

Oil supply and demand

The crude price variations of the last five years might be compared to the movements of a ball bouncing in an elevator. At regular intervals, a new high is reached, setting a record soon to be broken in turn. For each "bounce", we might try to identify the conjunctural reasons responsible for pushing prices upwards, but there is always another new high, because the elevator has not finished going up. The price of USD 100/bbl was reached "by accident" at the beginning of 2008. Prices will stay high in future, and this record will inevitably be left behind for good in the next few years. Supply, limited in its nature, is inadequate in the face of needs infinite in their desires. This has placed the crude price on a growth path whose direction could only be changed, it would seem, by massive development of replacement fuels or very large gains in energy efficiency. That is, unless the world economy were hit by a major economic crisis...

Before examining the outlook for supply, demand and prices, we would like to review the oil conjuncture in 2007 and the medium-term business environment. We will also examine the seeming "disconnect" between the crude price and market fundamentals, and offer an explanation for the uptrend in prices, by suggesting that it is a market-balancing mechanism that keeps consumption in step with production by destroying demand. After verifying the relevance of this interpretation, we will look at the prospects for supply growth. Comparing these forecasts with the anticipated demand trend leads us to believe that the price of oil will continue along a growth path in the medium term. However, how fast it rises will depend on our ability to innovate in the areas of energy efficiency and the production of alternative energies.

2002 - 2007: from USD 20 to 100 per barrel

The steady increase in the crude price, which started in the early 2000s, continued in 2007 (figure 1). The price slipped below the USD 60/bbl mark at the beginning of the year, which created the fleeting illusion that it was leveling out. But this only happened for conjunctural reasons: prices dropped because the winter was mild and demand for heating oil was low, temporarily easing

a very tight and therefore highly volatile market. Once these conjunctural reasons had disappeared, the market became even tighter. Shooting up from this low point to a series of highs, the crude price crossed one psychological threshold after another during the 12-month period, until it passed the USD 100/bbl mark in early January 2008.

We will briefly review the medium-term situation and the reasons for this price uptrend, then focus on the conjuncture for the year 2007.

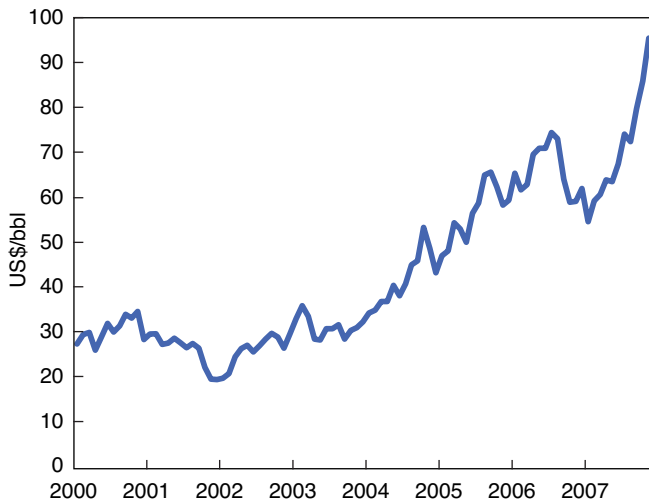
Medium-term business environment

Since the end of the 1990s, the world economy has posted very strong growth, driven by the United States and more particularly by the emerging countries (figure 2).

While the developed countries have entered the slowdown phase of the cycle, the developing countries have been and should continue to grow very fast in 2008. This growth is highly raw-material-intensive and has led to a rapid, unanticipated increase in oil demand. The highly mediatized rise in the price of oil and a few metals is actually typical for all commodities. Since supply cannot be significantly expanded in the short term, this strong demand surge has pushed the price of commodities up across the board.

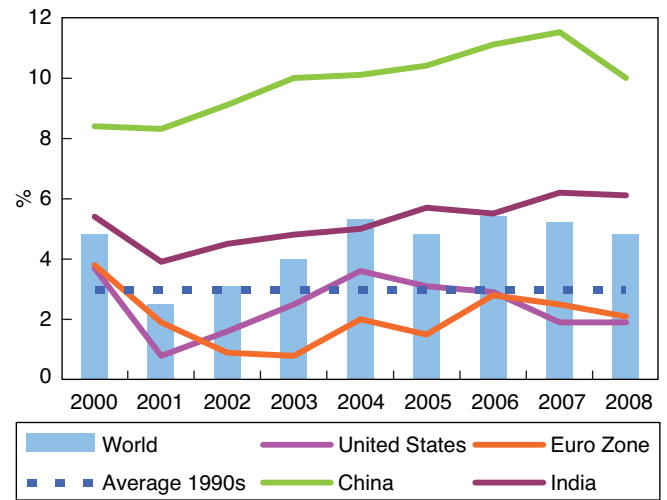
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Fig. 1 - WTI price



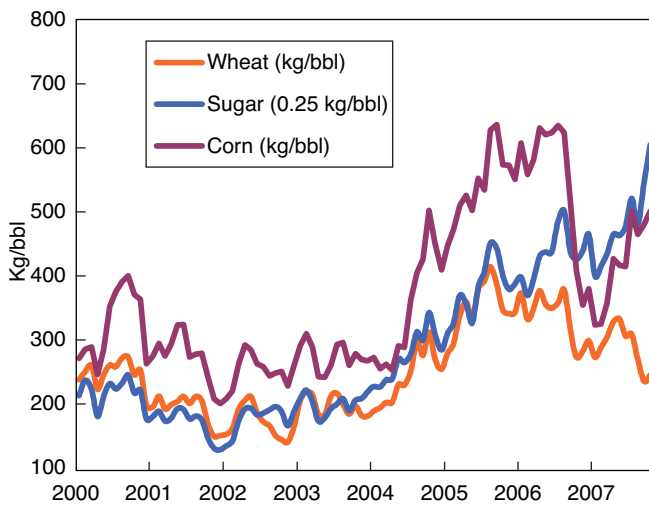
Source: Platts

Fig. 2 - Annual growth rate for real GDP



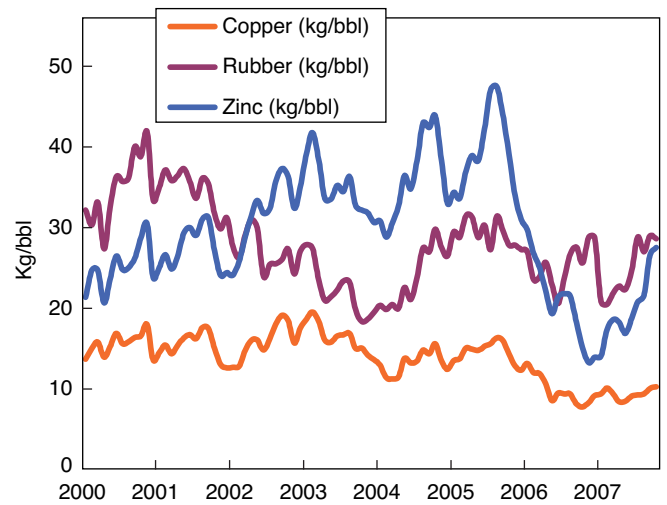
Source: FMI

Fig. 3 - Oil & alimentary raw materials



Source: FMI

Fig. 4 - Oil & industrial raw materials



Source: FMI

Overall, the price of crude rose faster than that of alimentary raw materials (figure 3) but slower than that of industrial raw materials (figure 4).

These raw materials all saw their price swing up initially, but then their prices diverged, depending on particular market conditions, especially producers' capacity to expand supply. On the oil markets, the acceleration of demand in 2003 and 2004 pushed supply to its extreme limits and, since then, accumulated project delays have constrained the development of supply (figure 5).

In 2007, the tensions remained high on the oil markets and the price continued to climb.

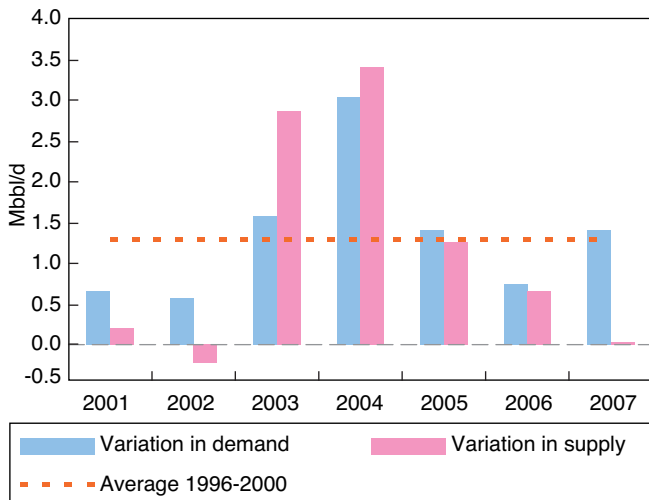
Short-term business environment

Starting in January, the daily WTI price rose steadily, almost monotonously, from USD 50.50 to 98.40, which is more than 13 cents a day!

Part of this increase can be attributed to the long-run rise in the barrel price, but the reversal in short-run factors between one winter and the next aggravated the

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Fig. 5 - World oil supply and demand

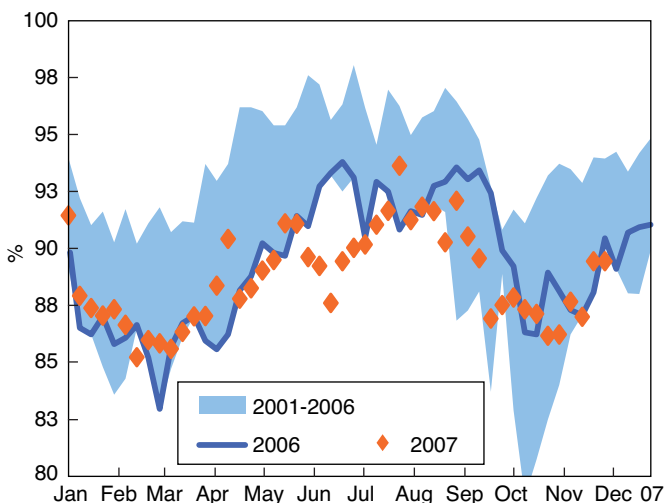


Source: IEA

change, as illustrated by the transformation undergone by the WTI forward curve (figure 6). It went from clearly contango to backwardation as the factors exerting a downward pressure on prices subsided and the conjunctural factors driving prices upward emerged.

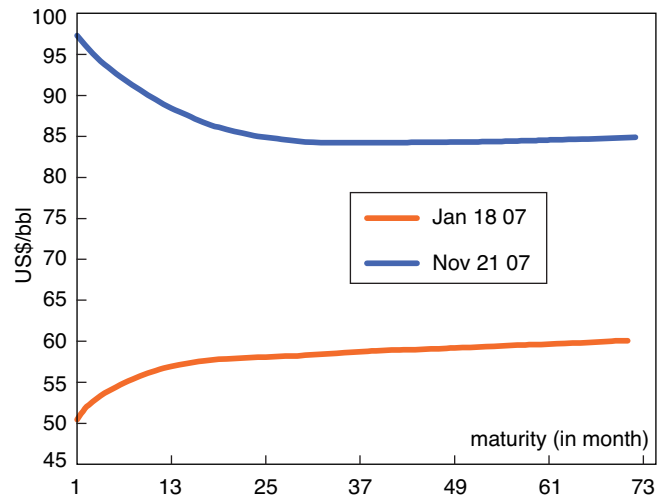
First of all, the disequilibrium created by the stagnation of production and the acceleration of demand has severely tested stocks. The most recent estimates for the year predict a decline of about 0.3 Mbb/d. However, the impact of this decline in stocks on the crude price was gradual. 2007 was a disappointing year for the refining sector. A series of unforeseeable incidents kept

Fig. 7 - Utilization rates for US refining capacity



Source: DOE-EIA

Fig. 6 - WTI forward-curve



Source: NYMEX

the refinery utilization rate at historic lows, especially in the United States (figure 7).

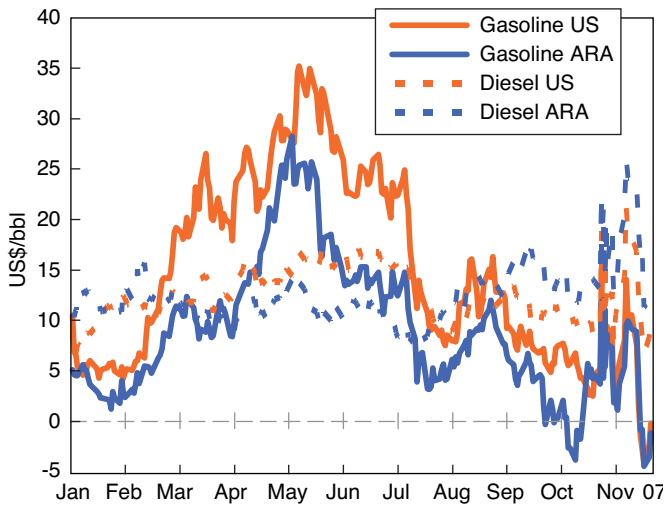
As a result, a lack of processing capacity constrained crude demand and allowed stocks to stay fairly high for a long time. In the United States, saturation at the Cushing refinery site in particular weighed on the WTI price, which was – abnormally – lower than the Brent price from March through July. During this time, of course, petroleum product stocks dropped alarmingly and the price of gasoline soared with the approach of the driving season (figure 8). More recently, due to the delay accumulated throughout the year, it was the turn of distillate prices to spike.

In addition, the midsummer subprime crisis indirectly affected the oil markets and, for several weeks, interrupted the steady rise in the crude price. Although the energy markets were spared, relatively speaking, and their fundamentals remained solid, an immediate demand for liquidity led, by means of arbitrage mechanisms, to a large movement to sell that pulled prices down. Lost ground was rapidly regained, however, especially since worries about the stockmarket made the oil markets even more attractive.

The crude price started up again and climbed throughout the rest of the year, reaching USD 100/bbl on the first workday of 2008. The psychological threshold – a three-digit figure, equal to the record high of the 1980s in constant money terms – was reached accidentally this time, as a result of conjunctural factors. With the continued uptrend, this record will inevitably be broken, but this time for structural reasons.

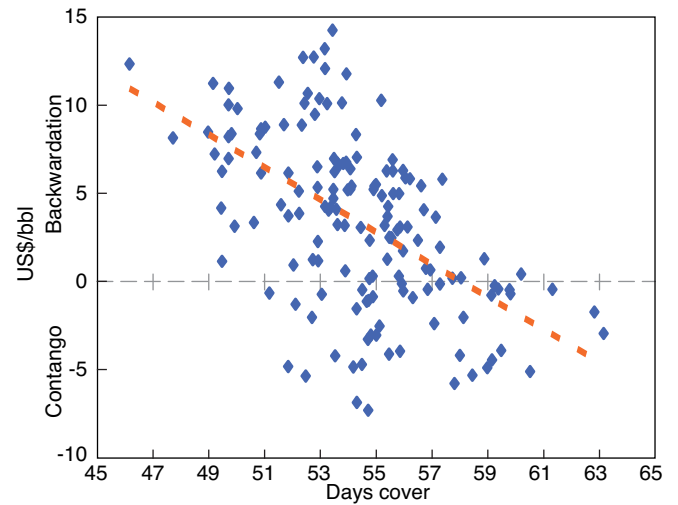
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Fig. 8 - Price differential between petroleum products and crude



Source: Platts

Fig. 9 - Differential between long-term and spot prices vs. OECD stocks (Jan. 1995 – Sept. 2007)



Sources: Platts-NYMEX

The price of demand destruction

While many arguments can be put forward in theory to explain the crude price increase, in practice they seem inadequate to justify the price levels observed at present. The usual mechanism no longer applies, because the market is following another rationale.

The crude price and the fundamentals

In the short term, the historical relationship between the level of stocks and the price differential, from one end of the forward curve to the other, remains valid (figure 9).

As far as the trend curve is concerned, the acceleration of oil demand has led to the development of fields that are technically more complex or more hazardous from the geopolitical point of view. Moreover, the boom in the oil supply and service sector has greatly inflated production costs. Since the end of the 1990s, the marginal cost has risen regularly and now stands at about USD 65/bbl.

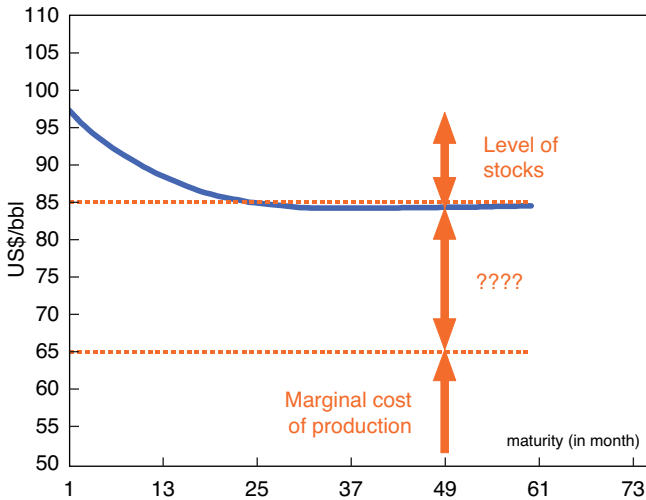
That leaves a mysterious twenty dollars or so that the fundamentals cannot explain (figure 10). That's a big gap, one that invites all kinds of futile explanations, usually with vague references to "speculation". Some explanations are more concrete: it's due to the eroding dollar or the formation of an almost structural risk premium tied to persisting tensions between the United States and Iran. Relevant though these arguments may be, it seems difficult to attribute an impact of USD 20/bbl to them.

So the mechanism used to explain and predict price variations throughout the 1990s no longer works. But why would it? According to economic theory, this mechanism – where the price, influenced by demand cycles, fluctuates around the marginal cost of production which corresponds to the equilibrium price – is only viable in a market in which supply is relatively fixed in the short term but can grow indefinitely in the long run. Obviously, the latter condition is no longer met on oil markets. The problem is not yet that production has leveled off, but that demand is rising too quickly and supply is developed too slowly. Consequently, the marginal cost of production is only relevant as a reference at times when the market is well supplied for conjunctural reasons. That's what happened last winter, for instance, when the price fell to about USD 55 bbl. Most of the time, in a constrained market, one should refer to the price at which demand is destroyed, i.e. the price level that keeps demand in line with supply.

In a situation where supply cannot cover demand, the increase in the oil price encourages rational consumers to gradually limit their use of oil to those purposes where it is most useful to them. This permits an adjustment between relative price and relative marginal product. There is controversy over this process, for it is very difficult to see how demand reacts to crude price increases. There are two explanations for this apparent insensitivity. First of all, the effect of a barrel price hike is considerably blunted by the time it gets to the end user. Secondly, the fact that the cost of living rises simultaneously exerts an opposite effect

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Fig. 10 - Breaking down the crude price



Source: NYMEX

that is stronger. In the final analysis, a pronounced increase in the crude price is necessary to balance the market.

We can see how this mechanism works by taking road fuel demand as an example. Road transport represents nearly 40% of total consumption, road fuel demand is showing a very sharp increase and the possibilities of substituting other fuels for petroleum products are currently limited. That's why it's a key factor in the analysis of crude price trends.

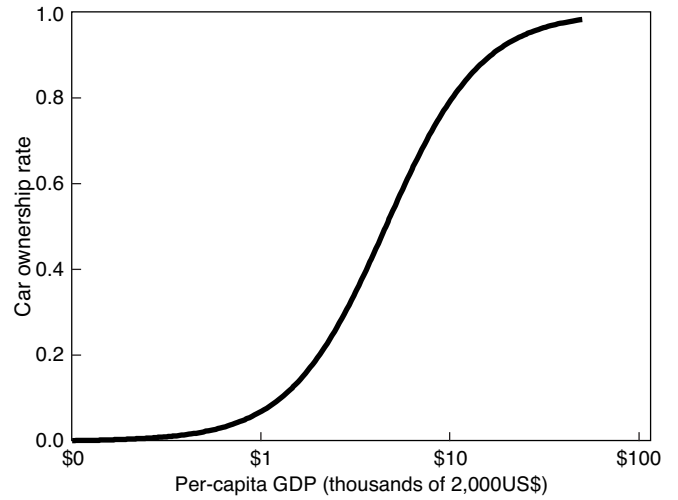
Determining factors in road fuel demand

Road fuel consumption per capita can be broken down into two terms: the automobile ownership rate and consumption per vehicle. The latter can then be broken down into unit consumption and the utilization rate.

The first term depends mainly on real income per capita. As the cost of living rises, the number of vehicles per capita forms an S-shaped curve (figure 11). The second term depends on real pump prices (negative effect), income per capita (positive effect) and the automobile ownership rate (negative effect).

If we combine the equations for these two terms, we can evaluate the elasticity of demand to the final price as well as the elasticity to GDP. The first is close to -17%; in other words, if the price per barrel were to double, consumption would drop by about 17%, all else being equal. The second decreases with per-capita income (figure 12) and is just over 100% for income per capita of USD 5,000, the world average in 2005.

Fig. 11 - Automobile ownership rate



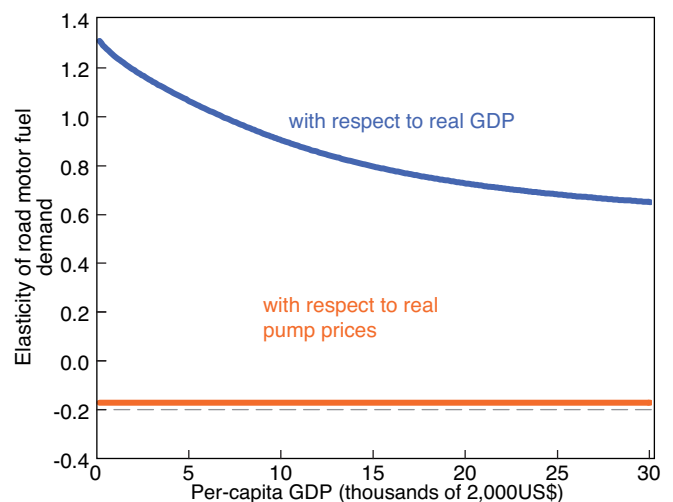
Source: IFP

Passing on high prices to consumers

Road fuels (and energy products in general) are special products whose prices are often governed by special systems that blur the signals transmitted by the oil price. The effect of high oil prices on international markets is blunted by taxes or subsidies before it reaches the end user (figure 13).

In some countries, heavy taxation cushions the effect of variations. That is true of Europe, for instance. Elsewhere — in most of the OPEC countries and many developing countries — prices are regulated by using

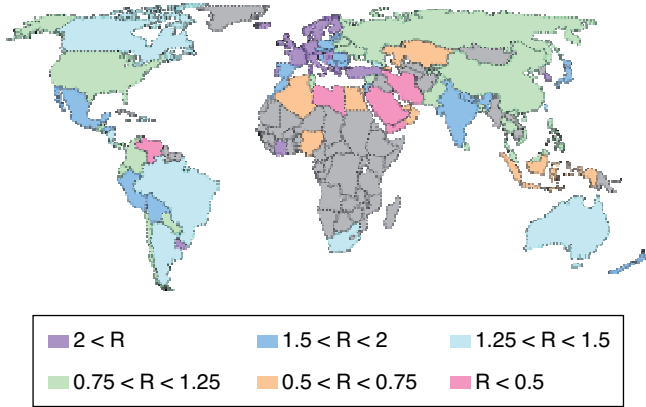
Fig. 12 - Elasticity of road fuel demand



Source: IFP

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Fig. 13 - R Ratio between the gasoline price in a given country and the price in the U.S. (current dollars)



Source: IFP

(growing) subsidies to offset increases. By weighting the elasticity of the pump price to the crude price calculated for each country (according to its share in total consumption), we get an average world elasticity of about 35%. If the barrel price were to double, the pump price would go up by about 35% in current US dollars.

But consumers react to price variations in constant money terms. There, too, the impact of the increase has been diluted. Since 2000, the general trend of overall prices and currencies has helped limit the impact of higher crude prices on consumers. The US dollar has fallen against many currencies while, at the same time, the strength of economic growth has caused inflation. For the period since 2000, we estimate that the average world elasticity of real pump prices to the nominal crude price is close to 20%.

Quantifying the "equilibrium price" of oil

Putting end-to-end all of these price elasticities, we obtain an elasticity of demand to the nominal crude price of approximately -3.4% at world level (all else being equal, a 100% increase in the barrel price would lead to a 35% increase in the pump price in current US dollars, equivalent to a 20% increase in constant US dollars, and cause consumption to fall by 3.4%). Given this very low number, the average elasticity to real income is close to 100%.

Between 2000 and 2005 (the last year for which road transport consumption data are available on a regional basis), real world GDP rose by 2.75% a year on average. Growth on the supply side permitted road fuel demand to increase by about 2.6% a year. The estimated aggregate values imply that it takes a crude price increase of about 10.22% a year for consumption to

adjust to production. That's in theory. In practice, the price hike was 13.25% a year (for the Brent). The process of demand destruction offers an explanation for the magnitude of the crude price increase since the early 2000s. Since demand showed little response to price, it took a very strong increase to keep consumption in step with production.

Obviously, the theoretical increase yielded by this calculation does not correspond exactly to the real price increase. There are two reasons for this. First, the indicated elasticity figures correspond to long-term adjustments. In the short run, adjustments to price fluctuations take place more slowly than adjustments to variations in income. It takes a more pronounced price increase to produce a quick effect on demand. Secondly and most important, the use of average world values biases estimates. The level of wealth in the fastest developing countries is still lower than USD 5,000 per capita and the elasticity of their consumption to GDP is therefore greater than the value that we used. Moreover, they often regulate pump prices (especially China) and the elasticity to price is therefore lower than our number. A regional approach must be used to find a more precise explanation for the magnitude of the increase.

Limited in its nature, infinite in its desires

A French poet, Lamartine, once referred to man as "*limited in his nature, infinite in his desires*". This is a fairly accurate description of the oil markets since the late 1990s, caught between constrained demand and an explosion in demand. Unless a major world economic slowdown occurs, this tension should persist in the medium term.

The supply trend from now to 2012

According to IFP estimates, the oil supply should grow by 1.64 Mbbbl/d/year between 2007 and 2012, bringing world production capacity to 93.6 Mbbbl/d by 2012. These estimates are based on projects announced by year-end 2007 and on the optimistic assumption that no delays in development occur; in other words, that development is not hindered by any economic, political or technical factor. As a result, the figure of 93.6 Mbbbl/d by 2012 should be considered a maximum.

OPEC is expected to account for 90% of this production increase. The organization should see its capacity grow by 19.5% (7.3 Mbbbl/d) at the initiative of a majority formed of Saudi Arabia, Nigeria and Angola. Production will rise in all OPEC countries in 2007-2012, except Algeria (-120 kbbbl/d) and Indonesia (-89 kbbbl/d).

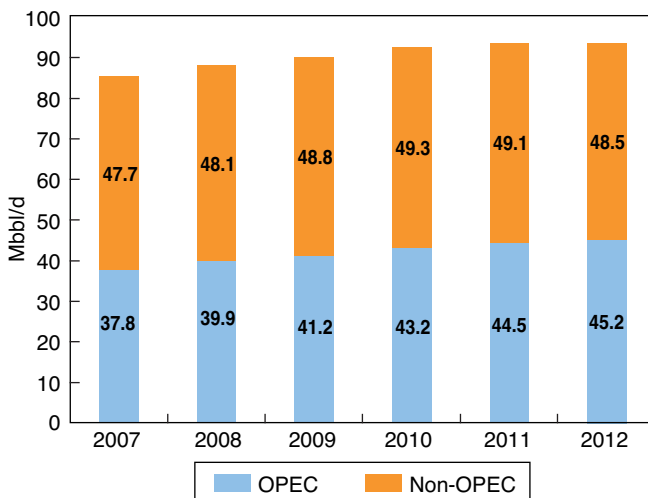
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Non-OPEC capacity is expected to rise by 800 kbb/d (1.7%) between 2007 and 2012, with Kazakhstan, Canada's tar sands and Azerbaijan as well as the deep offshore in Brazil and the Gulf of Mexico main contributors to this increase.

OPEC saw two membership changes in 2007: Angola joined early in the year and Ecuador rejoined in late November. Angola is one of the countries whose capacity is growing fastest (+1.1 Mbb/d) between 2006 and 2012. OPEC gained 2% of the market in 2007 when Angola joined and 0.7% in 2008 with Ecuador. Including the predicted increase in total OPEC capacity between now and 2012, the organization should see its market share reach 48.2%.

Middle Eastern capacity should expand by 17% (+4.6 Mbb/d) in 2007-2012, more than half of world growth. Saudi Arabia should boost capacity by 2.37 Mbb/d to reach 14.5 Mbb/d by 2010 (including natural gas liquids, or NGL), according to the Saudi Aramco plan. Capacity in Qatar should be up by 870 kbb/d, thanks in particular to the condensates and NGL associated with the development of North Dome. Iran faces with mature producing fields and delays in key planned development projects (e.g. Azadegan and Agha Jari). The national oil company, NIOC, is relying on an intensive use of assisted recovery methods – gas injection for the most part – to maintain Iran's level of production, but demand for oilfield gas reinjection is increasing faster than gas domestic production. The country will be obliged to make trade-offs between domestic consumption, exports and reinjection. This leaves one wondering about how Iranian oil production capacity can possibly grow.

Fig. 14 - OPEC & non-OPEC production capacity (2007-2012)



Source: IFP

In the medium term, Africa should post the second highest capacity increase after the Middle East: +1.42 Mbb/d (+13% for 2007-2012). The bulk of this increase will come from Nigeria (+1.1 Mbb/d) and Angola (+781 kbb/d), thanks to their deep offshore activity. In Nigeria, interruptions in production should not be ruled out, given the political situation, but capacity is expected to expand.

The CIS countries should report a 10% rise in capacity for the period (+1.29 Mbb/d). Kazakhstan is expected to grow fastest (+530 kbb/d), assuming that the giant Kashagan Field comes onstream in 2010, as recently announced. Azerbaijan and Russia should see capacity increase by 460 and 250 kbb/d, respectively.

In North America, production should be up by 7% (981 kbb/d) for the period. Canadian tar sands (+1,360 kbb/d) and the deep offshore in the Gulf of Mexico (+685 kbb/d) should help offset the large decreases predicted for the Mexican and U.S. onshore and shallow offshore sectors. This year, tougher legislation was passed in this region thought to be stable: in the U.S., royalties on deep offshore permits in the Gulf of Mexico were raised from 12.5% in January 2007 to 16.7%, and a new hike is contemplated for permits to be granted in March 2008. The province of Alberta, which contains most of Canada's conventional oil and tar sand resources, has decided to increase taxation on both, effective early 2009. These tax increases should only have a small impact on the development of liquid hydrocarbon production capacity.

Table 1
Variation in supply (2007-2012)

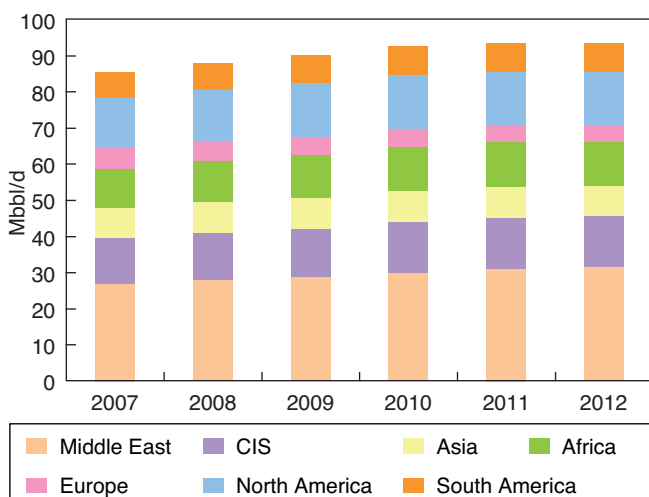
Variations 2007-2012	%	en kbb/d
World	9.6 %	8,198
Middle East	17.2 %	4,643
Africa	13 %	1,424
CIS countries	10 %	1,293
North America	7 %	981
South America	13 %	906
Asia/Oceania	2 %	158
Europe	- 21.3 %	- 1,208
OPEC*	19.5 %	7,384
Non-OPEC	1.7 %	814
GtL	450 %	370
CtL	16 %	30
Biofuels	110 %	680
Total GtL, CtL, Biofuels	120 %	1,080

* Ecuador considered as OPEC member in 2008
Source: IFP

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Growth in crude production in Latin America (+13%, or 900 kbb/d) should be driven by Brazil (+435 kbb/d), Venezuela (+232 kbb/d) and Ecuador (+164 kbb/d). The production of extra-heavy crude in Venezuela's Orinoco Belt should remain unchanged at 600 kbb/d for the period. New development projects are planned after 2012 that should double current capacity. The forecasts see a slight decrease in non-OPEC production on the continent, which should drop by 1% (-50 kbb/d) for 2007-2012. This is artificial, however, because Ecuador rejoined OPEC at year-end 2007. The latter event subtracts 560 kbb/d from non-OPEC production between 2007 and 2008. Actually, most of the non-OPEC countries in this zone are seeing capacity expand. The recent discovery of the giant Tupi Field off Brazil, with an estimated 5-8 Gbbl in reserves, should help boost production by 1 Mbb/d by 2015. Tupi is Brazil's first big discovery in deep presalt reservoir and it opens up bright prospects for domestic exploration.

Fig. 15 - Production capacity by geographic area (2007-2012)



Source: IFP

In Asia, production should remain virtually flat during the period 2007-2012, with 2% (160 kbb/d) growth in capacity. India should show the largest regional increase (+115 kbb/d), small by world standards. India is expected to pass the 1 Mbb/d mark in 2009 and outproduce Indonesia by 2012. China and Indonesia, Asia's top two producers, should see extracted volumes fall by 120 and 90 kbb/d respectively during the period under scrutiny.

In Europe, a production decline of about 21% (-1.2 Mbb/d) is anticipated. Liquid hydrocarbon output is down in Norway and the United Kingdom (-730 kbb/d and -352 kbb/d, respectively), despite the fact that

Buzzard Field (U.K.), the largest North Sea discovery in recent years, came onstream. This field should reach a production plateau of 200 kbb/d, which is high for this very mature area. Even so, and despite Norway's substantial gas and condensates developments (e.g. Snoehvit and Ormen Lange), Old World production is continuing its inexorable decline.

Increasingly, the world is relying on the so-called unconventional sources of energy to meet its demand for petroleum products. Besides the Canadian tar sands (1.3 Mbb/d in 2007) and Venezuelan extra-heavy crude (600 kbb/d in 2007), already mentioned, technologies are being developed to convert gas, coal or biomass to fuels. These are the GtL (gas to liquids), CtL (coal to liquids, see the relevant Panorama articles) and biofuels paths. The production of petroleum products using these methods is expected to increase from 880 kbb/d in 2007 to more than 1.9 Mbb/d in 2012 (+1 Mbb/d), not a negligible quantity in a tight market.

There is such a world shortage of services, engineering and construction capacity that many development projects have been delayed. In its medium-term oil market report, the IEA said it had identified 27 projects delayed from July 2006 to July 2007. The biggest project to be postponed (by nearly 5 years now) is the development of the giant Kashagan Field in Kazakhstan. It was supposed to start in 2005, but has been postponed several times; it is now set for 2010. This would be a substantial contribution to world supply: production is expected to plateau at 1.5 Mbb/d.

As far as long-term supply is concerned, experts disagree. It seems improbable that supply will continue to grow and the possibility that production will peak before 2020 cannot be ruled out.

The outlook for demand

Supply is limited, demand seems infinite. Emerging countries are growing fast and world energy needs are booming. The middle-classes in these parts of the world are earning enough to start buying energy-intensive durable goods, such as electronic household appliances or automobiles, on a massive scale.

Once again, the road transport sector can be taken to illustrate the world's thirst for petroleum products.

According to the macroeconomic reference scenario used by the IEA in its latest "International Energy Outlook", despite a slowdown after 2010, real GDP per capita should continue to grow exponentially in each region until 2030 (cf. Table 2). Naturally, the emerging countries will make the best showing.

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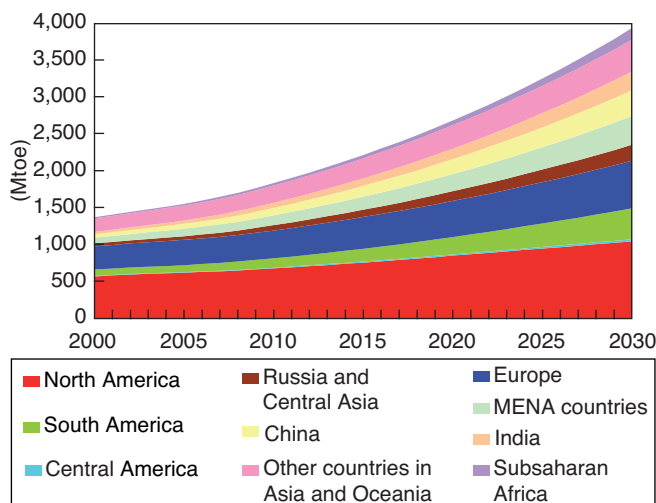
Table 2
Growth rate of real GDP (2004-2030)

	2004 - 2010	2010 - 2015	2015 - 2020	2020 - 2025	2025 - 2030
OECD North America	2.08	1.92	2.18	2.05	2.00
OECD Europe	1.92	1.81	1.83	1.77	1.81
OECD Asia	2.14	1.60	1.32	1.25	1.29
Total OECD	2.06	1.88	1.93	1.85	1.87
Non-OECD Europe and Eurasia	6.27	4.47	3.93	3.81	3.79
Non-OECD Asia	6.13	4.66	4.36	4.04	4.04
Middle East	3.04	2.28	2.05	2.08	2.22
Africa	3.10	2.84	2.74	2.72	2.80
Latin America	3.16	2.64	2.68	2.73	2.84
Total non-OECD	4.92	3.80	3.59	3.41	3.45
Total World	2.29	1.96	2.02	2.02	2.13

Sources: DOE-EIA, Global Insight, Inc.

If we consider this outlook for economic growth, if there is no change in national systems to set pump prices and if the crude price remained stable in constant US dollars from 2007, then road fuel consumption would increase by more than 150% between 2005 and 2030 (figure 16).

Fig. 16 - World consumption of road fuels (Mtoe)



Source: IFP

Of course, a scenario like this is unrealistic. As a result, growth in demand will be limited by the development of supply, and the market will be balanced, at least initially, by the fact that prices continue to rise.

In the medium term, is the crude price on an equilibrium growth path?

The forecast for supply growth, expected to be substantial until 2010, seems barely adequate to cover the increase in demand, especially insofar as mobility is concerned. The crude price should increase more slowly in the short term (if the value of the US dollar stops eroding). However, stocks must be replenished in 2008 so the market will still be feeling pressure. Mostly, after 2011, the possibilities of expanding production capacity are limited, according to current information. This suggests that prices will start to accelerate again then.

If we retain the economic growth scenario of the U.S. Department of Energy and the assumption that retail price setting systems will not be changed, the only thing that could keep demand in line with supply is an oil price increase comparable to that observed since 2002.

The magnitude of the price increase obtained is such that the scenario is no more realistic than the previous one, in which retail prices did not rise. The fact that prices continue to soar probably contradicts the very assumptions on which the simulations are based: systems that regulate end prices will not be able to withstand this upsurge and world economic growth is very likely to be impacted as well. Let's not forget that forecasters were overly pessimistic after the second oil shock, badly underestimating the consumer's ability to adjust to contracting supply and a rising barrel price. This scenario repeats the same mistakes, by failing to account for the ability of the world economy to accommodate a shock.

The main interest of this price increase scenario is that it can be compared with the previous demand growth scenario. Between these two extremes, it is probable that a compromise can be found. By changing our behaviors, pursuing our efforts in the area of energy efficiency and gradually developing replacement fuels, we can hope to keep the oil price increase under control. That is, unless the world economy were hit by a major economic crisis with other causes.

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