

# A subdued oil shock

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*There have been unprecedented developments on the oil markets in recent months, with the price of Brent North Sea oil breaking through the \$60/barrel level on 1 August before falling back to around \$55 on average in November. The upward tendency has now been practically uninterrupted since 2003, with the Brent price now \$25 higher than at that time. This surge seems to have been due to particularly strong demand for oil — by reason of generally firm world growth — at a time when refinery capacity utilisation is close to its peak (see section 1).*

*What effect has this shock had on the French economy?*

- *In the first place, it has adversely affected household consumption. The rise in the price of crude oil has in fact led to higher prices for the refined products consumed by households (see section 2). Given that in the very short term there is practically no possibility of substitution between the various types of energy, the rise in consumer prices of petroleum products was immediately reflected in additional spending on these products, estimated at almost €100 per household on average in 2004 and €200 in 2005 (see section 3).*

- *French firms, for their part, have had to cope with a rise in the costs of their energy inputs (see section 4). Some sectors, such as the chemical industry and transport, have been more affected than others. Nevertheless, for the economy as a whole the direct impact of the rise in energy prices on production costs appears to be still limited. Diffusion effects, via rises in the costs of other inputs, seem at this stage to be particularly confined and second-round effects (i.e., on wage costs) non-existent.*

- *Lastly, the French oil import bill has risen from 1.5 percentage points of GDP in 2003 to 1.7 points in 2004 and is expected to come out at 2.1 points in 2005. The same phenomenon has been seen in all the oil-importing countries, resulting in a transfer of wealth to the exporting countries amounting to 1% of world GDP in 2004 and 2005 taken together (see section 5).*

*In the end, France has not found itself reliving the traumas caused by the oil shocks of the 1970s. The price rise has been more evenly spread over time than in previous crises and this has enabled adjustments to be made, especially as the shock was partly cushioned by the appreciation of the euro versus the dollar. In addition, French energy intensity is now considerably lower than at the time of the earlier shocks and the monetary context is also very different. Finally, the intensification of competition now exerts severe pressure on prices, thus limiting the risks of a revival of inflation.*

## 1. A virtually continuous rise in the crude oil price since 2003

Between 2003 and 2004, the Brent price rose from \$29/barrel to around \$38, an increase of \$9. This year, assuming a price of around \$56.5 in Q4, it will have risen by a further \$16 to an annual average of more than \$54. Taking the two years together, the rise will have amounted to more than \$25. The real oil price, after deflation by the consumer price index, now lies between the level seen after the first oil shock and the level after the second shock. However, unlike the previous crises, the rise in the price of crude is this time not explained by any break in supply but mainly by firm demand resulting from strong growth in the world economy — even though recent events in the Gulf of Mexico have demonstrated that difficulties at the refinery stage also influence prices. Another feature of the present situation is that the price rise has been more gradual than at the time of the 1973 and 1979 shocks and this has probably enabled adjustments to be made. Finally, in the European countries the price rise was partly cushioned by the appreciation in the euro-dollar exchange rate over the period concerned.

### A shock linked more to strong growth in world demand for oil than to supply disturbances

Unlike its 1973 and 1979 predecessors, the present oil shock cannot be said to result from a break in supply, but is more in the nature of a demand shock. There has in fact been no sudden decline in world supply of the kind seen in the Middle East in the 1970s. It is more a succession of «mini-shocks» affecting the productive system (geo-political events and a series of hurricanes in the Gulf of Mexico) that has, in a context of steeply-rising demand, helped to maintain pressure on the market and force up prices.

The principal contributory factor to the recent rise in oil prices is indeed to be found in the rapid growth in world demand for oil (see Graph 1), which has led to a

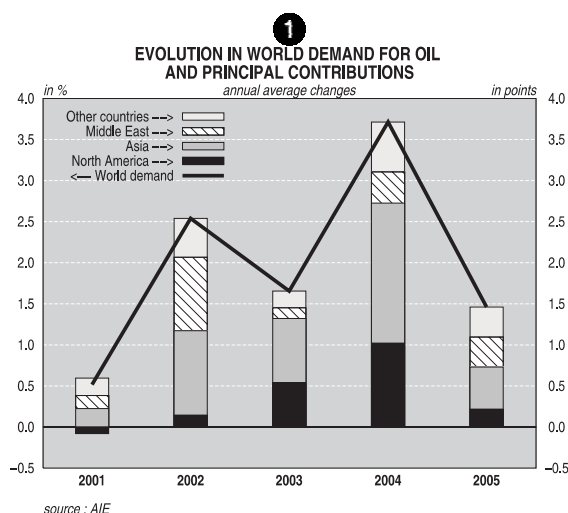
dwindling of the surplus crude oil productive capacity, located entirely in the OPEC countries. Strong growth in China, stimulated by rapid industrialisation, as well as in other Asian countries such as India, has coincided with continuing firm demand for oil from the United States. Moreover, this growth in demand was not correctly predicted. In 2004 and in the early part of 2005, in particular, the International Energy Agency (IEA) raised its forecasts for world demand for oil several times. In the present situation of quasi-saturation of productive capacity, OPEC is therefore no longer capable of acting as «swing producer» and of regulating the market.

During the past summer, it became clear that bottlenecks at the refining stage could also constitute a major problem for the oil market. Both gasoline prices and crude pri-

ces soared after the destruction of several United States refineries. Prices only started to ease when the IEA<sup>(1)</sup> decided to draw on its strategic reserves of oil and refined products. There has in fact recently been seen a correlation between the price of crude and the availability of refined products: the smaller the stock of petroleum products (petrol, domestic fuel) on the market, the greater the rise in the price of crude. There is at present no really satisfactory explanation of this correlation and it does not necessarily indicate a causal link. However, the fact is that the falls in the stocks of petrol this past summer and in heating oil stocks in the winter of 2004 coincided with rises in the price of crude.

### An oil shock more evenly spread over time than its predecessors and cushioned in the euro zone by evolutions in the exchange rate

In order to compare the scale of the oil price shock now being seen with those of the 1970s, it is preferable to look at prices expressed in constant euros, as this makes it possible to allow for the general evolution in inflation between the two periods. The evolution in the Brent price shown in Graph 2 on



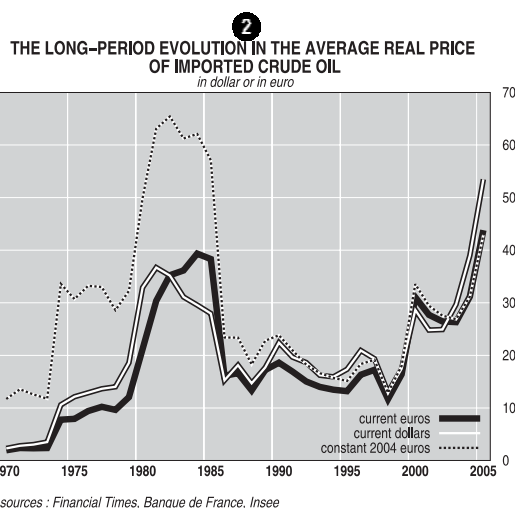
(1) The International Energy Agency, set up in 1974 by the oil-importing countries, has 26 member countries. Since December 1975, each member is obliged to maintain a minimum level of stocks of petroleum products equal to 90 days' average daily domestic consumption calculated on the basis of the previous calendar year. These stocks, which are held for precautionary motives, are known as «strategic stocks».

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this basis shows that, on the assumption of a price of \$56.5/barrel in Q4 2005, the level reached by the real price (in constant 2004 euros) is midway between the levels seen after the 1973 oil shock and after the 1979 shock. It is in fact roughly 30% higher than the peak following the first shock and still around 50% lower than the peak following the second shock.

Moreover, compared with its two predecessors, the price rise has been much less sudden. At the time of the first oil shock in 1973, the crude oil price more than trebled between Q4 1973 and Q1 1974, rising from slightly less than 5 dollars to more than \$15. The price rise at the time of the second oil shock was just as rapid, with the price doubling in less than one year from slightly below \$20 in Q1 1979 to almost \$40 in Q4 of the same year. This time the price rise of roughly 80% has taken place between 2003 and 2005, meaning that the present episode has been more evenly spread over time than its two predecessors.

Finally, in the euro-zone countries and in France in particular, the shock has been partly cushioned by evolutions in the exchange rate. Between January 2003 and January 2005, the euro appreciated by more than 10% against the dollar, making imports of oil and petroleum products less costly. The appreciation of the European currency has therefore to some extent eased the impact on the European oil bill.



### How to read the graph:

The graph shows the evolutions in the annual average price per barrel of crude oil imported into France since 1970. The prices are shown in current dollars and euros, together with prices «at constant 2004 euros», calculated by deflation using the consumer price index in order to have an idea of the evolution over time in the real price of imported crude. The prices are annual averages. For the year 2005, on the assumption of a Brent price of \$56.5/barrel in Q4, the average price per barrel of imported crude would be \$54.3 or €43.8. The price in constant euros would be 42.9, well below the peak of 65.4 reached in 1982.

## 2. Lower growth in French pump prices than in crude oil prices

Rises in the price of crude oil inevitably get passed on into higher consumer prices for petroleum products. However, despite the strong linkages between these evolutions, there has been no automatic repercussion. The price of top-grade lead-free petrol, for example, has risen by only 10%, compared with a rise in the price of crude between 2004 and 2005 of almost 40%. A number of different factors have in fact to be taken into account in order to understand the formation of pump prices. Despite a substantial increase in refinery margins, the impact of the French TIPP (domestic tax on petroleum products) has so led to a less rapid rise in the prices of the products consumed by households (petrol, diesel oil, domestic fuel oil) than in the price of crude.

### An unusual evolution in refining margins

The gross refining margin is defined as the difference in euros between the quoted price of the refined product in Rotterdam<sup>(2)</sup> and the spot price of Brent. This margin comprises not only the profits made at the refining stage but also, in particular, the induced costs of this process. In the summer of 2005, the rise in refining margins following the hurricanes that swept the Caribbean and the South of the United States was particularly marked. It was even greater for the medium distillates (diesel oil, domestic fuel oil) than for lighter products such as petrol.

Another key stage in the progress from crude oil to the final sale at the pump consists of the transport of the refined product and its distribution. The difference between the pre-tax price of the product available from French retailers (prices taken from the DIREM<sup>(3)</sup> survey) and that of the refined product quoted in Rotterdam makes it possible to give an approximation of the gross so-called transport-distribution margin. Here too, there is a dif-

ference to be seen between the average observed margin on petrol and the corresponding (higher) margin on the medium distillates<sup>(4)</sup>. The evolution of the latter is nevertheless less uneven (see Graph 3) than that of the refinery stage. The situation is relatively atypical in Europe and the substantial role played by supermarkets in sales of fuels through their networks produces a favourable competitive environment (economies of scale, for example).

### The impact of the domestic petroleum products tax on the rise in pump prices

In France, two types of tax are applied to the various petroleum products: value added tax (VAT) at the standard rate of 19.6% applied to all consumer goods and the TIPP (domestic tax on petroleum products), which is specific to this market. The transition from the pre-tax price to the full tax-paid price can be written as follows:

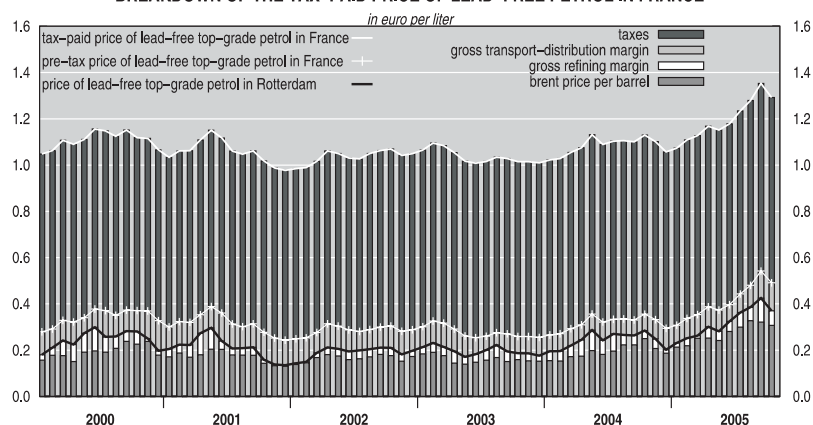
$$P_{TTC} = (P_{HT} + TIPP) * (1 + \text{ratetva})$$

where  $P_{TTC}$  designates the full tax-paid price,  $P_{HT}$  the pre-tax price and  $\text{ratetva}$  the rate of VAT.

Unlike VAT, the TIPP is applied to physical quantities and not to values. This means that a rise in the pre-tax price is not entirely passed on into the tax-paid price. A substantial portion of the tax-paid price is therefore unaffected when the crude oil price changes. It is in fact necessary to divide the change in the pre-tax price by a factor of roughly 4 to obtain an estimate of the change in the tax-paid price.

In the end, the evolution in the tax-paid price of fuels and, more generally, in the «petroleum products» item in the consumer price index, to a considerable extent explains the recent time-pattern of inflation. Its contribution to the year-on-year change amounted to roughly 0.4 of a point in January 2003 and not far off 1.2 of a point in September 2005.

**3** BREAKDOWN OF THE TAX-PAID PRICE OF LEAD-FREE PETROL IN FRANCE



sources : DIREM, Financial Times – calculations by Insee

(2) By “refined product” is meant either the top-grade so-called AVSR (Anti-valve-seat recession) petrol, top-grade lead-free petrol or domestic fuel oil. The price in Rotterdam constitutes a guide price for Europe and makes it possible to distinguish two stages in the transition from crude oil to the petrol available to consumers: refining and the transport-distribution stage.

(3) The DIREM (Directorate General for Energy and Raw Materials) collects so-called “pump prices” from the main French distributors throughout the territory. It then carries out an aggregation. The results are available on the Internet.

(4) This difference in absolute amounts seems to be explained mainly by the higher costs for medium distillates (for example, storage costs in the case of fuel oil) and the particular logistics needed for diesel oil. Moreover, given that French production of petrol is in surplus, this gap is likely to widen.

### 3. Given the limited possibilities of substitution between various types of energy in the very short term, the rise in consumer prices of petroleum products has meant an immediate increase in spending on energy by French households

*On average, the additional spending by each French household on petroleum products amounted to around €100 in 2004 and €200 in 2005. One reason for the substantial size of this increase is that this type of consumption is very difficult to reduce. In the very short term, households have few possibilities of substituting other types of energy. In other words, the volumes consumed remain practically stable and, this being so, the rise in prices is passed on almost entirely into expenditure.*

#### The price-elasticity of total energy consumption by French households is smaller than for fuels

In order to quantify the way in which consumers react to a rise in energy prices, i.e. the extent to which they adjust the volume of their consumption, estimates based on time-series data have been carried out.

The theoretical framework adopted is fairly traditional. Households seek to maximise their intertemporal utility (i.e., a function of their consumption of various types of goods over their lifetime horizon) subject to budgetary constraint. When faced with a relative-price shock (in this case, a rise in the price of energy that is more rapid than for the average price of all the goods consumed) they can, for a given level of consumption, reallocate the composition of their spending by types of good (for example, by buying fewer petroleum products because they cost more). In this case, this amounts to trying to find econometric relationships between the consumption of energy products, the relative price of energy and total consumption.

These estimates show the elasticity of the consumption of energy<sup>(5)</sup> to the relative price of energy to be relatively small, of the order of 10 to 15%<sup>(6)</sup> (see box page 20). This suggests that households confronted with higher energy prices do indeed slightly cut back the volume of their energy consumption, but not enough to compress their energy budget correspondingly, so that the share of energy products in the value of their total consumption increases substantially. This in turn

means that consumers, everything else remaining equal (including their income, their level of saving and the prices of other goods and services), tend to reduce the value (and hence the volume, at unchanged prices) of their purchases of other products in order to cope with the increase in their energy budgets.

A similar estimation was carried out for the consumption of motor fuels<sup>(7)</sup>. The price-elasticity of demand for motor fuels is estimated to be around 20% in the short term (i.e. over a time-horizon of roughly one quarter) and 40% in the long term. The short-term adjustment can take the form of reduced use of private vehicles and hence a reduction in the number of kilometres driven. In the long term, the adjustment is likely to mean, in addition, more irreversible changes on the demand side (such as the purchase of a new vehicle with greater fuel economy) or on the supply side (expansion of public transport, improvement in the rail network, etc).

Notwithstanding, the share of motor fuels in total consumption in value has risen substantially recently, in line with the rise in the relative price.

**The additional cost caused by the rise in prices of refined petroleum products (motor fuels, domestic fuel oil) is estimated to have been of the order of €100 per French household in 2004 and €200 in 2005**

Spending on energy represents roughly 10% of the average French household budget<sup>(8)</sup>. Motor fuels account for the largest part of this

(4.2%), with electricity, domestic fuel oil and non-discernible electricity and gas accounting for 2.2%, 1.5% and 1.2%, respectively.

In 2000, according to the family budget survey for 2001, households' total expenditure on petroleum products amounted to €1187. Adjusting the figures on the basis of the evaluation of expenditure by households on domestic and motor fuels recorded in the national accounts brings the average annual expenditure in 2004 to €1365.

In 2005, the price of refined petroleum products is estimated to have risen by 14.5% on an annual average basis on the assumption that the Brent price stabilises at €55/barrel and the exchange rate at \$1.19 to the euro. This increase would mean an annual addition to the energy burden on households amounting to roughly €200.

(5) In all the estimations, rather than use the series for total energy consumption published in the quarterly national accounts, it was decided to base the reasoning on the consumption of energy excluding water consumption. In all the estimations, the consumption is expressed in volume.

(6) The instantaneous elasticity is significant only at the 15% threshold, but the price has a significantly negative impact on energy consumption following a time lag of one quarter.

(7) The underlying theoretical framework is slightly more complex than in the previous case. In a first stage, households allocate their consumption between motor fuels, domestic energy and other goods. Next, they allocate their consumption of domestic energy between the various sources available to them (gas, electricity, coal, butane and fuel oil).

(8) Family household budget survey (2001).

### 4. The rise in energy prices seems to have had a limited overall impact on producer prices in France, albeit varying widely between sectors

Just as the rise in oil prices has been reflected in the prices paid for energy by consumers, it has also been passed on into the prices of the inputs used by firms in their production process<sup>(9)</sup>. Distinctions have nonetheless to be made between the different branches of the French economy. Those with greater consumption of energy products are naturally the first to be affected by the rise in oil prices. Particular examples are the chemical and transport branches.

Even so, the rise in production costs for the French economy as a whole seems to have been relatively limited. There may indeed have been certain diffusion effects between the various branches of activity, but these have been closely confined. As for the so-called «second-round» effects of the energy shock, via an increase in wage costs, nothing of the kind has so far been visible.

#### The direct impact of the rise in energy prices on production costs seems to have been limited, taking the economy as a whole<sup>(10)</sup>

For the economy as a whole, the direct impact on production costs resulting from the rise in energy prices (electricity, gas and petroleum products<sup>(11)</sup>) seems to be closely confined. Whereas energy prices rose by 7.3% over the whole of the year 2004, the impact on the production costs of all branches other than energy is put at 0.2 of a point (see Table 1). This estimate was obtained by multiplying, for each energy product consumed,

the evolution in the price of the product by the corresponding technical coefficient<sup>(12)</sup>.

Some branches appear to have been more affected than others. For example, the organic chemical industry seems to have sustained a direct addition to costs amounting to 4.5%, because of the steep rise in the price of naphtha. The steel industry was also badly affected by the rise in the price of coal. The transport branch, too, was affected more than the average (a 0.9-point rise in production costs attributable to the increase in energy prices). The same was probably true of fisheries. In the rest of the economy,

the impact of the rise in energy prices has been less important, thanks to the fact that most of the branches were relatively greater consumers of electricity, gas and heavy petroleum products, whose prices have risen less in relative terms.

For 2005, although no robust evaluation of this type has yet been able to be carried out, it is possible to give certain qualitative indications. For example, compared with 2004, import prices for energy products (water, gas, electricity and oil) are thought to have risen slightly faster (by almost 22%, compared with 15.7% the previous year). The orders of magnitude of the di-

(9) The channel for the transmission of the oil shock in the case of firms is fairly similar to that set out for households. In terms of consumption of petroleum products, the crude oil price in fact largely determines the prices of refined petroleum products used by firms. The elements concerning marginal behaviour remain similar. The tax considerations are somewhat different, however, since VAT does not apply.

(10) As the evaluation for the direct impact of energy prices involves very detailed data, it has been carried out only for the year 2004.

(11) The coverage adopted here is slightly broader than that of petroleum products. Taking all branches of the economy — excluding energy — the latter nevertheless account for more than 60% of the intermediate consumption appearing in the evaluation.

(12) The technical coefficient for energy relating to a given branch is its energy consumption as a proportion of branch output.

**Table 1 : Direct impact of the evolution in energy prices in 2004 on production costs, by branch**

	Agriculture	Industry excluding energy	Construction	Distribution	Transport	Market services	Total excluding energy
Evolution in the prices of energy consumed by the branch	6.8	7.8	7.2	6.8	11.4	5.4	7.3
Technical coefficient for energy	4.5	2.5	1.6	3.0	8.3	1.0	2.1
of which, petroleum products	3.4	1.1	1.3	2.2	7.6	0.5	1.3
Direct impact of energy prices on production costs	0.3	0.2	0.1	0.2	0.9	0.1	0.2

Source : Insee Première n°1024

How to read the table: The evolution in the prices of the energy consumed by the branch takes into account the detailed structure by product of this consumption.

The technical coefficient is the share of energy consumption by a branch in the output of the branch.

The direct impact of energy prices on costs is obtained by multiplying the evolution in energy prices for the branch by the technical coefficient. This is therefore the first-round impact of the rise in energy prices on the producer prices for the branch. It does not take into account the induced effects of this rise on the costs of the other factors of production.

rect effects are therefore likely to have been greater than those calculated here for 2004, everything else remaining equal.

**Diffusion effects, via the costs of inputs as a whole, seem at this stage to be relatively limited and second-round effects, via wage costs, non-existent**

The orders of magnitude shown above take no account of induced effects. They show solely the impact of the surge in energy prices on the production costs in each branch taken in isolation. They do not allow for the fact that, in a second stage, the rise in the costs of one branch are transmitted to the other branches that consume its products. The traditional method of estimating these induced effects

consists of using the intermediate use quadrant of the uses table in the national accounts showing the various branches and carrying out a certain number of iterations in order to obtain a total result taking account of the automatic diffusion of price rises throughout the economy. An exercise of this kind involves making fairly bold assumptions regarding the transmission mechanism — partial or complete — for the cost rises. Furthermore, it gives no information on the time by which the quantified effect is deemed to occur. But in any case, everything else remaining equal, it is greater than the direct effect taken on its own.

*A fortiori*, the proposed evaluations do not incorporate «second-round» effects, either. These describe the process by which rises in production costs, once they have

spread throughout the economy, are liable also to influence wage claims and, as a result, wage costs.

At this stage, given the rises in energy costs posted since 2003, the rise in producer prices seems remarkably confined (1.5% on an annual average basis in 2004 and 1.9% in 2005), suggesting limited diffusion effects. The same is true of the evolution in wage costs (0.5% and 1.5% in the past 2 years), pointing to an absence of second-round effects. The pressure exerted by international competition may in some sectors have been a factor holding back the rise in producer prices.

### 5. An oil shock that has affected European households less than their American counterparts but which automatically leads to a transfer of wealth from the oil-importing to the oil-exporting countries

The sequences of events described above in the case of France regarding consumer prices, household expenditure and corporate behaviour have also been observed in the other industrialised countries.

In France's principal trading partners, the impact of the rise in energy prices has been felt in inflation, even though the evolution in the underlying components of the price indices has been kept well in hand. However, the size of the additional amounts spent on petroleum products by households has not necessarily been the same, despite the fact that the orders of magnitude seem broadly similar in Germany and in France (around €200 per household in 2005). The addition seems to have been much greater in the United States, given that the country has also suffered from both the depreciation in the dollar (in 2004) and the series of hurricanes (in 2005). In any case, the trade balances of the importing countries have been considerably worsened by the rise in the crude oil price. The transfer of wealth from the importing to the exporting countries has been put at roughly 1% of world GDP for the years 2004 and 2005.

#### American households worse hit by the oil shock than French or German households

In the United States, spending on petroleum products (motor fuels and domestic fuel oil) was \$1442 per consumption unit<sup>(13)</sup> in 2003, when the last annual survey of household expenditure was made. Projecting this figure forward on the basis of information taken from the national accounts and with the closest possible coverage produces a figure for the additional annual expenditure of the order of \$280 (€220) in 2004 and \$420 (€330) in 2005. The comparable figures per consumption unit for France are €60 in 2004 and €120 in 2005<sup>(14)</sup>.

In the case of 2004, it emerges clearly that the difference compared with France can be almost entirely explained by the fluctuations in exchange rates (see above). In fact, import prices for refined products rose by more than 27% in the United States, against only 17% in France, thanks to the 10% depreciation of the dollar. For the year 2005, it is likely that the damage from hurricanes Katrina and Rita, by producing a sudden spike in fuel

prices, has helped to increase American households' expenditure still more.

In the case of Germany, the Destatis Institute has estimated that the additional cost a household caused by the rise in prices of refined products amounts to €176 in 2005, much the same order of magnitude as that obtained here for France.

#### A transfer of wealth from oil-importing countries to oil-exporting countries not far off one percentage point of world GDP over the period 2004-2005

The continuous rise in oil prices since 2003 is estimated to have led to a transfer of wealth from importing to exporting countries of the order of \$330 billion, or 1 percentage point of world GDP, in 2004 and 2005.

The rise in the price of Brent in these past two years has produced a shock to the terms of trade, reflected in a transfer of wealth from the oil-importing to the oil-exporting countries. According to the IMF<sup>(15)</sup> this transfer amounted to roughly

\$120 billion between 2003 and 2004 and more than \$210 billion between 2004 and 2005, or roughly 1% of world GDP in the space of two years.

This transfer of wealth can be analysed in terms of countries' trade balances. In the United States, first of all, imports of petroleum products as a proportion of GDP rose from 1% to 2% between the beginning of 2003 and mid-2005. This shock is still much smaller than in the latter part of the 1970s, when the energy bill fluctuated between 2.5% and 3% of GDP over a period of three years. Taking as reference point the oil imports recorded in 2003, the rise in 2004 and 2005 corresponds to a transfer of the order of \$100 billion to the rest of the world, or roughly 0.8% of United States GDP.

The conclusion is practically the same in the case of France, where the cost of petroleum product imports rose from 1.9% of GDP in 2003 to 2.9% in the first three quarters of 2005, meaning an addition of almost €18 billion. As France is an exporter of refined products, however, the impact on the trade balance is smaller than this (€12

(13) «Consumption units» (CU) provide a weighting system that gives a coefficient to each member of household, thus making possible to compare the standard of living as between households of different size or composition. The scale that is most commonly used at present (the so-called OECD scale) applies the following weightings: 1 CU for the first adult in the household; 0.5 CUs for all other persons aged 14 or more; 0.3 CUs for children under 14.

(14) In order to get around the problem of a potentially heterogeneous composition of households in the United States and in France (size, etc), the comparison of the additional costs linked to the rise in the oil price had been carried out on the basis of consumption units rather than households. According to the 2001 family budget survey, a French household is equivalent on average to 1.62 consumption units. Knowing this makes it possible to convert the data previously calculated per household (€200 in 2005) to the additional costs borne by each consumption unit (€120).

(15) Cf. «The impact of higher oil prices on the global economy» (2000). This is the latest document to have provided an evaluation of the transfer of wealth brought about by a rise in oil prices. Inasmuch as these calculations were made in 2000, it is not impossible that the estimates shown here for 2003 and 2004 understate the effects. Furthermore, the calculation takes account only of the effect of the oil price expressed in dollars and ignores fluctuations in exchange rates during the period.



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billion). In any case, the situation remains very different from the shock at the end of the 1970s and the beginning of the 1980s, when the oil bill was equivalent to around 5 % of GDP three years in succession.

The reduced sensitivity to the oil price seen in all the industrialised economies can be related to the decline in energy intensity, which practically halved in the space of 30 years in the OECD countries<sup>(16)</sup>. ■

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*(16) Energy intensity is to be understood here as the ratio between the primary use of oil and GDP. Source: OECD Economic Outlook n° 76.*

## BOX - ESTIMATION OF THE PRICE-ELASTICITY OF ENERGY CONSUMPTION

It is assumed that the representative consumer maximises his intertemporal utility under a budgetary constraint:

$$\begin{aligned} & \max \int_0^{\infty} e^{-\rho t} \text{Log}(U_t) dt \\ & \text{s. c. } \sum_i^n p_{it} c_{it} \leq P_t C_t \\ & \dot{w}_t = r_t w_t + R_t - P_t C_t \end{aligned}$$

where  $U_t$  is instantaneous utility at constant elasticity of substitution,

$$U_t = \left( \sum_{i=1}^n \alpha_i c_{it}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

with:

$\rho$ , the preference for the present;

$(c_{it})$ , the respective demand for goods  $i$ ,  $i = 1$  to  $n$  at date  $t$ ;

$(\alpha_i)$ , harmonised preference parameters of the Hickman et Lau (1973)<sup>(1)</sup> type  $(\sum_{i=1}^n \alpha_i^{\sigma} = 1)$ ;

$\sigma > 0$ , the elasticity of substitution between the goods;

$r_t$ , the rate of interest;

$(p_{it})$ , the prices of goods  $i$ ,  $i = 1, \dots, n$ ;

$P_t$ , the overall consumer price index at instant  $t$ ;

$w_t$ , the consumer's wealth;

$R_t$ , the consumer's income;

$C_t$ , the consumer's total consumption.

This programme is resolved in two stages. In the first stage, the consumers allocate their intertemporal income among consumer expenditures ( $P_t C_t$ ) in each period. In the second stage, for a given instantaneous level of consumption ( $P_t C_t$ ), the consumer allocates his purchases between the various goods. From the resolution of this programme, one derives the demand for consumption of good  $i$  in period  $t$  depending on total instantaneous consumption, the relative price of good  $i$  in relation to the price of total consumption and the elasticity of substitution between the goods:

$$c_{it} = \alpha_i^{\sigma} \left( \frac{p_{it}}{P_t} \right)^{-\sigma} C_t \quad (1)$$

Let  $c_{et}$  be the consumption of energy and  $p_{et}$  its price. Demand equation (1), is then verified at the level of the energy products:

$$c_{et} = \alpha_e^{\sigma} \left( \frac{p_{et}}{P_t} \right)^{-\sigma} C_t$$

Moving to a logarithmic formulation produces a testable linear equation. This gives the form of the long-term relationship in the dynamic (error-correction) model which will in practice be estimated using a VAR model in absolute amounts with three variables,  $\text{Log}(c_{et})$ ,  $\text{Log}\left(\frac{p_{et}}{P_t}\right)$  and  $\text{Log}(C_t)$ .

In a first stage, it is verified that all these series are integrated of order 1. For this purpose two additional tests are carried out: the first for non-stationarity (null hypothesis) using augmented Dickey et Fuller (ADF); the second for stationarity (null hypothesis) using Kwiatkowski, Phillips, Schmidt et Shin (KPSS) on the series in absolute amounts and the series in first differences. For the series in absolute amounts, the presence of a deterministic trend is allowed.

In a second stage, the number of lags is chosen using various criteria: AIC (Akaike Information Criterion), FPE (Final Prediction Error), HQ (Hannan-Quinn Criterion) and SC (Schwartz Criterion).

Once the number of lags has been determined, a trace test is used to estimate the number of cointegration relations ( $r$ ). If this number is strictly positive, a vectorial error correction model (VECM) with three variables (energy consumption, total consumption, relative price of energy consumption) is estimated with the number of lags and the number of cointegration relations indicated by the previous tests. The estimation period is Q1 1978 — Q2 2005.

It emerges from these estimations that the elasticity of energy consumption to the relative price of energy is 15% in the short term (i.e., a time-horizon of roughly one quarter) and 12% in the long term (see table). ■

**Table: Details of the estimations**

VECM	
Lags	3
Cointegration relations	1
Energy consumption	1.00
Total consumption	-0.52 (-17.67)
Relative price	0.12 (-2.55)
<b>Short-term elasticity</b>	<b>-0.15*</b>
<b>Long-term elasticity</b> <sup>(1)</sup>	<b>-0.12**</b>

Source: Insee, calculations by Insee

\*\* significant at the 5% threshold.

\* significant at the 15% threshold.

(1) The long-term price-elasticities are derived from the cointegration relations coefficients and therefore to be understood as everything else remaining equal.

(1) See Hickman, Bert G., and Lawrence J. Lau (1973), "Elasticities of Substitution and Export Demands in a World Trade Model," *European Economic Review* 4, 347-80.

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