to the front and sometimes to the back, but the key change is that curve as a whole has been set in motion; the cantilever has broken free of the wall.

Derivatives Markets and Financial Investors: The Consolidation Phase

In parallel with developments on the physical side of the market, the related oil derivatives markets witnessed major transformations that would eventually consolidate the importance of futures and over-the-counter (OTC) markets and financial players in the process of oil price formation. The increasing importance of the futures market in the process of price discovery is a result of a number of key transformations in the oil market over the last two decades, such as the change in the international pricing system, the large entry of financial players, and the increase in players' diversity in recent years. While financial institutions have been the largest traders of oil since 1985, banks have become more involved in bridging the gaps between producers and a more diverse set of customers. Tight market conditions, among other factors, such as low interest rates on alternative assets and financial innovation, encouraged the entry of active money funds and institutional investors into commodities markets, including the crude oil market. As Alan Greenspan noted, when "it became apparent that the world's industry was not investing enough to expand crude oil production capacity quickly enough to

meet rising demand, increasing numbers of hedge funds and other institutional investors began bidding for oil."[19] Tight market conditions increase the upside potential for financial investments and speculative bets, especially in the presence of shocks originating from various sources.

Thus, the growing interest of financial investors in the oil market from 2004 onwards has been endogenous to oil market conditions; it was interlinked with the tightening of the physical market as a whole, should not be thought of as an external development that occurred in isolation, and represents a consolidation of a trend that began with the collapse of the administered pricing system and the emergence and increasing importance of derivatives markets in price discovery.

The Layers of Oil Price Discovery

After the collapse of the OPEC-administered system and the short experiment with netback pricing in 1986-87, market players adopted market-related pricing, which became and remains the principle method for pricing crude oil in international trade.[20] Its structure is based on formula pricing where the price of a certain variety of crude oil is set as a differential to a certain benchmark or reference price. The reference price is derived from the market and not set by an international body. Oil market conditions in the early 1980s were ripe for a transition to the new pricing system. The end of the concession system and the nationalisation of multinational oil companies' assets in the late 1970s disrupted the oil supplies to these companies and established the basis of arm's-length deals and exchange outside these companies. The emergence of many suppliers outside OPEC and many buyers in the late 1970s and early 1980s further enhanced the importance of spot deals. These and other factors have led to the development of a complex structure of oil markets that consists of spot, physical forward, futures, options and over-the-counter markets. Such a complex structure emerged in the North Sea around the market for Brent crude.[21] In the early 1980s, the Brent market only consisted of the spot market and the informal forward physical market (the 15-day market). By the late 1980s, it had become quite complex, including a futures contract traded on the International Petroleum Exchange (IPE) (later changed to the Intercontinental Exchange [ICE]), options, swaps and other

[19] Statement of Alan Greenspan before the Committee on Foreign Relations United States Senate, 7 June 2006.

[20] For details see Mabro, R. (2005) 'The International Oil Price Regime: Origins, Rationale, and Assessment', *The Journal of Energy Literature*, XI(1); Fattouh, B. (2006), 'The Origins and Evolution of the Current International Pricing System: A Critical Assessment', in R. Mabro (ed.), *Oil in the 21st Century*, Oxford: OUP; P. Horsnell and R. Mabro (1993), *Oil Markets and Prices: The Brent Market and the Formation of World Oil Prices*, Oxford: Oxford University Press.

[21] The Brent Blend is a mixture of oil produced from separate oil fields and collected through two main pipeline systems, the Brent and Ninian, to the terminal at Sullom Voe in Shetland, UK and then transferred through tankers to European refiners or, when arbitrage allows, across the Atlantic. The Brent and Ninian systems were separate but in 1990, the two were commingled and Ninian ceased to trade as a separate crude.

trading instruments. In North America, other complex layers of trading instruments, including the most liquid futures market, have emerged around West Texas Intermediate (WTI) grade crude.[22]

In the early stages of the current oil pricing system, crude oil was priced off the spot market quotations of these benchmarks, as reported by the price reporting agencies such as Platts and Petroleum Argus. However, the declining liquidity of the physical base of the reference crudes and the narrowness of the spot market has pushed many players to look for an alternative market for price discovery. The alternative was found in the futures market where financial contracts are traded.

There are very divergent views on the efficiency of futures market in the process of oil price formation. On the one hand, sceptics argue that the existence of futures markets may encourage excessive speculation, which in turn might serve to destabilise the underlying physical markets. On the other hand, the proponents of futures markets argue that the shift to the futures market is justified by the perceived inadequacies of the spot markets which had become vulnerable to manipulation, distortions and squeezes. These proponents emphasise the price discovery function of futures markets through higher liquidity levels and a greater transparency than is possible in the physical markets. By collecting and aggregating market participants' views and expectations and disseminating a regular flow of information about prices and liquidity, futures markets can improve the price formation process in the spot market. Also, a futures price is, after all, determined by actual transactions in the futures exchanges and not on the basis of assessed prices set by oil price reporting agencies. Furthermore, the timely availability of futures prices enhances price transparency. The volume of daily transactions and the volume of open positions are useful information to gauge the liquidity of the market.

The price discovery function of the futures market takes on a special importance in the context of the crude oil market, as there have been serious doubts about the ability of the spot physical market to generate a price that accurately reflects the value of the marginal barrel. One of the main problems is the declining liquidity of the physical base of the international benchmarks, mainly WTI and Brent, and the narrowness of the spot market. In thin and illiquid markets, reported deals are far apart and irregular. As a result, very few or even no price quotations for actual transactions are observed in a trading day. Thus, in order to obtain a regular flow of price quotes, markets rely on oil price reporting agencies for daily price assessments of reference crudes. The process of price discovery is not fully transparent and the factors that enter into the assessment process are not clear. Furthermore, some have argued that limited liquidity increases the crude market's vulnerability to manipulation,

[22] WTI is a blend of crude oil produced in the oil fields of Texas, New Mexico, Oklahoma and Kansas. WTI deliveries are made at the end of the pipeline system in Cushing, Oklahoma. Cushing serves as a major crude oil marketing hub in the USA where, in addition to WTI, it receives imported crude oil from the Gulf Coast. Crude oil in Cushing is then transported through a network of pipelines to refineries in central parts of the USA.

distortions and squeezes.[23] Squeezes are made possible by two features: the anonymity of trade and the huge volume of trading compared to the underlying physical base.[24] Squeezes are much easier to perform in a thin market with few players.

Thus, in theory, one could distinguish between two main layers for price discovery. One layer is assessed prices made by oil reporting agencies, and more recently, by bids and offers on partial cargos. These prices are derived from relatively illiquid physical markets which lack transparency and are dominated by few players. These prices play a key role in the oil market since most of the oil traded is based on contracts that include assessed prices in their pricing formula. Another layer is the futures market, which is more transparent, highly liquid and characterised by a large number of players with diverse expectations.

An interesting issue that warrants further exploration is the nature of the relationship between these two layers. Limited empirical evidence from other commodities suggests that spot markets act as satellites of the futures markets, with most of the new information being first incorporated in the futures price, and then transmitted to assessed prices.[25] This is not surprising given that trading in futures markets can be conducted more efficiently and cheaply when compared to the illiquid crude oil physical benchmarks. In this respect, the futures market plays a key role in price discovery. In its absence, market players would have to rely on illiquid and highly non-transparent physical benchmarks for price discovery. On the other hand, the physical market is intended to ground prices in the futures market, through the possibility of physical delivery of WTI, and through cash settlement against assessments of OTC cargo market values for Brent.

Transferring and Pricing Risk

In addition to its price discovery function, the futures market, together with other OTC markets, provides a mechanism for pricing and transferring risk between speculators and hedgers. Generally, the more atomistic and short-term the hedger, the more likely futures markets are to be able to serve the hedging need alone. Larger hedgers, and particularly those hedging larger volumes further down

[23] A squeeze refers to a situation in which a trader goes long in a forward market by an amount that exceeds the actual physical cargoes that can be loaded during that month. If successful, the squeezer will claim delivery from sellers who are short and will obtain a cash settlement involving a premium. Naturally, the price of the particular crude that has been squeezed will rise relative to that of other marker crudes. Sometimes a reversal of the sign of the usual differential may occur.

[24] Mollgaard, H.P. (1997), 'A Squeezer Round the Corner? Self-Regulation and Forward Markets', *The Economic Journal*, 107(440):104−12.

[25] See Garbade, K.D. and W.L. Silber (1983), 'Price Movements and Cash Discovery in Futures and Cash Markets', *Review of Economics and Statistics*, 65:289−97. Garbade and Silber perform empirical analysis for seven commodities (crude oil is not included) and find that for all the seven commodities, markets are well integrated over one or two months, but there is considerable divergence between cash and futures markets over shorter time intervals, especially for grains. As regards to the price discovery function, they find that in general futures markets dominate. Spot markets act just as satellites of the futures markets. Most of the new information is incorporated first in the futures markets and then flows to the spot market.

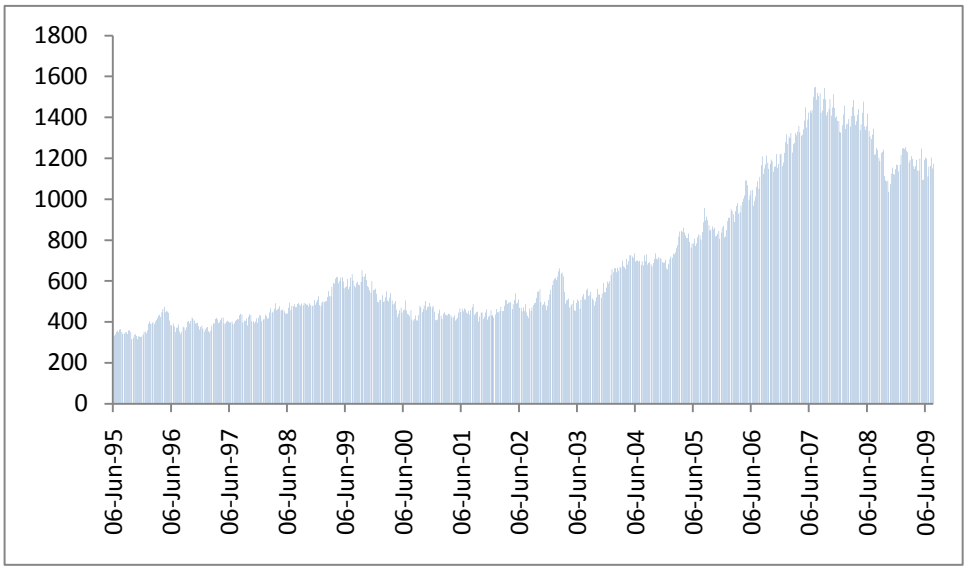
the curve, are more likely to rely on OTC markets, where the more difficult forms of hedging execution can be achieved with fewer distortionary feedbacks onto prices.

Hedgers are defined as those who use the markets to manage the price risks associated with the use of a commodity, while speculators are those that enter markets to profit from price movements. The role of speculators in the futures markets is essential as they constitute the major source of liquidity, which is essential for price discovery and for efficient risk management. However, the distinction between the two types of market participant is hard to make in practice. As recently noted, "the line between minimizing risks – which is what the term 'hedge' connotes – and maximizing profits – which is what the term 'speculation' connotes – can be exceedingly difficult to draw".[26]

The Market Participants

One way to gauge the increasing level of interest in the futures market is to examine the evolution of open interest: this indicates the number of futures contracts bought (long)[27] or contracts sold (short) and not yet liquidated either by an offsetting transaction or through physical delivery. As seen in Figure 12, the total open interest (futures contracts only and across all maturities) increased dramatically reaching more than 1.4 million contracts in June 2008.[28]

Figure 12: Total Open Interest (Thousands of Contracts)



Source: CFTC

[26] Staff of S. Permanent Subcomm. on Investigations of the Comm. on Homeland Security and Governmental Affairs, 111th Cong., Excessive Speculation in the Wheat Market 4 (5 June 2009).(Hereinafter, 'Wheat Report')
[27] An investor is said to be long if she 'has bought a futures contract to establish a market position; (2) [has] a market position that obligates the holder to take delivery; (3) or one who owns an inventory of commodities.'
[28] The data appears weekly in the *Commitment of Traders Repor*t (COT), which provides a breakdown of each Tuesday's open interest broken down by aggregate commercial, non-commercial and non-reportable holdings.

Given the difficulty of distinguishing between hedgers and speculators, until September 2008, the Commodity Futures Trading Commission (CFTC) data division broadly classified participants in commodity markets into two groups: commercials and non-commercials. Commercials include entities such as producers, consumers or merchants that have physical risk to hedge. It is important to note that the CFTC does not consider the motivation for commercials entering into the market and hence it is only fair to assume that some commercials may occasionally trade the futures market for speculative motives. The term "'Non-commercial' refers to those participants with no interest in the physical market, although given that they may still be exposed to price risk through instruments, or that they may deal on behalf on those with physical price risks, some of their trading may in effect be closer to hedging in its motivations. In other words, the CFTC's categorisation is usually based on a general classification of traders, and generally not on the exact motivation of every trade.

Based on unpublished data, in 2008 the CFTC provided new information on sub-categories for both commercials and non-commercials.[29] The subcategories for commercial participants included commercial producers, commercial manufacturers, and commercial dealers and swap dealers. The main sub-categories for non-commercial participants include hedge funds, floor brokers and traders. Within commercials, the open interest of swap dealers has witnessed the highest growth between 2004 and 2008 as seen in Figure 13. Within non-commercial, the open interest of hedge funds has witnessed the highest growth between 2004 and 2008 as seen in Figure 14.[30]

[29] See CFTC (2008), *Interagency Task Force on Commodity Market, Interim Report on Crude Oil*, July.
On crude oil, see also Büyükşahin, B. Haigh, M.S., Harris, J.H., Overdahl, J.A. and Robe , M.A.(2008) 'Market Growth and Trader Participation in Futures Markets', *CFTC–Office of the Chief Economist Working Paper*, December.

[30] Starting in September 2009, the CFTC has provided this more disaggregated data on a weekly basis, splitting the long and short positions in a given week for both the NYMEX and the ICE contracts for WTI, across the new categories of producer-merchant (partially, but not completely equivalent to the previous commercial category), money-manager (including hedge funds), swap dealers (including the main banks and market makers), and others. Over time this disaggregation should produce a much richer, more complete and granular view of changes in futures market positioning. Indeed, even as a snapshot it provides a significant amount of useful information.

Figure 13: WTI Average Open Interest by Commercial Participants

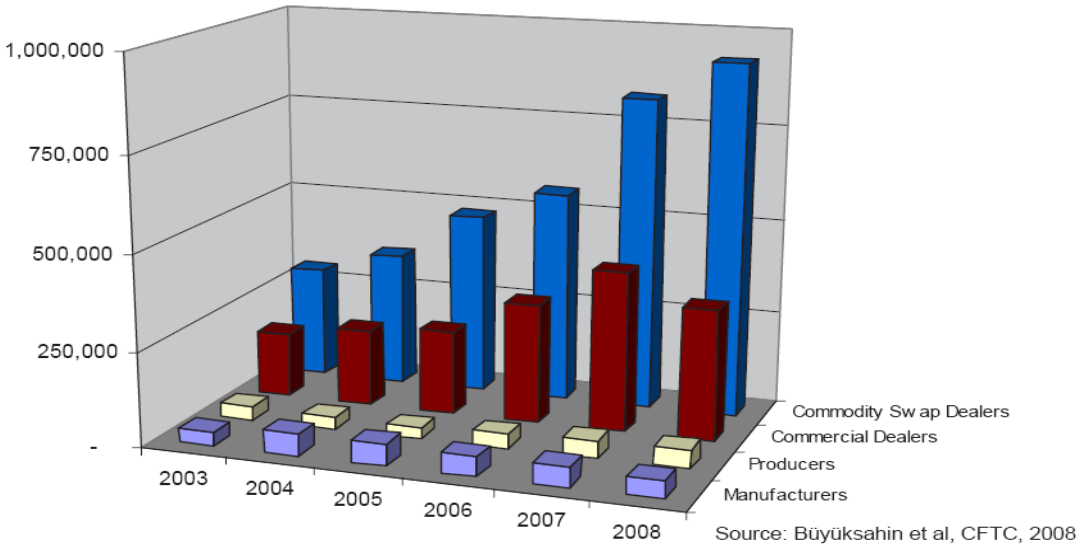
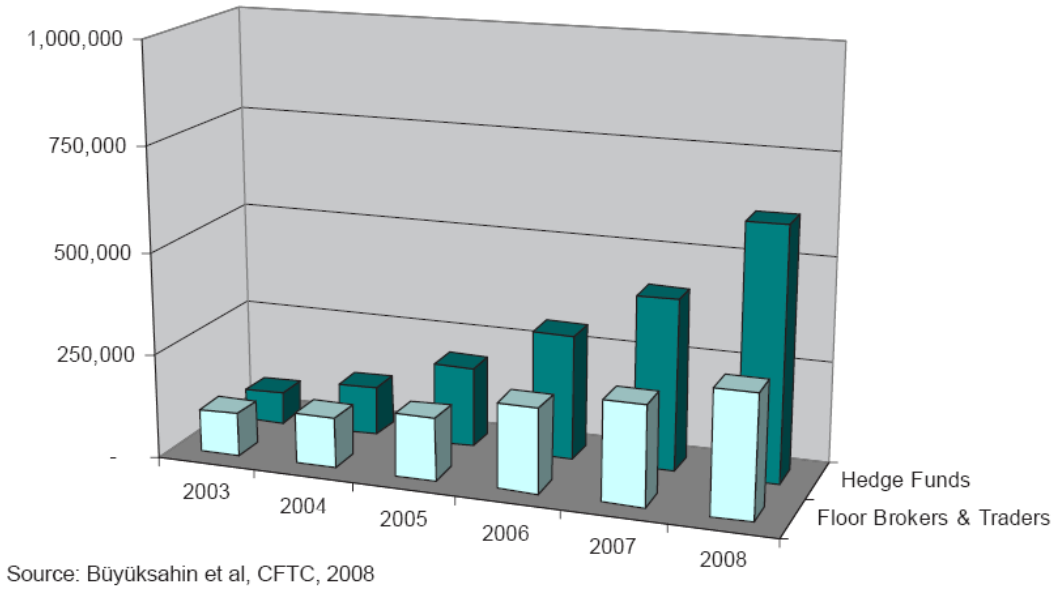


Figure 14: WTI Average Open Interest by non-Commercial Participants



Many reasons have been suggested as to why non-commercials have increased their participation in commodities markets. The historically low correlation between commodities' returns in general and other financial assets' returns, such as stocks or bonds, has increased the attractiveness of holding commodities for portfolio diversification purposes for some institutional investors such as pension funds and insurance companies. Second, expectations of relative higher returns in investment in commodities due to perception of tightened market fundamentals have motivated many investors to enter the oil market. Third, because commodity returns are positively correlated with inflation, many

investors have entered the commodities market to hedge against inflation risk and weak dollar.[31] Finally, financial innovation has provided an easy and a cheap way for various participants, both institutional and retail investors, to gain exposure to commodities.

Exposure to commodities markets can take more than one form. For instance, investors could gain exposure by holding physical inventories. Other than for precious metals, where storage and carry costs tend to be small relative to overall value, this option is often impractical and costly for many investors. Another way to gain exposure to commodities is to buy shares of companies that produce those commodities. The main disadvantage of this strategy is that the correlation between movements in share prices and price movement in the underlying commodity is often low, and there is an additional layer of management and company specific risk that can sometimes swamp the underlying commodity risk. Alternatively, financial investors can take positions in the futures market, the OTC markets, or through structured products. The main advantage of holding futures contracts, provided that the risk is taken further down the curve and does involve a constant churn of rolling prompt positions, is that the profit and loss realised is directly linked to the price movement of the underlying commodity.

Until recently, tracking investor interest in commodities was limited to tracking non-commercial futures positions in US futures markets. However, the rapid entry of financial actors, such as institutional investors, hedge funds and retail investors in commodities, has meant that these new types of investors can no longer be ignored. These financial players can be divided into five broad camps. 1) Macro hedge funds that trade in a range of markets, not just commodities. They have a top-down approach and take a view on macroeconomic issues. 2) Specialist commodity hedge funds that are more bottom-up, use large quantities of data and take a strong view of fundamentals of supply and demand. 3) 'Black box' hedge funds that have a view of the oil price based on calculations known only to them. 4) Institutional investors that primarily consist of pension funds, sovereign wealth funds and insurance companies; they typically put a small share of their funds into commodities for the sake of portfolio diversification. They also tend to sell when prices are high and buy when they are low, stabilising the market, owing to (price-weighted) limits in their portfolios. Finally, there are the retail investors, including private investors and high net worth individuals. Retail investment in commodity markets has been one of the fastest growing categories via the easy-to-access Exchange Traded Product (ETP) category.

Initially, institutional players' investment was through commodity indices, although greater maturity in the market has led away from reliance on passive indices and towards a more active, bespoke and focused approach. A commodity index swap is simply a financial instrument that allows for the exchange of financial flows between the buyer and the seller based on the value of a specified index,

[31] The fact that crude oil is being used to hedge against inflation and weak currencies is not clear and requires further explanation.

and in the case of most swaps, that index will be the price or price strip of a single commodity. Commodity indices comprise different commodity futures with different indices and have different weightings of those commodities. A 'swap dealer', usually a bank or broker-dealer, offer investors a swap whose value is linked to the value of a specified commodity index. These swaps are sold 'over the counter' (OTC). Swap dealers who are short in the OTC market may choose to hedge their risk in the futures market by taking an offsetting position; they may find a natural hedge within their existing overall book; or they may choose to add that risk to their book. Thus, index investments tend to be long only, and a significant proportion of their transactions will ultimately pass through the futures market in some form.

Another way to gain exposure to commodities is through exchange traded products (ETPs). These comprise exchange traded funds (ETFs) and exchange traded notes (ETNs). Like commodity swaps, ETPs allow investors to gain exposure to commodity indices or particular commodities. Unlike commodity swaps, ETPs are constructed as funds whose share can be traded on the stock exchange like any other share, and the ETPs themselves can be structured as being long or short. Commodity based ETPs have grown rapidly in recent years as they seem to offer a simple and a cheap way for investors to go into commodities. However, in oil, they have proved to be an extremely poor method of gaining exposure to the general level of oil prices. For example, the largest oil ETP, the United States Oil Fund (USO), was launched in April 2006 when WTI was trading above $68 per barrel. By October 2009 prompt WTI was trading $10 higher than that, but instead of rising, USO lost 60% of the value. USO rolls its contracts each month, meaning the expiring front contract is sold to purchase the new front contract, and in a contango market, the cumulative cost of those rolls had not only eaten up all the price appreciation, it had destroyed most of the initial value. While a few ETPs, particularly those that trade in precious metals, involve physical holdings, most have direct links to the futures market since these funds hold a basket of futures contracts to give value to their shares. As investment flows into ETPs increase, so does the volume of commodity futures contracts.

Financial Players, Speculation and Oil Prices

Despite fulfilling the key role of liquidity provision, the recent behaviour of oil prices has raised concerns about the entry of new financial players, with many attributing the marked increase in price volatility and sharp price movements to the trading strategies of these new players and the large flows of funds in and out of the paper oil market. In what follows, we review the main theoretical and empirical evidence on the relationship between speculative flows and oil prices.

The Theory

Many observers hold the view that the new players trade on noise and sentiment rather than on fundamentals, with adverse effects on the functioning of oil markets. Noise traders are often defined

as agents who sell and buy assets on the basis of irrelevant information rather than on market fundamentals or the arrival of new information.[32] They are usually contrasted with arbitrageurs, rational speculators or 'smart money' players who trade on the basis of information and thus tend to push prices towards fundamentals. Although noise traders may be active in financial markets, the traditional view has been that speculators trading on noise can be ignored in models of price formation because they will continuously lose money and will eventually exit the market. As Friedman (1953) points out, "people who argue that speculation is generally destabilizing seldom realize that this is equivalent to saying that speculators lose money since speculation can be destabilizing in general only if speculators on average sell low and buy high".[33]

However, this traditional view has been challenged by more recent work. [34] Some studies have shown that, on average, noise traders may be more aggressive than arbitrageurs, because these traders are more optimistic and over-confident and thus are likely to bear more risk. If higher risk is rewarded in the market, then noise traders can earn higher expected returns on average, and hence as a group, they need not disappear from the market. Other studies find that irrational traders can affect prices even if trading decreases their wealth overtime, implying that the price impact of irrational traders does not rely on their long run survival.[35]

However, even if noise traders are assumed to survive in the market, the question is whether changes in demand due to noise trading are big enough to affect prices and destabilise the market. In fact, many have argued that herding behaviour can lead to such a situation. Herding undermines the role of price discovery, may induce higher volatility and, under certain circumstances, can lead to sharp price swings. Herding results from an investor's decision to follow the apparent trading strategies of other investors. If the shifts in demand are correlated and do not cancel each other out, then noise trading is capable of influencing market prices. Interestingly, recent theoretical developments indicate that herding can occur even if the assumption of rationality is maintained. For instance, under the assumption of information asymmetry, poorly informed traders have the incentive to watch the better informed traders and follow their trading strategies.[36] Other studies emphasise that the potential for herding behaviour implies that arbitrage is not without risk; thus it is not necessarily the case that arbitrageurs will always be able to arbitrage away the noise trade. Arbitrageurs may not have the

[32] Black, F. (1986) 'Noise', *Journal of Finance*, 41, pp. 529–543.
[33] Friedman, M. (1953), *The Case for Flexible Exchange Rates: Essays in Positive Economics*, Chicago: Chicago University Press.
[34] See for instance Shleifer, A. and L.H. Summers, (1990) 'The Noise Trader Approach to Finance', *Journal of Economic Perspectives*, 4, pp. 19–33. Their approach is based on the assumptions of irrationality and that arbitrage is not risk free and hence is limited.
[35] Kogan, L., Ross, S.A, Wang, J. and. Westerfield, M.M (2003), 'The Price Impact and Survival of Irrational Traders ', NBER Working Paper No. W9434, January
[36] For a review, see Bikhchandani, S. and Sharma, S. (2001), 'Herd Behaviour in Financial Markets ', *IMF Staff Papers*, 47(3), pp. 279-310.

incentive to counter shifts in demand by noise traders and may instead decide to ride the wave in the hope that they can dispose of the assets near the top before the noise traders.[37]

A number of theoretical studies have suggested that institutional investors have a greater tendency to engage in rational herding or momentum trading than other types of investors. Some studies explain this tendency in terms of the incentive/monitoring hypothesis. Since fund managers usually benchmark their performance on the basis of the performance of other managers, a fund manager may have the incentive to copy other fund managers' strategies if there is uncertainty about the ability or skill of that manager.[38] Similarly, some studies attribute herding behaviour to the agency problems in the money management industry. In this situation, the manager may act on behalf of her own interests (for instance maximise her commission income) rather than acting on the behalf of the fund for which she is responsible. These principal agent problems may result in short term horizon investments and, as a consequence, institutions may adopt similar trading behaviour even if their own information suggests otherwise.[39] Other studies argue that if a manager's compensation depends on how her performance compares to other managers, this can distort the managers' investment decisions resulting in the holding of inefficient portfolios and causing herd behaviour.[40]

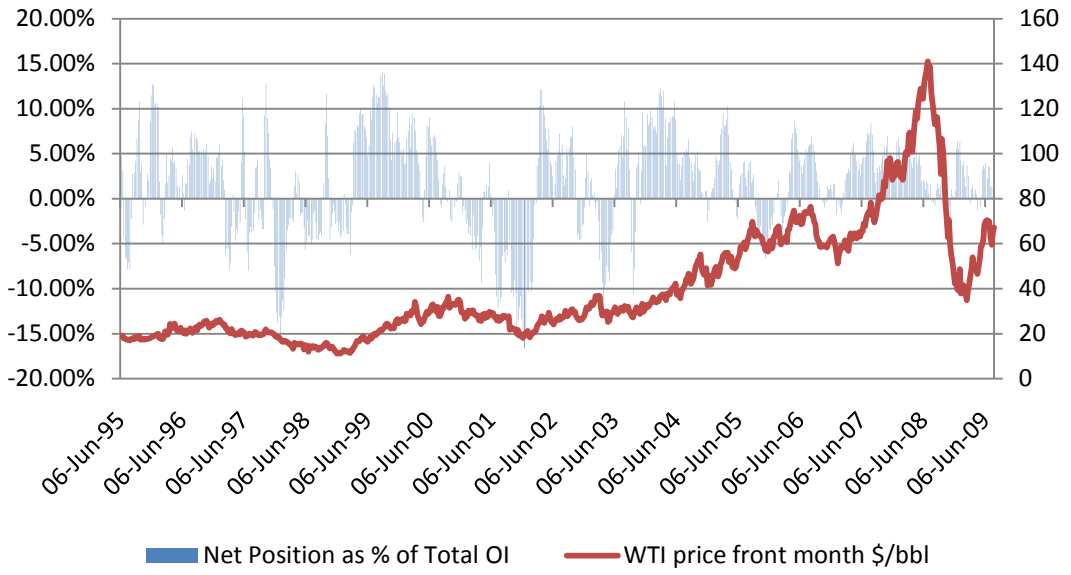
The Evidence

In contrast to the development of elegant theoretical models, empirical studies on the impact of financial players on oil prices have been limited.[41] Due to data limitations, the diversity of players in the market, and the difficulty of identifying the motive behind trading decisions, the empirical literature has struggled to offer much in the way of firm conclusions. Consequently, there is a broad diversity of views about the role of financial markets in price formation at present. Most of the studies that examine the role of speculation base their results on CFTC data, and most particularly, the relationship between the changes in the net long position of non-commercial traders and oil prices (see Figure 15).[42] Based on such data, it is possible to make three broad generalisations. First, the

[37] Brunnermeier, M.K. and Nagel, S. (2004), 'Hedge Funds and the Technology Bubble ', *Journal of Finance*, 59, pp. 2013–40.
[38] Scharfstein, D. and J. Stein (1990), 'Herd Behavior and Investment', *American Economic Review*, 80, pp. 465–79.
[39] Lakonishok, J., A. Shleifer, and R. Vishny (1992), 'The Impact of Institutional Trading on Stock Prices',.*Journal of Financial Economics*, 32, 23-43.
[40] Roll, R. (1992),'A Mean/Variance Analysis of the Tracking Error', *Journal of Portfolio Management*, 18, 13-22.
[41] Despite the richness of these theoretical discussions, the empirical evidence on herding lags behind. The empirical studies from financial markets other than oil reveal that, generally, institutional investors feedback trade more than individuals. However, they also show that the extent of such feedback trading is rather modest. In reviewing the literature, Richard Sias notes that that out of the eleven studies reviewed, four did not find any momentum trading; five did find weak evidence of institutional momentum trading; while two found strong evidence of momentum trading. See Sias, Richard W. (2007), 'Reconcilable Differences: Momentum Trading by Institutions', Financial Review, 42(1), pp. 1-22.
[42] The Technical Committee of the International Organization of Securities Commissions (IOSCO) initiated a Task Force in 2008 to examine a set of topics including the role of new participants in the futures markets and

variability of net positions is higher than the variability of oil prices. Second, there is no common trend between prices and speculative positions. In other words, there appears to be no persistent pickup in net long non-commercial positions coinciding with oil prices trending upward. Third, changes in non-commercial traders' net long positions may coincide with changes in oil prices. But this observation does not establish that speculators necessarily influence oil prices and could be the result of change in fundamentals that affect both oil prices and the expectations and behaviour of active money managers. In other words, correlation does not imply causation.

Figure 15: Net Position as a Percentage of Open Interest (Non-Commercials) and Oil Price



Based on disaggregated data, the CFTC itself examined the relationship between changes in oil prices and the change in net positions for commercial, non-commercials, commodity swap dealers and hedge funds. They found that the correlation for commodity swap dealers is very variable and hovers around zero. On the other hand, the correlation for hedge funds has been generally positive, suggesting that net positions of hedge funds often move in the same direction of oil prices. However, correlation does not imply causality. The ITF Interim Report on Crude Oil published in 2008 performs Granger-Causality tests and concludes that there is "little evidence that daily position changes by any of the trader sub-categories systematically precede price changes" (p. 27). With no access to the underlying data, it has not been possible for other researchers to replicate the CFTC analysis, although over time the provision of more data under the new disaggregations will facilitate a broader set of empirical results on this issue.

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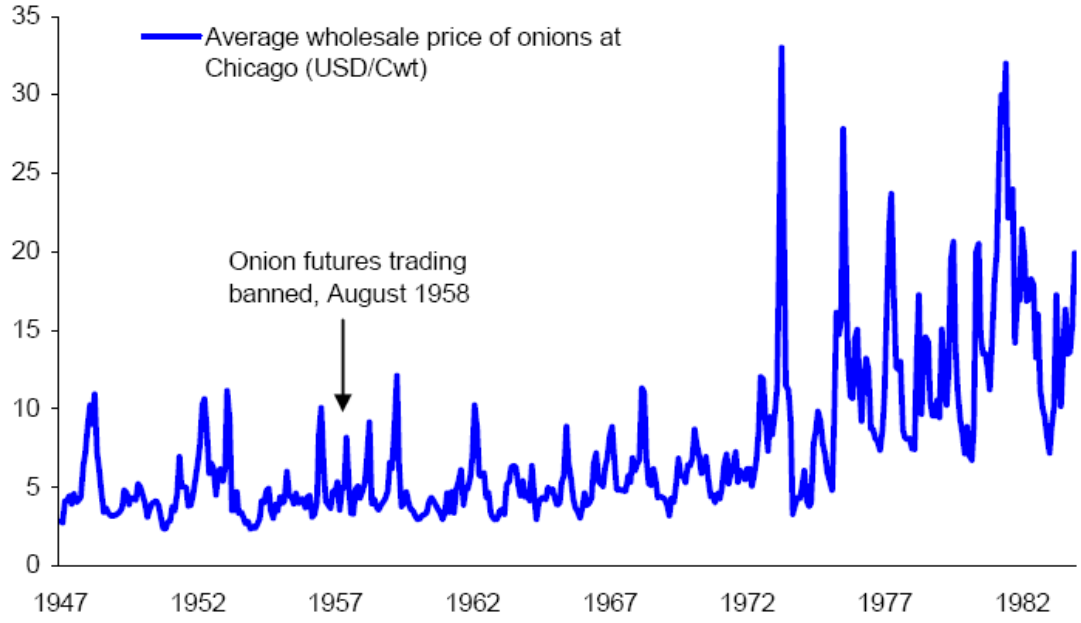
their impact on price discovery and volatility. In their final report, they provide a useful summary of current knowledge, based on studies conducted by international and national organisations such as the IMF, the European Commission, the UK Treasury Report, and the CFTC. See Technical Committee of the International Organization of Securities Commissions (2009), 'Task Force on Commodity Futures Markets: Final Report', March.

Another trend in the empirical literature examines whether commodities traded in the futures market or exchanges exhibit higher volatility than non-exchange traded commodities. A recent study exploring the history of futures markets suggests that futures markets have been associated with comparatively lower, rather than higher, commodity price volatility.[43] An example often cited is that of the onion market. In 1958, the US Congress banned the trading in onion contracts on the Chicago Mercantile Exchange. However, the ban, which is still in force today, did not succeed in preventing wild swings in the price of onions in the 1970s and 1980s, as seen in Figure 16. During the current boom, there is evidence that non-exchange traded commodities which are not open to speculators have witnessed the sharpest price increases (See Figure 17).[44]

Figure 16: US onion prices from 1948 to 1983

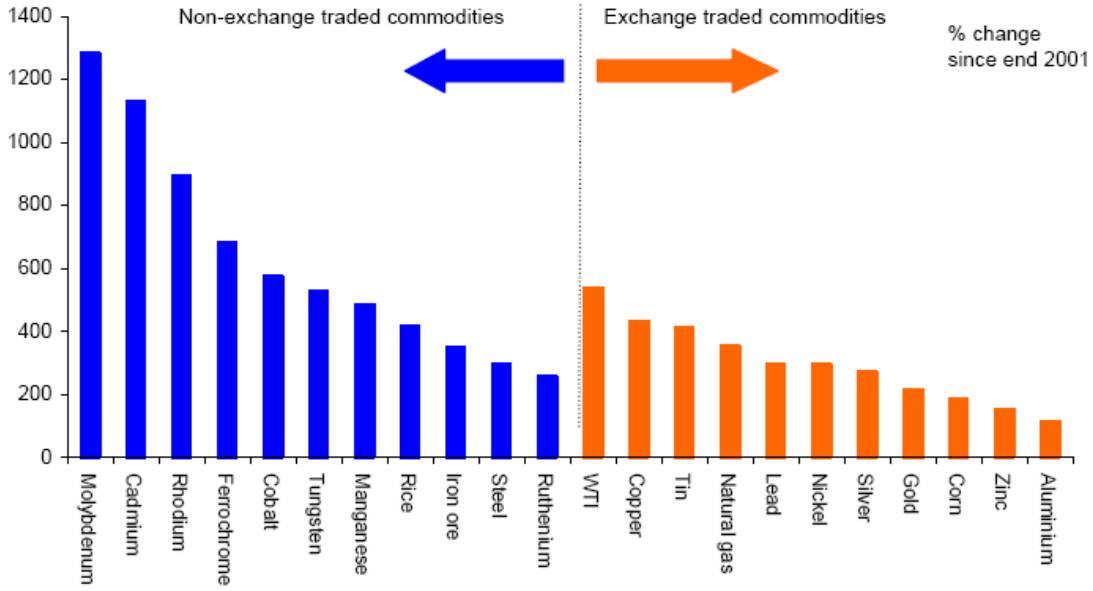


Source: Deutsche Bank, Commodities Weekly, 14 August 2009, Figure 1.

[43] See Jacks, D.S. (2007), 'Populists versus theorists: Futures markets and the volatility of prices', *Explorations in Economic History* 44, 342–362

[44] Deutsche Bank, *Commodities Weekly*, 14 August 2009.

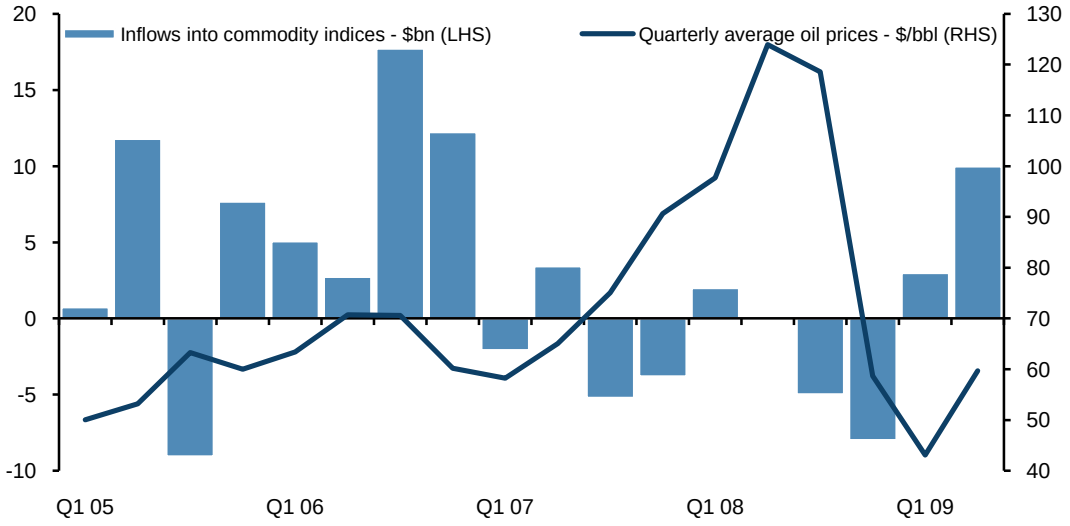
Figure 17: Price appreciation during the 2001-2008 commodity boom for exchange and non-exchange traded commodities



Source: Deutsche Bank, Commodities Weekly, 14 August 2009, Figure 2.

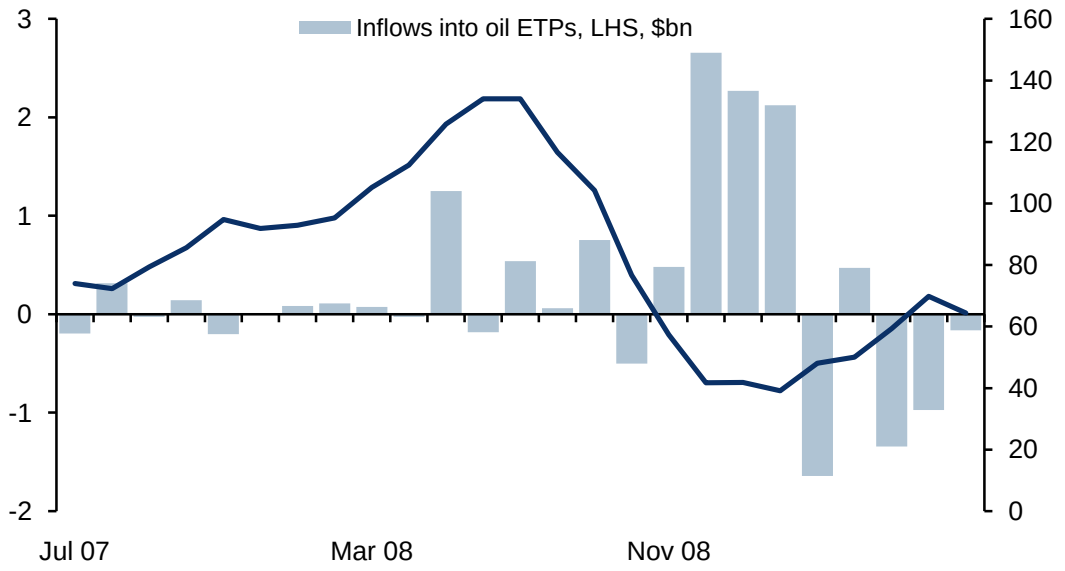
A number of observers have raised concerns that the massive influx of funds into commodities through commodity index swaps and ETPs has resulted in unwarranted upward pressure on oil prices. Figures 18 and 19, however, provide little evidence in support of this hypothesis. As can be seen from these graphs, there is no systematic relationship between inflows and outflows in commodity indices and ETP and the average oil price.

Figure 18: Inflows into Commodity Indices and Quarterly Average Price



Source: Barclay's Capital

Figure 19: Inflows into Oil ETPs and Monthly Average Price



Source: Barclay's Capital

An alternative view pertaining to the causation of crude oil pricing volatility and sharp swings focuses on the fact that changes in crude oil market fundamentals or even expectations have not been sufficiently dramatic to justify exclusively the extreme cycles in oil prices that have been seen over the last two years. According to this view, the oil market has been subject to a speculative bubble which has seen the oil price persistently rise above its fundamental value. Many economists and market observers have all recently gone on record supporting the concept that unfettered speculation in physical commodity markets have caused wholly unnecessary 'speculator premiums' to the ultimate consumers and have undercut market fundamentals.[45]

Some studies argue that in 2008 all the necessary conditions for the generation of an oil bubble were present: a short term inelastic supply, a commodity which is actively traded, and a credible story that feeds into expectations of ever rising prices.[46] The existence of such conditions, however, is not sufficient to prove that the oil market has been subject to a bubble. These studies support their argument by pointing to a number of bubble signs: the large influx of funds into the oil market, the rapid accumulation of inventories,[47] and the price-rise above the marginal cost. Assessing these various factors in the oil market, a recent study concluded that "market prices were not consistent with

[45] See the testimony of Michael Greenberger before the Commodity Futures Trading Commission on Excessive Speculation: Position Limits and Exemptions, 5 August 2009. Greenberger provides an extensive list of studies that are in favour of the speculative view.
[46] See Ahmad R Jalali-Naini, Opec Secretrariat, Research Division, *The Impact of Financial Markets on the Price of Oil and Volatility: Developments since 2007*: 33 (April 2009).
[47] See, for instance, L.K. Stevans and D.N. Sessions, 'Speculation, Futures Prices, and the US Real Price of Crude Oil', *Social Science Network*, 2 July 2008.

market fundamentals. It was the case of a short-lived bubble".[48] When the flow of speculative money reversed, the bubble burst.

Others point to the fact that while prices should reflect expectations of future market fundamentals, these expectations are often biased, exaggerated, and tend to focus on extreme events with low probability of occurrence effectively pushing prices above fundamentals.[49]

Proponents of the speculative view also point to some specific examples in which excessive speculation has been a major contributor to price volatility and price increases in the energy markets in recent years. In just one example, the dominance of a single speculative hedge fund, Amaranth, in the natural gas futures market drove up energy prices so much that upon its failure, the futures price dropped by 43% in just two months, between July and September of 2006.[50] Based on this and similar events, such proponents consider that excessive speculation has caused unnecessary volatility in the energy markets.[51]

Other studies explain oil price fluctuations in terms of a combination of fundamentals and speculation. For instance, the World Economic Outlook points to the possibility that "short term expectations can be influenced by sentiment and investor behaviour which can amplify short term price fluctuations as in other asset markets".[52] In its medium term oil market report, the IEA concludes that "it is questionable whether one can appropriately claim that oil price is therefore driven by speculation and by how much. Rather, it has to do more with the pricing mechanism in the market, which itself reflects the relative bargaining powers of sellers and buyers, which in turn will be heavily influenced by fundamental factors" (p.108). The report, however, later argues that "speculation… does appear to have an impact on the spot market in the very short term, particularly on a day-to-day basis" (p.109).[53]

In summary, the empirical evidence fails to analyse the broader aspects related to speculation and thus has not created a consensus. The first view considers that the current commodity boom can be explained by fundamentals such as strong demand, low inventory and spare capacity, and adverse supply shocks. Derivative investors and various categories of financial investors cannot systematically drive oil prices under that view. An opposing view sees the oil market as having been distorted by substantial and volatile passive investments causing a bubble in oil prices.

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[48] Against this view, see Scott H. Irwin, Dwight R. Sanders, and Robert P. Merrin, *'Devil or Angel? The Role of Speculation in the Recent Commodity Price Boom (and Bust)'*, paper presented at the Southern Agricultural Economics Association Meetings, Atlanta, Georgia, 31 January - 3 February 2009

[49] Ahmad R Jalali-Naini, OPEC Secretariat, Research Division, *The Impact of Financial Markets on the Price of Oil and Volatility: Developments since 2007*: 33 (April 2009).

[50] Staff of S. Permanent Subcomm. on Investigations of the Comm on Homeland Security and Governmental Affairs, Excessive Speculation in the Natural Gas Market 51-75 (25 June 2007) (hereinafter, 'Natural Gas Report').

[51] Izabella Kaminska, *Goldman still bullish on commodities: Oil, corn, copper to rise*, ft.com/alphaville, 10 November 2009, *available at* http://ftalphaville.ft.com/blog/2009/11/10/82451/goldman-still-bullish-on-commodities-oil-corn-copper-set-to-rise/ (last visited 12 November 2009).

[52] IMF (2008), *World Economic Outlook*, October.

[53] International Energy Agency (2009), *Medium Term Oil Market Report* - 2009 Edition, June.

The Dual Nature of Crude Oil and the Role of Expectations

Rather than framing the analysis in terms of fundamentals versus speculation, or attempting to slice the oil price into fundamental and non-fundamental components, a more useful approach is to recognise that crude oil has the characteristics of both a physical commodity and a financial asset. The changing nature of crude oil did not occur in a sudden manner, but has been the result of various structural transformations, some gradual and some discontinuous, in the oil market over the last two decades. These include the change in the oil pricing regime, the rapid growth of the paper market, the entry of diverse players with different investment strategies and the perception of limited feedbacks and long-term inelasticities. As a physical commodity, the oil price is influenced by current market fundamentals such as the supply-demand balance and the level of inventories. As a financial asset, the oil price is influenced by expectations of market fundamentals, as well as by other macroeconomic news. Thus, crude oil prices do not only reflect current market fundamentals, but also expectations about the future evolution of these fundamentals.

There are many advantages to using this approach. First, it recognises the major structural transformations in the oil market, both in terms of the change in the supply-demand dynamics and the role of financial players in the process of price formation. Second, it recognises that the players affecting oil prices have become more diverse. Third, it places the behaviour of financial players within the physical parameters of the crude oil market and thus avoids the pitfalls of analysing oil markets on the basis of speculation versus fundamentals. Finally, it brings to the fore the role of expectations in the process of oil price formation.

The Three Phases of the Cycle: Towards an Explanation of Oil Price Swings

A framework which takes into account the dual nature of crude oil as a physical commodity and as a financial asset, and highlights the role of expectations, offers an inclusive structure to answer the following three key events: the sharp rise in the oil price in the first half of 2008; the collapse in oil price in the second half of 2008; and the rise in oil prices in 2009. This analysis is quite important for understanding the key drivers of oil prices and for suggesting some measures to reduce oil price volatility and prevent sharp oil price cycles.

What Happened in the First Half of 2008?

In the first half of 2008, short term expectations about the existence and timing of feedbacks from prices to oil supply and demand were destabilised. Given highly inelastic oil supply and demand, and the passive behaviour of key players over the last cycle, market participants were sceptical as to whether rises in the oil price would induce meaningful changes in supply, in demand, in players'

behaviour or in government responses (i.e. generate feedbacks) that would bring a stop to the rise in the oil price. The regular flow of news and information about the tightness of the supply-demand balance reinforced those perceptions. In the first half of 2008, news about the collapse of non-OPEC supply growth, rapid decline rates in non-OPEC oil fields, that the world might be running out of oil or that oil production had peaked, and that demand was likely to outpace supply, caused many market participants to become bullish on oil prices.[54] Despite the weaknesses in OECD demand (especially in the US) and higher uncertainty about the prospects of the global economy, the market suppressed such information and instead focused on potential supply shortages, geopolitical concerns, and the weak US dollar.

In a market characterised by indeterminacy of beliefs and the perception of a limited supply-demand response, there is an implicit band in which oil prices could freely oscillate, leaving a role for what is known in the literature as multiple equilibria or sunspots.[55] The events of the last few years have highlighted two features about the *implicit* bands and behaviour of traders within the bands. First, the band has become very wide as a result of lifting the upper bound. Second, financial players are not shy in testing the upper and lower bounds which may result in overshooting or undershooting of prices.

Within the implicit band, price changes are influenced by a wide variety of public signals about current fundamentals and information and news which affects expectations about the future evolution of these fundamentals. But this may not always be true in an environment of high uncertainty. In such an environment, market participants tend to form their expectations of futures prices on the basis of other players' expectations. In other words, investment decisions will depend on 'higher order beliefs', i.e., players' beliefs about other players' beliefs, players' beliefs about other players' beliefs about other players' beliefs, and so on. This captures the intuition provided by Keynes's beauty contest metaphor where traders are motivated to guess other traders' guesses to benefit from short-term movements in oil prices. [56]

In such an environment, public information or signals take a leading role, even if these public signals do not necessarily reflect large changes in underlying fundamentals or provide new information to the market. Since public signals can affect a player's guess about other players' guesses, they could have

[54] During the first half of 2008, there were a wide variety of high price forecasts. In May 2008, a Wall Street equity analyst pointed to the possibility of a super-spike that would take the oil price to $200 per barrel (The New York Times, 21 May 2008). Likewise, a producing country minister warned that the price of crude could keep rising to reach $200 a barrel, blaming the falling value of the US dollar (BBC News, OPEC warns oil could reach $200, 28 April 2008, http://news.bbc.co.uk/1/hi/business/7370441.stm**),** and in June 2008 the chief executive of the Russian gas monopoly, Gazprom, predicted that oil prices could reach the figure of $250 per barrel in 2009 (The Daily Mail, 11 June 2008).

[55] See Morris, S. and H.S. Shin (2001), 'Rethinking Multiple Equilibria in Macroeconomics', *in NBER Macroeconomics Annual* 2000, 15, pp. 139-182, MIT Press: Cambridge, Mass.

[56] This idea has been formalised recently by Allen, F., S. Morris, and H.S. Shin (2006) 'Beauty Contests and Iterated Expectations in Asset Markets', *Review of Financial Studies* 19, 719.

a disproportionate impact on the oil price. [57] Participants closely watch public signals and other news on fundamentals and other market participants' reaction to these signals. What will matter in forming investors' expectations is what other investors think and how other investors are likely to respond to public signals and information. Building on these insights, one can explain why the impact of public signals and information (such as data on inventories, weak dollar, and peak oil) on oil prices was amplified in the first half of 2008.

What is important to stress is that when the role of public signals dominates, market players' privately held information about the status of market conditions takes a back seat. This is perhaps best reflected in models of information cascades. [58] The main feature of such models is that when investors are not certain about their private information or signals, investors begin to ignore their private information and base their actions on the observed actions of previous agents that have already entered the market. Although each individual is acting rationally, the crowd or the herd as a whole may make the wrong decision. Similar insights can also be found in game theory models. Very informed investors with detailed knowledge of the market still have the incentive to join in coordination games even when their private information indicates that oil prices should be moving in the opposite direction. This renders the distinction between different types of financial investors in such a world somewhat meaningless. For instance, even when rational arbitrageurs understand that the prices have risen or fallen too far, they still have the incentive to ride the wave, as doing so generates high short term returns. Since market participants have different beliefs and diverse opinions about the exit strategy, the oil price upward trend could continue for some time. [59]

Such insights also account for another interesting feature of the oil market in the 2000s boom years. While there is abundance of public news and information, traders often limit their attention to a few signals which they consider as important. Until the collapse of the oil price toward the end of 2008, market participants based their decisions on a few signals and public information, such as news about inventories and the weak dollar, while ignoring other types of information such as a weakening US and OECD oil demand and the fact that the market was well supplied. This type of behaviour is expected. For coordination games to work in practice, market participants should only consider signals that are public and are thought to affect the expectations of other participants at a particular point in time. This implies that they would focus only on a limited number of signals while suppressing other important information. After all, it is impossible to coordinate on a large number of public signals.

[57] See Morris, S. and H.S Shin (2003), 'Global Games: Theory and Applications', in M. Dewatripont, L. Hansen and S.Turnovsky (eds), *Advances in Economics and Econometrics (Proceedings of the Eighth World Congress of the Econometric Society)*, Cambridge Cambridge University Press.
[58] See for instance Bikhchandani, S., D. Hirshleifer and I. Welch (1998), 'Learning from the Behavior of Others: Conformity, Fads and Informational Cascades', *Journal of Economic Perspectives*, 12, pp. 151–70.
[59] See Abreu, D., and M. K. Brunnermeier (2003) 'Bubbles and Crashes', *Econometrica*, 71(1), 173-204.

The End of the Boom

One could argue that the sharp reversal in oil prices from July 2008 to February 2009 came in two distinct phases. The first was a cooling off in prices from their peaks, brought on primarily by the combination of a supply-side response from the key marginal producers following the Jeddah meeting in June 2008, and by mounting evidence in the rear-view mirror that OECD demand had weakened far more than initial expectations and provisional data flows had suggested. The second phase was more directly associated with the intensification of the global financial crisis, and the associated decline in expectations of future global economic growth. After peaking intra-day above $147 on 11 July, and posting its highest settlement value above $145 on 14 July, prices had fallen to $124 at the end of July; to $115 by mid-August; $110 by the start of September, and to $101 on 12 September - the last trading day before the Lehman bankruptcy. The overshoot in prices had by then been largely corrected by the market itself in the two-month period before the Lehman default. We would argue that, while the second phase was led by changing expectations about demand, this first phase was led by changes in expectations in supply. Some of the force behind rising prices had come from a perception that key producers were unwilling, or even unable, to increase production in response to higher prices. That position became untenable when key producers announced, and then delivered, significant increases in output. The Jeddah summit in June 2008 seems to have been a critical factor in altering market perception. The declaration by Saudi Arabia that they would increase output to 9.7 mb/d, followed by later market confirmation of that increase, played a key role in convincing the market to price in a more elastic supply response. To that extent, much of the initial adjustment in prices reflected a more proactive signalling from key producers, and a more realistic pricing in on remaining capacity on the supply side. The flow of demand side numbers did not look particularly weak to the market at that point; it was only later that the scale of global demand weakness over that period became clearer through the lagged data flow. However, after changes in supply-side expectations had done the first $40 or so of work, a further $65 or so of downside was opened up when rapid changes in demand-side expectations came to the fore as the key driver of prices. That period began with a watershed event, the Lehman bankruptcy, and the associated dramatic shift towards extreme fears for the world economy.

In mid-September 2008, just as Lehman Brothers was entering into bankruptcy, the Wall Street consensus of expectations for US growth in 2009 stood at 2.5%. By the end of October, consensus expectations had shrunk to zero growth, and by the end of February 2009 they had fallen further to a decline of 2.5%. Over just five months, the forecast for US economic growth fell by 5% points. The depth of the recession was shock enough for the system, but perhaps most damaging for commodities markets in general was the withdrawal of so much expected growth over such a compressed time period. The figures for consensus views of global economic growth are just as striking. Prior to the Lehman default, global GDP growth for 2009 was widely forecast at about 4.5%, but within six

months the consensus was for a decline of close to 2%. At the low point of expectations, early in 2009, the global recession was also expected to be of significant duration and impact very heavily on 2010 global growth as well. Indeed by the time of that low point, relative to the business-as-usual path as was envisaged before the intensification of the financial crisis, the cumulative impact of the turndown was such that world economy was expected to finish 2010 about 10% smaller. Such a scale of reduction in the prospects for GDP growth, and hence for commodities demand, over such a condensed time-period, is unprecedented.

In terms of the oil market repercussions, there were two effects at work simultaneously in the months that followed the Lehman bankruptcy. The first was the parallel impact of sharply reduced economic prospects on the expectation for oil demand growth. The second was the implication of a rush to liquidity and away from risk in markets. The former was enough to create the momentum for a sharp retrenchment in prices, and the latter caused a rapid liquidation of positions and sharp increase in risk aversion, which in turn created the conditions for an undershoot in prices.

Just before the Lehman bankruptcy, the International Energy Agency (IEA) forecast that global oil demand would average 87.6 mb/d in 2009. That forecast was reduced in each of the next eight IEA reports, and as by as much as 1 mb/d in the largest of those downgrades. By the time the downward revisions had finished, the 2009 forecast had fallen to just 83.2 mb/d. Demand expectations had fallen by 4.4 mb/d over few months. The worst period for the oil market was that from September 2008 through to March 2009, during which it faced continual downgrades in expectations for both global GDP growth and global oil demand growth. At the lowest point for sentiment, there were increasing fears the world faced a major economic discontinuity, a global economic crisis with little precedent, which at various points conjured comparisons with the Great Depression. There is a something of a parallel here between the rise in prices in 2008 and the nature of the supply response as envisaged by the market. In 2008, the concern was that the supply response to higher prices was insufficient to balance the market. In 2009, the concern was that the reduction in OPEC supplies would not be sufficient to achieve market balance during a period in which economic and oil demand downgrades were continuing with no discernible end. Indeed, until macroeconomic expectations began to stabilise, there was, and probably could not have been, any recovery in oil prices.

The loss, relative to prior expectations, of over 4 mb/d of demand, and the fear of more severe economic discontinuities and demand loss to come, were the main drivers of the decline in prices, which drove the value of the OPEC basket and the price of WTI below $35 per barrel. However, there does appear to have been an undershooting effect at work on top of the straightforward dynamics of rapid demand loss. The truncation of, and re-pricing in, credit markets brought about a sudden desire for far greater liquidity within most financial markets. Activity across riskier markets in particular was severely curtailed, while asset holders sought safer instruments for retaining value. The reduction in the amount of gearing available to investors also brought about a fairly rapid unwinding of positions,

with any given capital base now being deemed capable of covering for a substantially lower amount of market risk.

The Rise in Oil Price in 2009

Despite the collapse in demand and the sharp rise in inventories, by the end of October 2009 the value of the OPEC basket rose by 132% in dollar terms and by 117% in euro terms since its 24 December 2008 low. To many observers, this is a clear indication that the oil price had become detached from oil market fundamentals. However, this view ignores the increasing role of expectations and news and information about future fundamentals in the pricing of crude oil. Just as the move to the lows for price had been accompanied by a rapid reduction in both GDP and oil demand expectations, the recovery in prices accompanied a period of improving GDP expectations, and a particularly marked rebound in oil demand expectations following a flow of stronger than expected global demand data. In terms of GDP, consensus expectations for 2009 recovered from a low of a decline of nearly 2% to a more modest decline of 1%, and 2010 expectations went from a low of about 2.5% up to an expectation of growth of 4.2% for some banks. The latest *World Economic Outlook* projects activity contracting by 1% in 2009 but expanding by about 3% in 2010. Such projections are fuelling expectations of a strong rebound in oil demand, especially in non-OECD countries.

In terms of oil demand, the IEA expectation for the year over year change in demand in Q4 2009 had, by November 2009, risen from its nadir of a decline of 1.4 mb/d up to a forecast increase of 0.1 mb/d. Again, by November, in absolute terms the forecast of Q4 2009 demand had risen by 2.2 mb/d from the low. A significant amount of additional demand was feeding into market expectations, and the move away from persistent fears of a multi-year economic discontinuity dramatically improved overall sentiment and the willingness to assume risk. There was considerable volatility in GDP and demand expectations, and the partial recovery in economic expectations was naturally associated with a strong recovery in values across a wide range of financial and commodity markets.

The powerful shocks on demand caused by the crisis were counteracted by both a powerful supply response from OPEC and the expectation of weak non-OPEC supply growth, the latter fuelled by increasing concerns that the credit crunch and low price environment would limit investment flows in the oil sector. Analysis and commentary by influential players in the oil market seemed to affect these long-term expectations about the potential of oil supply. For instance, Goldman Sachs' commodities team insisted that there was an 'unrecognised energy crisis', arguing that 'although the financial crisis has been recognized, the energy crisis has not, as the deepening of the financial crisis did not allow oil prices to remain high enough for long enough to generate a solution to the energy problem, which has not gone away.' This will cause 'a likely return to energy shortages as dwindling OPEC spare capacity is likely unable to meet rising demand as non-OPEC production growth is restricted by limited

investment in oil production infrastructure.' [60] More recently, Goldman Sachs reinstated the message that 'although the financial crisis had been addressed, the commodity crisis has not.' [61]

In an interview with The Independent published on August 3, 2009 under the title, 'Warning: Oil Supplies are Running Out Fast', Dr. Fatih Birol of the IEA argued that 'many governments now are more and more aware that at least the day of cheap and easy oil is over' and that 'there is now a real risk of a crunch in the oil supply after next year when demand picks up because not enough is being done to build up new supplies of oil to compensate for the rapid decline in existing fields.' [62]

In its weekly commentary, Barclays' Capital writes that

> *with the backdrop of a hail of recent announcements on capital expenditure reductions for both conventional and non-conventional oil, together with the continuing move away from investment in alternative energy, we believe that the sharp fall in industry confidence is likely to have a more lasting effect on the health of the supply-side. Indeed, for that not to represent a severe problem over the course of the following decade, the weakness in global oil demand would have to become fairly prolonged. It tends to be a far longer process to reinstate projects than it is to mothball or cancel them, and the scale of the current industry freeze and confidence loss seems likely to severely affect non-OPEC production. Further, given how much of expenditure in mature areas is directed at trying to contain decline rates, we suspect that those decline rates might now be set for another step up.* [63]

In a recent report, analysts at Deutsche Bank argued that

> *concentration of remaining oil reserves into OPEC government hands will lead to under-investment in new supply and higher volatility in regulatory and fiscal regimes, and more volatile pricing. Consumer governments are adding to uncertainty with total lack of clarity on environmental legislation/regulation outcomes. That deep uncertainty in supply and demand will likely disincentivise private sector oil supply investment, exacerbating overall oil under-investment, and leading to peak oil supply within the next six years.*

Based on such analysis, expectations that the future supply–demand balance will tighten in the medium to the long term have become dominant. According to this view, on the supply side, the impact of the crisis will constrain investment and hence will limit future supplies. On the demand side, global economic recovery will cause a rebound in global oil demand. These expectations of medium and long-term tight fundamentals were reflected in the price at various maturities. While both

[60] Kate Mackenzie, 'Goldman Sachs and the unrecognised energy crisis', 4 June 2009, http://blogs.ft.com/energy-source/2009/06/04/goldman-sachs-and-the-unrecognised-energy-crisis/).
[61] *Financial Times*, 9 August 2009
[62] (http://www.independent.co.uk/news/science/warning-oil-supplies-are-running-out-fast-1766585.html).
[63] Barclays' Capital, *Oil Market Weekly*, January 2009.

the front end and the back end of the oil price curve saw sharp declines in the few months after the collapse of Lehman Brothers, long-term oil prices have fallen more slowly, reflecting concerns about the impact of the current crisis on long-term investment and expectations of a fast recovery of the global economy. In effect, current weaknesses in the oil market, manifested in falling demand and a glut of inventories in the second half of 2008 and first quarter of 2009, have had limited effect on long term expectations about fundamentals in the oil market. Concerns about long term fundamentals placed a limit on how much market players were willing to discount the price at the front end relative to the price at the back end of the curve. On the one hand, the oil price was relatively high given current market fundamentals. On the other hand, the oil price was relatively low compared to the expected long term prices. Thus, the oil market reached a stage at which either the long term price had to adjust downward or the front end the curve has to adjust upwards. Throughout 2009, it was the front part of the curve that carried most of the adjustment.

In the last few months of 2009, oil prices have oscillated within the 'psychological' range of $60-$80 (although the upper bound of the range has been broken few times). In effect, the oil market has operated within an *implicit* band. The upper and lower bounds were determined by different sets of beliefs which themselves were based on *expected* fundamentals of the oil market. Within these upper and lower bounds, the oil price is driven mainly by global macroeconomic news, expectations about the global recovery, the weak dollar, and change in inventories. However, the oil price could also move up and down without any large changes in the underlying fundamentals. This is especially the case if financial investors coordinate on public signals or if public signals facilitate some form of momentum trading. Also, the market could be attracted to some focal points such as OPEC's announcement of its preferred oil prices. Financial investors may wish to test the boundaries in some circumstances. But unlike the pre-crisis period, the market has comparatively high levels of spare capacity and inventories. Periods of high spare capacity have historically been associated with low volatility. Furthermore, in the presence of large spare capacity, the market response can be fast and large to prevent a sustained trading momentum and a persistent rise in oil price. The existence of such a feedback, however, depends on market players' price preferences and whether key players with surplus capacity become concerned that sharp rises in oil prices could endanger the prospects of economic recovery.

This by no means indicates that the current implicit band is fixed and that prices will not stray below or the above the boundaries. As with any financial asset, news that can cause market participants to revise their expectations about long-term fundamentals (although such long-term fundamentals do not exist and are highly uncertain) can cause the implicit band to shift even when there is a little change in current fundamentals.

Measures to Mitigate Oil Price Swings

The above analysis raises a series of key questions: What affects market participants' expectations? Why do certain views dominate the market? From a policy point of view, it raises the issue of whether consumers and producers can play a role in stabilising market participants' expectations about a preferred price range. In the last year or so, many ideas have been proposed to enhance oil price stability.[64] Attaining this objective is considered to be vital for protecting both consumers and producers from the costs and uncertainties associated with volatile oil prices, for ensuring a regular flow of investment into the oil industry and alternative energies, and for promoting a sustainable development path. In what follows, we discuss a few of these proposals, highlighting their advantages and limitations.

The Role of Financial Regulation: Recent Developments and Potential Impacts

Heightened oil price volatility has brought the issues of excessive speculation and the regulation of commodity derivatives markets to the fore. Many analysts argue that the main purposes of derivatives markets have always been to support sound price discovery mechanisms based on commercial hedgers (usually commercial handlers of a physical commodity) using futures markets for their intended purpose: to shift pricing risk.[65] In a smooth functioning futures market, prices are determined by the healthy tension between commercial consumers and commercial producers. Speculators are needed in the futures market to create sufficient liquidity for commercial users, but excessive speculation, i.e., speculation that overwhelms the dynamics of supplier/consumer hedging, completely unmoors the market from economic fundamentals.[66] When speculators make up too large a share of the futures market, they have the potential to upset the healthy tension between consumers and producers.[67] The resulting volatility makes it more difficult for commercial consumers and producers to successfully hedge risk, because prices do not reflect market fundamentals, and so they abandon the

[64] The list discussed in this report is not exhaustive and currently there is a wide range of proposals. For instance, Robert Mabro calls for a change in the international pricing regime which shifts the process of price formation from the futures market to the physical market. He recommends setting a committee which explores the various alternatives to the current pricing regimes and identifies their relative weaknesses and strengths (private communication, 30 November 2009). Similarly, Giacomo Luciani proposes the use of an auction system for price discovery, with Saudi Arabia taking a leading role as a price maker by conducting regular auctions on its crude oil, and creating the condition for the development of a secondary market by removing destination restrictions. Luciani, G. (2009) *From Price Taker to Price Maker? Saudi Arabia and the World Oil Market, Paper presented at the Rahmania Annual Seminar, Riyadh, January 20-22.*

[65] The Wheat Report; The Natural Gas Report; Commodity Futures Trading Commission (CFTC), 'The Economic Purpose of Futures Markets and How they Work', http://www.cftc.gov/educationcenter/economicpurpose.html

[66] Testimony of Michael Greenberger, Commodity Futures Trading Commission 9 (5 August 2009); Jonathon Ira Levy (2006), 'Contemplating Delivery: Futures Trading and the Problem of Commodity Exchange in the United States, 1875–1905', *American Historical Review* 307.

[67] The Wheat Report.

futures market and risk shifting—thereby further destabilising the price discovery influence of these markets.[68]

These concerns about the impact of excessive speculation have pushed many governments to consider tightening regulation on commodity derivatives markets. After a long period of regulatory uncertainty, it is becoming increasingly clear that the US might be moving towards extending speculative position limits from agricultural markets to energy and metals markets, removing exemptions of position limits for certain group of traders, imposing higher capital and margin requirements for OTC trading and shifting towards greater regulation of OTC markets. In addition, the CFTC will continue to improve its data reporting system providing more disaggregated data on the various market participants. In fact, on 11 December 2009, the US House of Representatives approved the Wall Street Reform and Consumer Protection Act of 2009 which calls for tighter financial regulatory reform, including key provisions to regulate the over-the-counter derivatives marketplace.[69]

One important element of the current regulatory reform programme is the imposition of speculative limits. Many observers have called for stricter position limits on speculative activity across all crude oil and other physical commodity derivatives markets, both regulated and over the counter (OTC). Regulatory position limits are intended to draw a line between that speculation necessary for liquidity and excessive speculation. Thus, position limits are considered by many analysts to be a major regulatory tool designed to maximise the influence of market fundamentals on pricing. According to this view, position limits can control speculation by limiting the number of derivatives contracts that individual investors can hold and thus control their share of a market and subsequent impact on it.

While the idea of imposing position limits has gathered momentum,[70] it is important to raise the following question: what behaviour are these regulations designed to control? In the case of banks, the apparent intent of regulation is to avoid excessive risk-taking and to prevent another credit crunch.

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[68] *See, e.g.*, The Natural Gas Report, *supra* note 6, 73–74;

[69] Carl Hulse (2009), 'House Approves Tougher Rules on Wall Street', New York Times, 11 December. U.S. Commodity Futures Trading Commission Chairman Gary Gensler commended the House of Representatives "for passing historic, landmark legislation that, for the first time, will bring regulation to the over-the-counter derivatives marketplace. The bill comprehensively regulates swap dealers and major swap participants and lays out the framework for the use of clearinghouses and transparent trading facilities" (CFTC Chairman Gary Gensler Comments On House Passage Of H.R. 4173, CFTC website).

[70] In January 2010, the CFTC announced its proposals for setting position limits. While the new limits are more rigid, they do not appear to be strenuous compared to the Exchange's own guidelines and will affect only a small number of traders. The proposals will offer swap dealers 'limited risk management exemption' while long only term passive investors will not benefit from such exemptions. See Kate Mackenzie, 'CFTC targets funds in position-limit clampdown', Financial Times blog, http://ftalphaville.ft.com/blog/2010/01/14/126541/cftc-targets-funds-in-position-limit-clampdown/

Concerns about excessive risk-taking have led regulators, both in the United States and internationally, to adopt or propose a new regulatory framework which will be dynamic and which over time is expected to increase the power of national regulatory authorities, increase global regulatory coordination, and expand the scope of regulation. In the case of commodities markets, on the other hand, the ultimate purpose of the regulation proposed seems to be to limit volatility, or more accurately, price swings. As in the case of excessive risk taking by banks, these are considered to be damaging to the global economy and must be controlled in order to help prevent another global recession.

The effectiveness of the proposed measures will depend on the underlying causes of the price swings that the proposed regulation intends to control. If poorly regulated markets are the underlying cause of price swings, then strengthening the regulatory structure could help dampen oil price volatility. If, on the other hand, price swings are caused by herding behaviour, then regulatory measures such as position limits will only play a limited role in curbing herding among financial investors. Alternatively, if oil prices are driven by long-term expectations, then position limits would have no impact on the formation of these expectations and hence on oil prices. Further, if the main objective of proposed regulations is to tackle asset price booms, then authorities should widen the policy options to include the role of monetary policy (for instance by making asset price stability a target for monetary policy), prudential regulation, or even fiscal policy (by reducing overall demand).

Thus, it is far from clear whether regulatory measures, such as position limits, will prevent sharp price swings or are the most effective way to tackle asset price booms. There does not currently appear to be any international consensus on the merits of position limits. However, these regulations will have an impact on the structure of the derivatives market, the location of trading activity and the cost of hedging and risk management. Existing evidence shows that when governments have introduced new regulatory measures, liquidity, as measured by futures contracts turnover, has declined.[71] However, it remains unclear whether the decline in liquidity is associated with an increase or decrease in price volatility. It is also widely acknowledged that for regulations to have any impact there is a need for international coordination, otherwise liquidity would migrate away from US exchanges to other exchanges outside the US and to over-the-counter markets with the potential effect of reducing transparency in the marketplace.[72]

[71] Deutsche Bank, *Commodities Weekly*, 14 August 2009.

[72] This has been recognised by the CFTC commissioner Michael Dunn where he stated that "the result of putting in position limits, without having over-the-counter authority and some type of agreement internationally, is [that] we will in fact end up with less transparency in the marketplace than we currently have." *Financial Times*, 'CFTC walks fine line over pushing trades away', January 14, 2010.

The Role of Expectations and Data Availability

Given the key role that expectations play in the process of oil price formation and the interaction between short-term and long-term prices, any analysis of oil prices requires a thorough understanding of how expectations are formed over the oil price cycles.

In one aspect, expectations are formed on the basis of data and information and analysis surrounding these data. Poor data contribute to the volatility of oil markets both through allowing some inaccurate information to filter into investors' expectations and by increasing speculation on key data. Although the coverage and quality of information about crude oil market fundamentals have improved in recent years, there are still some major data problems. On the demand side, data on oil consumption, even those for OECD, are not standardised, are subject to major revisions and are published with a considerable lag. This problem is becoming more acute as many countries and regions in the non-OECD such as China, India, and the Middle East, all of which have become the major source of demand growth in recent years. In many of these countries, there are serious statistical shortcomings in the area of data on consumption and the pricing policies of petroleum products, including the size of subsidies and taxes imposed on these products. Regarding data on inventories, OECD data on crude oil and product stocks are published monthly and with a considerable lag. Data on non-OECD stocks are not available on a regular basis and subject to a great deal of speculation. For instance, in the context of China, it would be difficult to gauge whether the growth in imports is due to increase in demand or increase in demand for stockpiling. On the supply side, the dominance of less transparent national oil companies inside and outside OPEC decreases the accuracy and transparency about the monthly levels of oil production.

In addition to lagging indicators of supply and demand, it is important to explore the possibility of increasing the availability and transparency of data that can help us better understand future market fundamentals. For instance, on the supply side, detailed data on investment plans in the oil sector and investment in alternative energy and information about new discoveries and change of size reserves can affect expectations about medium term and future market fundamentals. On the demand side, information on energy policies and their potential implications on long-term demand would also alter long-term expectations. In fact, the provision of better data and information and independent and credible analysis of how the market fundamentals may evolve in the future may reduce the degree of uncertainty. Such analysis may also help dilute some of the extreme views and signals that dominate the market psyche and drive coordinated financial flows in some instances.

It is important to note that a major challenge for 'price discovery' on the basis of 'medium-term fundamentals' is that such fundamentals do not yet exist. There are too many unknown variables such as developments in technology in the transport sector and in oil extraction, change in consumer behaviour, and the impact of energy and climate change policies, among others. Thus, while efforts to

increase data availability and transparency can help stabilise expectations, it is important to recognise that there are limits on how much these efforts could influence oil price behaviour.

The Oil Price Band

There have been many calls to establish a price band with an oil stabilisation fund to dampen volatility and prevent sharp swings in oil prices. Given current oil market conditions and the divergent interests of the various players, it is not clear whether this heavy-handed approach is feasible. To enforce a band, there is a need for credible mechanisms that induce feedbacks in the market. If such feedbacks are built into the expectations of market participants, then the price could be contained within the band without any adjustment in actual levels of output. For instance, if prices rise above a given ceiling, then expectations that oil demand would fall or supply would rise would bring the price down. Similarly, if the oil price falls below a given floor, then expectations that supply would fall or demand would rise, will push the price back to within the band.

It remains unclear where the response would come from if the price were to increase above the upper bound. One potential response would be for OPEC to increase production to bring the price back within the band. However, the response from OPEC in a rising market is not straightforward. While OPEC cuts production in a falling market, it assumes a passive a role in a rising market. The Organisation is reluctant to put a ceiling on oil prices either by auctioning part of the available spare oil or by engaging in heavy discounting of its heavy crude oil. Various explanations have been offered to explain this OPEC behaviour. Some argue that OPEC has realised that higher oil prices do not have adverse effects on the growth of the global economy and/or inflation, and that oil demand is more price inelastic than it originally thought. Others have noted that OPEC is concerned about high oil prices, but that influencing oil prices is beyond its ability, especially since there was a market perception that OPEC's spare capacity was less than what is officially announced and not of the right quality. The most likely explanation is that OPEC is concerned about high oil prices and under certain conditions may have the ability to influence the oil price. However, OPEC may be reluctant to put a ceiling on the oil price as there are fears that any such action might induce a downward spiral of oil prices, which the Organisation might not be able to control.

What about consumers? One of the very interesting features of the last oil boom was the lack of response from oil consuming governments to rising oil prices. Other than occasionally criticising OPEC and/or speculators, the response from consuming countries was extraordinarily subdued. There is one card that consuming countries could use to generate a fast feedback from high oil prices to the market, but it was not used in the last boom: the release of oil from strategic petroleum reserves (SPR). Using the SPR or more generally establishing a global oil fund to police the upper bound is fraught with risks. The release of oil from the SPR may not work or even backfire if the market interprets such an action as reflecting a sense of emergency and/or deteriorating market fundamentals.

Furthermore, as the experience of the foreign exchange market has shown, speculators can attack the 'band' causing the SPR to deplete and lead to a collapse of the price band.

What about protecting the price floor? Here the response from OPEC is straightforward. The Organisation would implement output cuts to prevent prices from falling below the floor. If OPEC is able to generate expectations of such a response, then it may not even need to implement the cut. However, the market may wish to see whether appropriate cuts could be implemented in practice, in which case it will take the Organisation a long time to bring the price within the bound. The largest uncertainty, however, concerns importing governments' response if prices fall below the floor. In theory, there might be some options available for importing governments. For instance, non-OPEC suppliers could support OPEC policy by announcing output cuts. Leaders from key consuming countries could send clear signals that low oil prices are damaging and provide public support for OPEC moves. Alternatively, importing countries may show willingness to support the price by creating artificial demand – for instance through building up the SPR. It is clear that these and other similar options require far- reaching changes in policy which no importing government seems, so far, willing to make or is even capable of implementing.

Stabilising Market Participants' Expectations: The Role of Signals

Rather than adopting a price band, one of the main objectives of both oil importing and exporting governments should be to stabilise market participants' long-term expectations about a range of preferred oil prices. The main aim should be to discourage actions that may result in movements very far from this preferred price range.

The main criticism of this proposal is that it involves such a weak commitment that it would not change anything in practice. But this is not necessarily true. Coordination games provide some useful insights into this issue. In such games, players have a common interest in reaching certain outcomes but in order to reach these, they need to coordinate their actions and all move in the same direction. It has been long recognised that when individuals are confronted with large uncertainty, focal points may in some instances play an important role in providing a point of convergence for individual expectations.[73] Some focal points may be *a priori* more reasonable or more prominent and noticeable than others. In the context of the oil market, the impact of the focal point would be stronger when governments of different countries agree and communicate their preference about that point.

Historically, producers and consumers have had very divergent interests, with producers favouring higher prices and consumers favouring lower prices, depending on the stage at which the oil price cycle importers and exporters found themselves. Currently, there is a realisation among both groups

[73] Schelling, T. (1963), *The Strategy of Conflict*, New York: Oxford University Press.

that too low or too high oil prices serve no one. On the one hand, low oil prices constrain the flow of investment required by the industry to ensure stable oil supplies. On the other hand, high and volatile oil prices can damage prospects of global growth and create worldwide imbalances with destabilising consequences. For instance, the French president Nicolas Sarkozy and the UK Prime Minister Gordon Brown urged 'oil producers to agree a target price range, based on a clearer understanding of the long-term fundamentals... that are not so high as to destroy the prospects of economic growth but not so low as to lead to a slump in investment, as happened in the 1990s'.[74] The French President went even further, raising the question, 'why don't producer countries and consumers agree on general price guidelines to give to the market?'[75]

Similar signals have also emerged from key oil exporters. In a rare precedent, King Abdullah of Saudi Arabia said in a newspaper interview that he considers $75 to be a 'fair' price for a barrel of crude oil. He reiterated his position in December 2009 arguing that "we [the Saudis] expected at the start of the year oil prices between $75 and $80 a barrel and this is a fair price...Oil prices are heading towards stability".[76] The Saudi Oil Minister, Ali Bin Ibrahim Al-Naimi, justified the target price as the 'price that marginal producers need to maintain investments sufficient to provide adequate supplies for future oil consumption needs'.[77] Indeed, in the OPEC meeting in September 2009, Mr Al-Naimi announced that the current price 'is good for everybody, consumers and producers'. He reiterated his position in December 2009 arguing that "the market is stable right now, volatility is at minimum, everybody is happy with the price, it is in the right range".[78] In its blueprint for oil price stabilisation,[79] ENI considers the optimal price to be somewhere in the region $60-$70 given current market conditions. This optimal price band is needed to ensure adequate return on investment to producers, encourage rational and efficient use of energy, safeguard food production, and encourage investment in new technologies. A price above $75, on the other hand, would hurt economic growth.

The recent convergence of the views of key players about a preferred oil price range has helped stabilise market expectations in the oil market. The mere convergence of interests and views, however, is not enough to stabilise expectations in the long term or to ensure a stable equilibrium. First, to be credible and prominent, it is important that the preferred price range be in line with market fundamentals. This implies that the preferred price range should adjust to changes in oil market fundamentals. This differentiates the current proposal from commodity agreements.

[74] Gordon Brown and Nicolas Sarkozy, 'We Must Address Oil-Market Volatility', *The Wall Street Journal*, 8 July 2009
[75] *Emirates Business 24|7* daily newsletter, 'Sarkozy calls for regulated oil prices' 27 May 2009.
[76] Reuters, 'Oil price might rise "reasonably"-Saudi King in paper",26 December 2009.
[77] Reuters, 'Low oil prices mean less future supply – Saudi', 19 December 2008.
[78] Ayesha Daya and Maher Chmaytelli, 'Saudi Arabia's Al-Naimi Says Oil Price IS Perfect", Bloomberg, December 5, 2009.
[79] ENI (2009), ' Blueprint ', *Oil ENI Quarterly*, Year II, No.7, October.

Second, if key players have different beliefs regarding oil market fundamentals, due to limited and imperfect information about market fundamentals and uncertainty about the behaviour of key players in different market circumstances, then it would be difficult to sustain a convergence of views and to attain a credible focal point. Thus, sustaining convergence of view about market fundamentals may requires some building confidence measures and information sharing about key variables such as costs, investment flows and the demand-supply balance. This may help avoid creating a large divergence of opinion among various market participants including consumers and producers.

Third, if anticipated feedbacks are slow, or are perceived to be absent on either the demand or supply side, the market is likely to drift away from the preferred price range. This creates further grounds for cooperation between consumers and producers. If market perceptions are wrong about the extent and the timing of feedbacks (for instance, if the market believes that there are no feasible instruments while in fact these exist), then policy diplomacy could play a role in preventing sharp price movements by increasing the visibility of these feedbacks and policy responses. The best example is the Jeddah meeting in July 2008. Saudi Arabia sent a strong signal to the market that it was deeply concerned about sharp rises in oil prices and their impacts on growth and demand. Despite the fact that the market was well supplied, the Kingdom was willing to bring additional output to the market. It is not clear whether the market took this additional output, as demand was already showing strong signs of weakness during the third quarter of 2008. However, this meeting altered market perceptions about a key feedback/response which was perceived to be absent in the market.

Concluding Remarks

The sharp swings in oil prices in 2008 and 2009 have raised concerns among both major consumers and producers about the adverse economic, political and social consequences of such violent price movements. In concert with recent debates over economic policies, the G20 and other bodies are considering policies intended to prevent a repeat of the recent swings in oil prices. Based on the above analysis, it is possible to draw the following concluding remarks.

- While the dichotomy between fundamental and speculation continues to dominate the current policy debate, this dichotomy is too simplistic to assist in formulating policy. The idea that the oil price can be sliced into various components reflecting fundamental and non-fundamental factors is difficult to implement theoretically and empirically. Instead, the current behaviour of oil price should be explained in terms of developments in the physical market, the related derivatives markets, and the interaction between them.
- During the 1980s and the 1990s, expectations about short-term oil price behaviour rested on the assumption that changes in oil prices would induce supply, demand or policy feedbacks – or a combination of them – which would prevent prices from rising above a certain ceiling or

from falling below a certain floor. These perceptions of strong feedbacks stabilised long-term expectations about oil prices. However, as oil prices rose sharply during the boom years, uncertainty about the existence of and the timing of feedbacks from prices to oil supply and demand markedly increased. The perception of strong feedbacks in the oil market was replaced by the perception of limited feedbacks.

- In parallel with developments on the physical side of the market, the related oil derivatives markets have witnessed many major transformations that would eventually consolidate the role of the futures and over-the-counter (OTC) markets in the process of oil price discovery. In theory, one could distinguish between two main layers for price discovery. The first layer is based on price assessments produced by oil reporting agencies. These prices are derived from relatively illiquid physical markets which lack transparency and are dominated by a few players. The second layer is the futures market which is more transparent, highly liquid and characterized by a large number of players with diverse expectations. A key issue in need of further analysis is the nature of the relationship between these two layers of price discovery.
- The last few years have seen a large inflow of funds into the oil market and the entry of a wide range of financial players. This process has transformed commodities in general and crude oil in particular into an asset class like any other financial asset such as stocks and bonds. This represents an important transformation with long term implications on oil prices. Being a financial asset, the expectations of the future fundamentals and news and information about these fundamentals play an important role in its pricing. The growing importance of financial investors in the oil market should not, however, be thought of as an external event that happened in isolation. It was interlinked with the tightening of the physical market.
- While the last two decades have seen the development of elegant theoretical models that analyse the role of financial players in asset price booms/busts, the empirical literature has struggled to offer much in the way of firm conclusions. Currently, there is a wide range of views about the role of financial markets in the oil price formation process, and little consensus.
- Designing effective policies to prevent a repeat of the sharp swings in oil prices requires in the first instance a proper understanding of the underlying causes of these swings, and a thorough analysis of recent developments in oil markets and their likely future evolution. It is possible to dissect the 2008-2009 price cycle into three distinct phases:
    - Phase 1: In the first half of 2008, doubts about the existence and timing of feedbacks from prices to oil supply and demand became pervasive. This destabilised short-term expectations and created a wide band within which the oil price could oscillate. Within the implicit band, price changes are influenced by a very wide variety of

public signals about fundamentals or expectations of fundamentals. Prices also depend on market players' expectations about other players' expectations, creating the grounds for herding behaviour. In such an environment, public information or signals can take a leading role even if these public signals do not necessarily reflect large changes in underlying fundamentals or provide new information to the market. Furthermore, while there is abundance of public news and information, traders often limit their attention to a few signals which they consider important — as it is impossible to coordinate on a large number of signals. Limited feedbacks also led market participants to revise their longer term expectations and the prevailing consensus on long-term prices broke down. As a result, during the boom years, prices in the short and long run became jointly determined and the whole futures curve became subject to a series of roughly parallel shifts.

- Phase 2: The sharp reversal in oil prices from July 2008 to February 2009 came in two distinct phases. The first was a cooling off in prices from their peaks, brought on primarily by the combination of a supply side response from the key marginal producers, following the Jeddah meeting in June, and by mounting evidence in the rear-view mirror that OECD demand had weakened far more than initial expectations and provisional data flows had suggested. The second phase was more directly associated with the intensification of the global financial crisis, and the consequent rapid fall in consensus expectations for global economic growth. Until expectations about the global economy began to stabilise, there was, and probably could not have been, any recovery in oil prices.

- Phase 3: In the second quarter of 2009, the powerful shocks that affected global oil demand were counteracted by perceptions of global recovery and the perception of tight future market fundamentals — fuelled by increasing concern that the credit crunch and the low price environment would limit investment flows in the oil sector and in alternative energy. Analysis and commentary by influential financial players seemed to affect these long-term expectations. The consolidation of expectations of tight future fundamentals placed a limit on how much the market was willing to discount the spot price in relation to the long-term price. On the one hand, the spot price was quite high given current market fundamentals. On the other hand, the spot price was low compared to the expected long-term prices. In the second quarter of 2009, the oil market reached a stage at which either the long-term price had to adjust downward or the spot price had to adjust upwards. Throughout most of 2009, it was the spot price that carried most of the adjustment.

- The above analysis highlights the role of expectations in the oil price formation process and raises the key issues of how expectations are formed and whether consumers and producers can play a role in stabilising market participants' expectations about a preferred price range.
- Among other things, expectations are formed on the basis of data and information and the analysis surrounding these data. Poor data can contribute to the volatility of oil markets by allowing inaccurate information to filter into investors' expectations and by increasing uncertainty. Thus, extending the coverage of data and improving the quality of information about crude oil market fundamentals can help stabilise expectations and oil prices. However, it is important to note that a major challenge for 'price discovery' on the basis of 'medium-term fundamentals' is that such fundamentals do not yet exist. There are too many unknown variables such as developments in technology in the transport sector and in oil extraction, change in consumer behaviour, and the impact of energy policy, among others. Thus, while efforts to increase data availability and transparency can help stabilise expectations, it is important to recognise that there are limits on how much these efforts could influence oil price behaviour.

- Beyond this, there have been many calls to establish a price band with an oil fund to stabilise expectations, dampen volatility and prevent sharp swings in oil prices. A fundamental weakness of such proposals is that such a system has to be managed by parties with very divergent interests. Furthermore, it would be hard to design the institutional mechanisms that could generate feedbacks to prevent the price from straying outside the band.
- One of the main objectives of both oil importing and exporting governments should be to stabilise market participants' longer term expectations about a range of preferred oil prices. The main aim should be to discourage decisions that may result in movements very far from this reference price range.
- The recent convergence of views of key players about a preferred oil price range has helped stabilise market expectations in the oil market in recent months. The mere convergence of interests and views, however, is not enough to stabilise expectations in the long term or to ensure a stable equilibrium. To be credible and prominent, it is important the preferred price range be in line with market fundamentals. Furthermore, if key players have different beliefs regarding oil market fundamentals, due to limited and imperfect information about market fundamentals and uncertainty about the behaviour of key players in different market circumstances, then it would be difficult to sustain a convergence of views and to attain a credible focal point. Thus, sustaining convergence of view about market fundamentals may requires some building confidence measures and information sharing among key market

players. Finally, if anticipated feedbacks are slow, or are perceived to be absent on either the demand or supply side, the market is likely to drift away from the preferred price range. This creates further grounds for cooperation between consumers and producers. If market perceptions are wrong about the extent and the timing of feedbacks (for instance, if the market believes that there are no feasible instruments while in fact these exist), then policy diplomacy could play a role in preventing sharp price movements by increasing the visibility of these feedbacks and policy responses.