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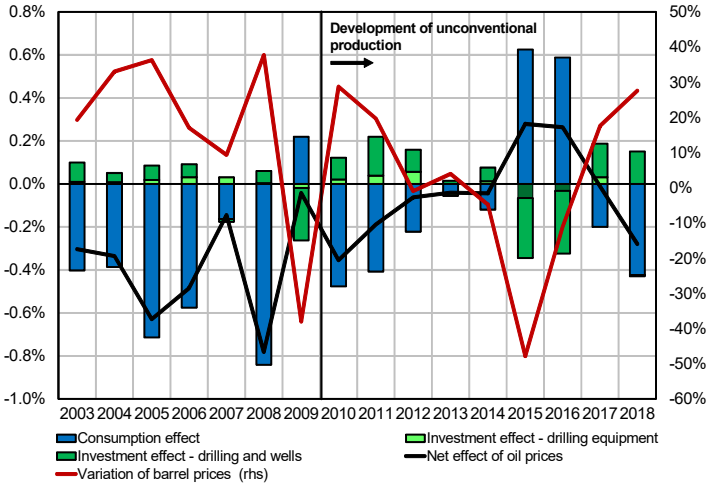
The Impact of Oil Prices on the US Economy

- Since the end of the 2000s, oil and gas production in the United States has increased sharply, thanks to the development of so-called "unconventional" drilling techniques such as the combination of horizontal drilling and hydraulic fracturing (or "fracking").
- This rise in production has significantly improved the country's energy trade balance and reduced its energy dependence. The conjoint rise in oil exports and fall in imports have allowed the United States to approach equilibrium on the oil trade balance and to secure a larger share of the global oil and gas market.
- Increases in oil prices have a marked negative impact on activity in oil net-importer countries. Until 2010, the US economy suffered from the rise in crude prices, as it weighed on household purchasing power and pushed up the price of intermediate consumption for firms. Since 2010 and the strong growth in domestic oil production, the impact of oil prices on the US economy has been less clear-cut. Increases now have a very positive impact on the level of investment in the hydrocarbon sector, which counters the negative effect observed on consumption.
- Nowadays, the total net effect of a rise in oil prices on US activity may remain negative despite the shale oil revolution. A decrease in household purchasing power brought about by a rise in fuel prices might not be more than partly offset by the strong growth in investment in the oil and gas sector (see Graph).

The macroeconomic impact of oil prices on GDP growth in the United States



Source: BEA, DG Trésor calculations.

Note: The net effect of oil prices on the US economy results from a consumption effect (econometrically estimated here) and an investment effect (estimated from national accounts).

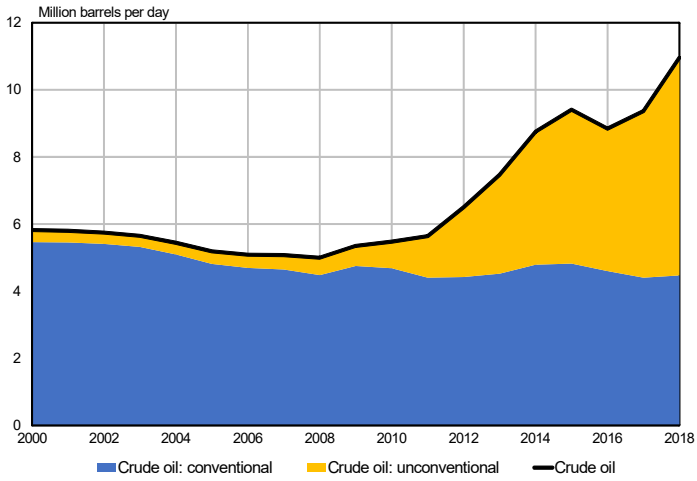
1. The United States has become one of the largest oil producers thanks to the shale revolution

1.1 The hydrocarbon sector has grown strongly since the 2000s

During the 2000s, the combination of several unconventional oil-drilling techniques (see Box 1) was developed in the United States, and especially the association of horizontal drilling and hydraulic fracturing. US crude oil production doubled in 10 years as a result, from 5 million barrels per day (Mb/d) in 2008 to 11 Mb/d in 2018. While unconventional oil production remained rather marginal until the late 2000s, it almost equalled conventional extraction in 2018, the latter having stayed relatively stable over the period (see Graph 1), and US production almost doubled in 10 years.

Over the same time frame, US natural gas production went up from 12 Mb/d oil equivalent (Mboe/d)[1] in 2008 to 17 Mboe/d in 2018, of which more than half came from shale gas. The United States also substantially expanded production of liquefied petroleum gas, up to 4.4 Mb/d in 2018.

Chart 1: A breakdown of crude oil production in the United States

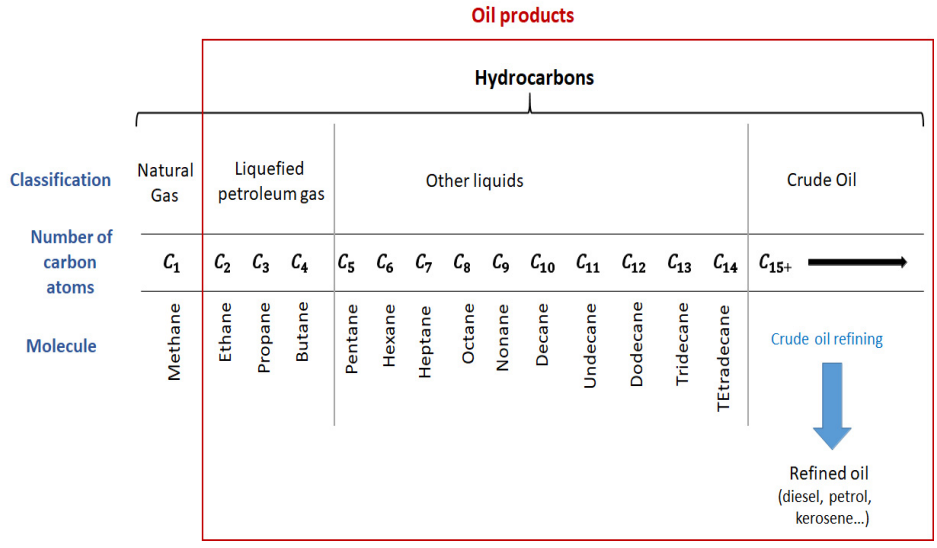


Source: US Energy Information Administration (EIA).

Box 1: Some definitions regarding the hydrocarbon sector

In this paper, the word hydrocarbon refers to a range of products extracted directly from the subsoil, such as: (i) natural gas (methane); (ii) crude oil; (iii) liquefied petroleum gas which is usually obtained in a gaseous state during natural gas or crude oil processing, and can be easily liquefied for storage or transport purposes (including ethane, propane and butane); and (iv) other liquid hydrocarbons (see Figure 1). Crude oil serves as a basis for several refined oil products such as fuels (diesel, petrol, kerosene, etc.). The term "oil products" refers to all refined oil products and hydrocarbons, excluding natural gas.

Figure 1 : Hydrocarbons and oil products



Source: US Energy Information Administration (EIA).

(1) Since gas volume is generally measured in cubic feet, a unit conversion is necessary to compare oil and gas quantities. Cubic feet are converted into "Mb/d oil equivalent" by matching the energy released when burning one barrel of crude oil with the quantity of natural gas needed to produce the same amount of energy. 1 million cubic feet per day is equal to 5.8 Mb/d oil equivalent.

Oil and gas are referred to as "unconventional" when they are found in certain types of rocky subsoils which require specific extraction techniques.

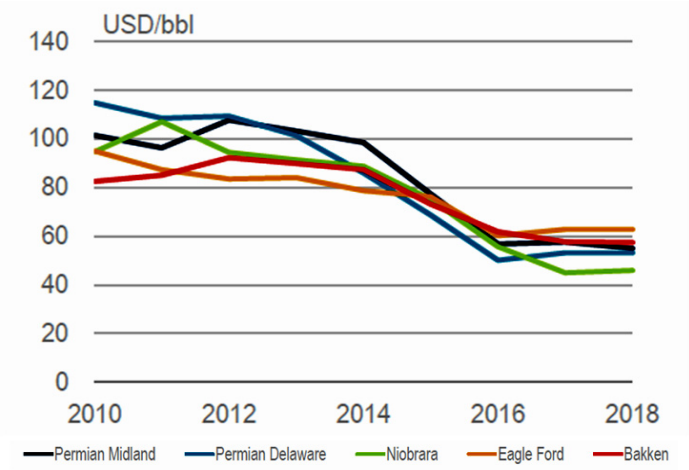
- Conventional hydrocarbons - including oil and gas - are found in "reservoirs" made up of porous and permeable rock suitable for classic drilling, or pumping, either onshore or offshore.
- Unconventional oil and gas include shale oil (also referred to as "light tight oil") and shale gas. They are found in impermeable clay source-rock which requires additional extraction techniques on top of drilling, such as hydraulic fracturing. Oil sands and tar sands are another type of unconventional hydrocarbons, but they are not exploited in the United States (unlike in Canada, for example) and are therefore not discussed here

Since the first shale-products boom in the 2000s, drilling techniques have undergone rapid progress. Horizontal drilling, which provides much higher yields than vertical drilling, is much more frequently used. Horizontal drilling combined with hydraulic fracturing has improved profitability in unconventional extraction sites.

The relevant oil price in the United States – and the one we refer to here – is that of West Texas Intermediate (WTI), a variety of crude oil produced in Texas. It differs from Brent, a blend of crudes extracted from North Sea fields whose price serves as a reference in Europe. These two indicators are of course closely correlated.

The US hydrocarbon sector – which reached $219bn in value added in 2018, or 1.1% of nominal GDP[2] – is composed of a number of small independent operators coexisting with traditional large producers (or majors) whose projects are more capital-intensive. The breakeven price of American shale oils greatly decreased thanks to the new technological developments, from over $80 in 2010 down to nearly $40 per barrel in early 2017[3] (see Graph 2), which provided strong support for unconventional production. The breakeven price however remained flat in 2018, according to a 2019 report by the International Energy Agency (IEA). Breakeven levels vary across regions in the United States.

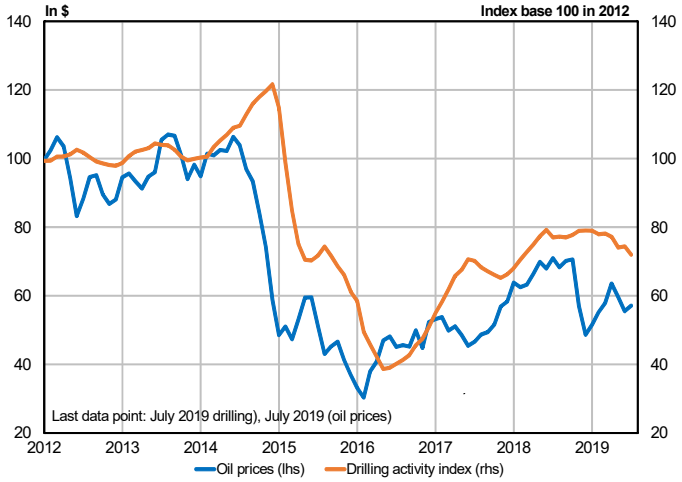
Chart 2: Breakeven prices of American shales



Source: Rystad energy, IEA.

Drilling activity is therefore highly dependent on oil prices (see Graph 3), especially as regards small producers of unconventional oil. The number of active drilling installations (or rig count) is considered one of the indicators of oil activity in the United States. Between 2014 and 2016, the sharp drop in prices led to a slowdown in drilling activity. This allowed companies which focused on wells with higher profitability – thanks to a better knowledge of the subsoil – to make productivity gains. Conversely, the 29% increase in prices observed between January 2017 and June 2018 led to a rise in the rig count, from 683 to 1,056.

Chart 3: Activity index of conventional and unconventional drilling and oil prices (WTI)



Source: IEA, Fed.

(2) The sector's value added stood at $271bn in 2017, or 1.8% of nominal GDP. It decreased between 2008 and 2018, in spite of the doubling of crude oil production in the United States over the period, because of a drop in WTI prices (from $100 per barrel in 2008 to $65 in 2018).

(3) Excluding land acquisition and seismic research costs. By comparison, the breakeven price for new deep-water conventional exploitation was estimated at $58 on average in 2019 by the Rystad Institute, and $42 for onshore exploitation in the Middle East.

Box 2: The unconventional oil and gas sector remains financially fragile

Shale oil and gas production requires major investments. The financial situation of the sector's firms is however fragile. Many of them took advantage of the low-rate environment to engage in massive borrowing (mostly from banks), and are now facing high indebtedness levels, while the cost of drilling a well stands anywhere between $6 and $8m.[a] During the drop in oil prices observed from 2014 to 2016, most companies in the sector tried to reduce their debt by curbing investment expenditure and issuing stock to finance their activity.[b]

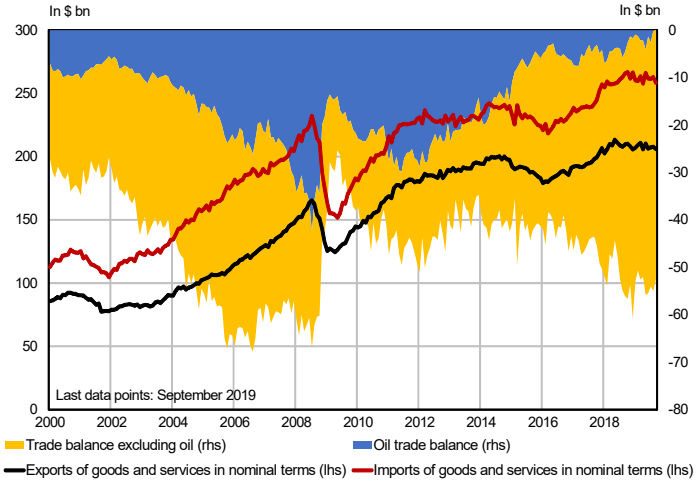
Oil and gas sector companies tend to reinvest the cash-flow generated by unconventional production. This however does not fully cover their investment expenditure, even with a high barrel price. The cash-flow net of investment expenditure (or free cash-flow) is negative as a result. Dividends distributed by unconventional oil and gas companies are therefore low, and as yet insufficient to increase household disposable income. This situation is nevertheless improving, thanks to productivity gains, as recently shown by cash-flow on a par with investment expenditure.

a. R.S. Kaplan (2018), "A Perspective on Oil", Federal Reserve Bank of Dallas Working Paper
b. S. Cornot-Gandolphe (2017), "The Resurgence of Shale Oil ", Ifri study.

1.2 The US energy trade balance has improved

The United States is close to no longer being an oil net-importer. This results from the drop in imports and rise in exports which have been observed since the Obama administration lifted the embargo[4] on crude oil exports in December 2015. The oil trade balance indeed stood at –$50bn in 2018, against –$386bn in 2008 (see Graph 4).

Chart 4: US trade balance, total and excluding oil

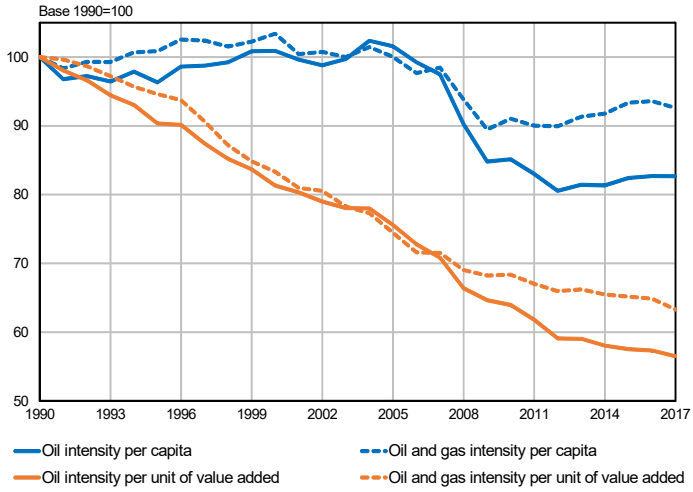


Source: Census; DG Trésor calculations.

US oil energy dependence – i.e. the ratio of net oil imports relative to domestic oil demand – has significantly decreased as a consequence, falling from 57% in 2008 to 11% in 2018.

In addition to the growth in oil production, this change has been brought about by the 40% drop in oil energy intensity (i.e. the amount of oil used to produce one unit of GDP) observed in the country over the past 30 years (see Graph 5). Intensity per capita in particular plummeted between 2005 and 2011, due to a substitution of gas for oil linked to the mismatch between oil and gas prices, the latter having nosedived with the rise in shale gas production.

Chart 5: Oil intensity in the United States



Source: EIA, BEA; DG Trésor calculations.

1.3 The United States is securing a growing share of the oil and gas market

The United States accounted for about 13% of global oil production in 2018 (world production standing at 83 Mb/d), against 7% in 2008, which makes it one of the largest crude oil producers. It is also a major natural gas producer, with 21.5% of global production in 2015 (overall production then standing at 73 Mboe/d). In addition, the lifting of the embargo in 2015, combined with the shale revolution, allowed the country to become a leading exporter of crude

(4) The embargo was put in place in the United States in the aftermath of the oil crisis of 1973-1975 in order to support the constitution of a strategic petroleum reserve. The ban on exports was however not total, since it permitted the export of crude oil to Canada and from Alaska. The Bureau of Industry and Security could furthermore authorise some oil exports by granting permits on a case-by-case basis.

oil.[5] Furthermore, the United States enjoys large reserves which have considerably grown with the shale oil and gas revolution.

Since the rise of unconventional techniques, the increase in American production and its potential for further development have been pushing oil prices down. According to some analysts, the United States has become a "swing producer", that is a producer which can adjust supply to demand in the short run.[6]

2. The impact of oil prices on the US economy nowadays

2.1 The negative effects of an increase in oil prices have diminished since 2000

During the oil crises of 1973 and 1979, the spikes in oil prices weighed strongly on the US economy – which was then an oil net-importer – through a net rise in inflation. According to economic literature, estimated elasticities of the US GDP to oil prices after a year were then negative, and varied between –0.29 and –0.07 (Huntington,[7] 2005). A 10% increase in the price of oil led to a GDP decrease of about 0.2% after a year. According to Hamilton[8] (1983), most recessions in the United States between 1945 and the early 1980s were preceded by a rise in oil prices.

More recently, the effects of an oil spike on US GDP growth have diminished for several reasons: better-anchored inflation expectations allowed by a stronger credibility of monetary policy, higher flexibility in the labour market through a drop in real wage rigidity, and the lower oil intensity of the US economy (see Huntington,[9] 2005, and Blanchard and Gali,[10] 2008). The effect of a rise in oil prices however remained significantly negative during the 2000s.

Nowadays, because of the strong increase in US oil production, the impact of oil prices on US activity is more ambiguous. Recent studies have reached contrasting conclusions: estimated elasticities[11] of US GDP to oil prices after less than a year may now fall in a range between –0.124 and +0.017 (see Oladosu,[12] 2018) according to literature. According to the Dallas Fed,[13] the more US oil production increases, the stronger the positive effects should be. At any rate, an oil shock would not affect the US economy today as strongly and negatively as it did in the past. Moreover, the United States benefits from dollar-denominated oil prices, which is an advantage in comparison to other oil-importing countries.

2.2 The transmission channels of oil prices to the economy

A rise in oil prices affects household spending and corporate activity by driving up prices for the energy products they consume in the short run. This is the sole observable transmission channel of oil prices to activity in a non-oil-producing economy. In the case of the United States, an increase in oil prices has three types of positive effects which can offset that negative impact.

(i) A rise in investment: corporate investment decisions in the oil and gas sector are influenced by the changes to the barrel price, both in the conventional and the unconventional sector – this is a "direct" effect on sectoral behaviour

(ii) Associated knock-on effects along the sector's value chain – an "indirect" effect on other sectors

(iii) .Positive consequences on household consumption, stemming from higher revenue through employee income – a Keynesian multiplier effect linked to the circular flow of income

(5) Since the lifting of the embargo in 2015, US crude oil exports have significantly increased to reach 2 Mb/d in 2018, or about 19% of domestic crude oil production. Two main factors can explain the development of US crude oil exports. On one hand, the development of unconventional production calls for the creation of new refining infrastructure in the United States, since most refineries were not able to process light crude oil from unconventional sources. On the other, foreign demand for light oil has increased sharply, because that type of crude is better suited to stricter norms limiting sulphur levels in transport fuels.
(6) The relevance of that concept is debated because many factors must be taken into account at every instant, such as the global supply and the existence of bottlenecks.
(7) Huntington, H.G. (2005) "The Economic Consequences of Higher Crude Oil Prices", *Energy Modeling Special Report*, 9.
(8) Hamilton, J.D., 1983 "Oil and the Macroeconomy since World War II", *Journal of Political Economy*, 91(2), 228-248.
(9) *Ibid.*
(10) Blanchard O. and J. Gali (2007), "The Macroeconomic Effects of Oil Price Shocks: Why are the 2000s So Different from the 1970s?", *NBER Working Paper* No. 13368.
(11) By comparison, using the Mésange macroeconometric model, a $10 increase leads to a -0.1 pt reduction in GDP after a year and -0.24 after two years.
(12) Oladosu G., P. Leiby, D. Bowman, R. Uría-martínez and M. Johnson (2018) "Impacts of oil price shocks on the United States economy: A meta analysis of the oil price elasticity of GDP for net-oil importing economies", *Journal of Energy Policy*.
(13) R. S. Kaplan (2018), "A Perspective on Oil", *Federal Reserve Bank of Dallas Working Paper*.

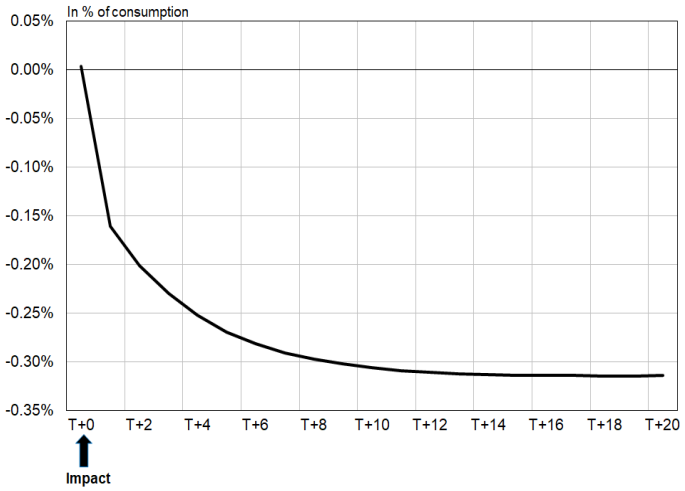
A rise in oil prices therefore has contrasted effects on the various components of the US GDP.

2.3 Household consumption is negatively affected by a rise in oil prices

Holding other factors constant, an increase in oil prices puts a drag on household consumption expenditure. A higher energy bill indeed reduces household purchasing power, especially for fuel and heating oil. Energy consumption represented 3% of the after-tax income of US households in 2017.

Using an energy inflation equation and a consumption equation, one can quantify the impact of oil prices on inflation, and ultimately on household consumption, while excluding the other (positive) effects of oil prices on activity and (negative) effects on the intermediate consumption of firms. In the medium run, a 10% increase in oil prices results in a −0.3 pt effect on household consumption, which in turns leads to a −0.2 pt effect on GDP. Such a rise ceases to have any significant impact on growth after eight quarters (see Graph 6).

Chart 6: Impact on private consumption of a +10% shock on oil prices



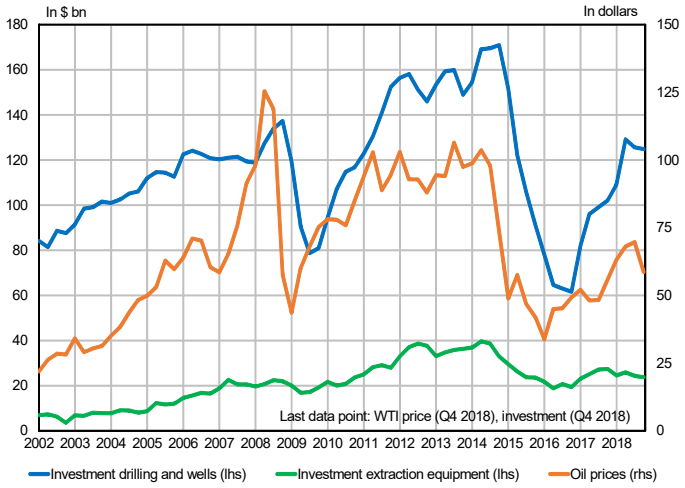
Source: DG Trésor calculations.

According to those estimates, the sharp drop in barrel price observed in 2015 and 2016 (by −47% and −20% respectively) negatively impacted inflation by around −2.1 pt in 2015 and −0.9 pt in 2016, and positively affected household consumption by around +0.9 pt each year. It is estimated that this "consumption effect" translated into an activity increase of +0.6 GDP pt in both 2015 and 2016.

2.4 An increase in oil prices supports corporate investment

Activity in the hydrocarbon sector has a positive impact on investment. In accounting terms, the effect of investment in this sector is visible in two items: (i) investment in structures, via the component "Drilling and wells", and (ii) investment in equipment, via the component "Extraction equipment". Both types of investment are very sensitive to oil price variations (see Graph 7).

Chart 7: Investment in the oil and gas sector and oil prices



Source: BEA.

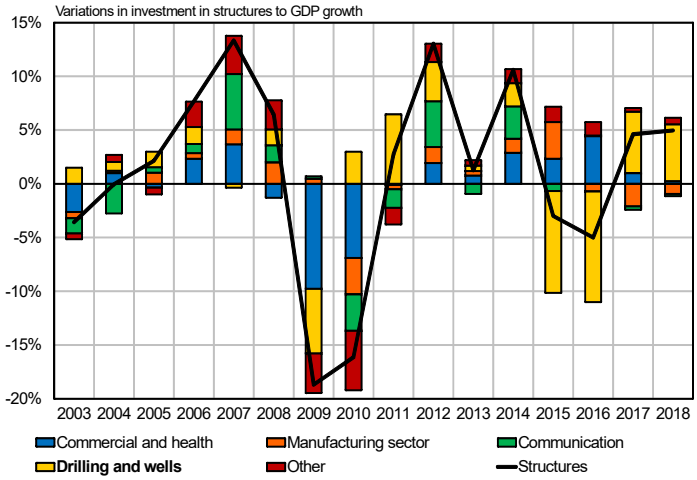
With the development of oil and gas production in the United States, the volume of investment in the hydrocarbon sector (including drilling, wells and equipment) grew relatively to GDP, from 1.0% of GDP in 2009 to 1.3% in 2014. The development of unconventional production has also reinforced the sensitivity of US oil production to variations in barrel prices.[14] Indeed, a classic offshore well usually requires several hundred million dollars of investment, takes several years to build, and has a life expectancy of over 20 years. On the contrary, according to the Dallas Fed, a horizontally-drilled unconventional well requires only 6 to 8 million dollars of investment and is quickly exhausted, with 80% of production usually happening during the first 12 months of exploitation. Investments in the hydrocarbon sector dropped sharply in 2016, down to 0.5% of GDP, due to the decrease in oil prices, before rising back to 0.8% of GDP in 2018.

In real terms, drilling investment grew by almost 29% in 2018, following the spike in oil prices. This progress represents a contribution of 5.3 points to the growth in investment in structures (see Graph 8), equal to 0.2 points

(14) R. McCracken (The Agility of Shale Oil Production).

of GDP growth. In 2017 and 2018, total investment in the sector (including drilling and extraction equipment) supported GDP growth by 0.1 and 0.2 points respectively, after putting a drag on activity in 2015 and 2016 (by around –0.4 pt in each year) during a period of decreasing oil prices.

Chart 8: The contribution of investment in structures to GDP growth



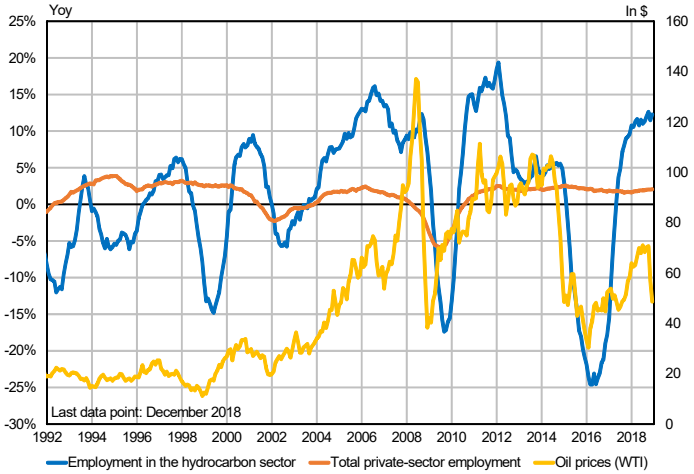
Source: BEA, DG Trésor calculations.

Since the shale gas revolution, the knock-on effects of the hydrocarbon sector on other sectors have been significant, especially in Texas where half of national oil is produced at 5 Mb/d. The hydrocarbon sector is tied to other sectors in the economy through various value chains, and its momentum has repercussions on the demand addressed to other sectors, in particular via intermediate consumption costs (Melek,[15] 2018).

2.5 A rise in oil prices leads to dynamic job creation in the hydrocarbon sector, albeit with little effect on total employment

Activity in the oil and gas sector has positive effects on employment and therefore on the disposable income of households. The development of shale drilling has been a source of dynamic job creation. Sectoral employment reacts strongly to variations in both drilling activity and oil prices (see Graph 9). It contracted significantly in late 2014, in the wake of a drop in oil prices, and picked up again with the rise in prices observed in 2016.[16] The impact of an increase in oil prices on total employment would nevertheless remain modest.

Chart 9: Variations in employment levels in the hydrocarbon sector and in the overall private sector



Source: BLS.

2.6 The overall net effect of a rise in oil prices on US activity has become less negative since the shale oil revolution

When summarising the effects of the various transmission channels examined above, there are two opposing effects of a rise in oil prices on US activity: i) a "consumption effect" (corresponding to the impact of oil price variations on household consumption, econometrically estimated, see part 2.2) which weighs on activity, and ii) an "investment effect" (corresponding to variations in investment expenditure in the oil and gas sector as observed in the national accounts, see part 2.3) which supports activity (see Graph on the cover).

These effects result from both the past and present variation in oil prices. Other impacts on activity are not taken into account here: neither those (negative) of pricier intermediate energy goods, nor the (positive) knock-on effects from the oil and gas sector on the rest of the economy. Finally, the Keynesian multiplier effect deriving from other mentioned impacts is also omitted.

According to this approach, the sensitivity of US growth to an increase in oil prices has subsided since 2010 (see Graph on the cover). It appears that, up until 2010, the negative "consumption effect" was markedly stronger than the positive "investment effect" during a period of rising oil prices. Since 2010 and the growth of unconventional production, the investment effect on the sector partially offsets the consumption effect.

(15) N. C. Melek (2018), "The Response of US Investment to Oil Price Shocks: Does the Shale Boom Matter?", *Federal Reserve Bank of Kansas City working paper*.

(16) According to the Dallas Fed, over 40,000 jobs were created in Texas in the oil and gas sector between December 2016 and April 2018, and a total of 60,000 jobs was created in the United States.

According to our estimates, the 47% drop in WTI prices recorded in 2015, followed by another 20% fall in 2016, supported US growth by +0.3 pt in either year (see Table 1). The additional purchasing power it offered households (a contribution of +0.6 GDP pt per year), explained by the drop in fuel prices, was offset in half by the strong contraction observed in oil and gas investment during both years.

The rebound in the barrel price observed in 2017 led to fresh investments in oil exploitation, which countered the effect of lower household purchasing power that year. The total effect was neutral for the US economy. In 2018, according to our estimates, the continued rise in oil prices resulted in a slowdown in the US economy, with a net effect of −0.3 pt.

Table 1: Breakdown of the effect of oil price variations on GDP growth in the United States

(in GDP pp)	2014	2015	2016	2017	2018
Investment in the oil and gas sector	+0.1%	−0.3%	−0.3%	+0.2%	+0.1%
Direct effect of oil price variations on household consumption	−0.1%	+0.6%	+0.6%	−0.2%	−0.4%
Net effect of oil price variations	0.0%	+0.3%	+0.3%	0.0%	−0.3%
Oil price variations	**−4.8%**	**−47.8%**	**−11.1%**	**+17.6%**	**+27.6%**

Note: The net effect of oil prices on the US economy results from a consumption effect (econometrically estimated here) and an investment effect (estimated from national accounts). Every year, the quantified effects also include lag effects resulting from past variations in oil prices

Emma Hooper, Corentin Ponton

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