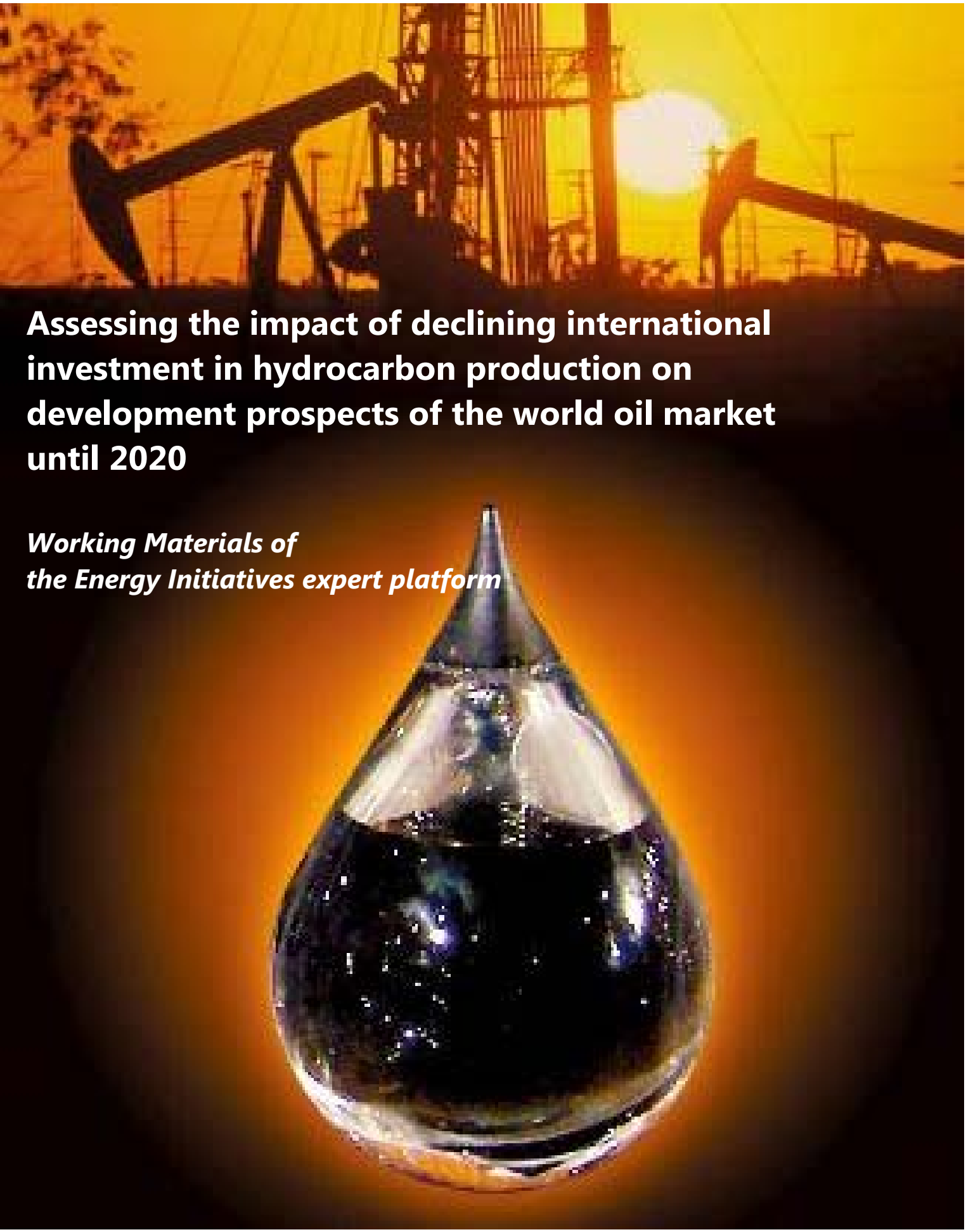

Assessing the impact of declining international investment in hydrocarbon production on development prospects of the world oil market until 2020

Working Materials of
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Urgency of the problem

The dramatic drop in oil prices in 2014 affected, as a matter of course, the level of investment in the world oil and gas sector. Thus in 2017, investment in hydrocarbon production fell almost by half when compared to the all-time peak recorded in 2014. However, in that same 2017, investment in unconventional hydrocarbon production grew over 2016 figures, in the wake of a strong recovering trend in oil prices. These two factors point out that 2018 will probably mark the beginning of an upsurge in investment in hydrocarbon production, subject to the continuation of the current oil price dynamics.

Nevertheless, investment activity has been on the wane during the last three years. Because new projects in conventional production begin to yield returns on average three to six years after the investment is approved, and in the case of shale, one to two years after project approval, 2017 seemed to show no further decline in world production, though growth rates had slowed. However, the most significant impact of the investment downturn of 2014-2017 will theoretically make itself felt by 2020-2023. Accordingly, short- and medium-term planning would require an assessment of the impact of the investment slump on world oil production considering the current oil price situation.

This issue is complicated by the fact that, in the context of robust development of new technologies, several categories of oil resources can be identified that will be affected in different ways by fluctuating investment flow.

All of the aforesaid is indicative of the urgency of the problem reviewed herein.

Main conclusions

- Global trends in investment in the oil and gas industry and the volume of crude oil production suggest that **over a period of several decades, any volatility in the level of investment had an ever-declining impact on the variability of production output**. This may be explained by the emergence of economically viable opportunities for the rapid and diversified development of technologies, in particular those associated with hydrocarbon production. The fact enhances the production sector's flexibility and resistance to various external forces.
- Analysis of the impact of levels of investment in various types of oil resources on their respective production, shows that **stable production gains are expected in the period to 2020.** At the same time, while conventional projects form the largest share of production, they play virtually no part in determining its growth dynamics. **Unconventional production, on the other hand, has a significant impact on growth dynamics in the period to 2023.** A slowdown in unconventional growth rates may lead

to a decline in the growth rates of overall production to under 1%. Therefore, it makes sense to consider **the question of a possible deficit on the oil market after 2020.**

- The answer to the question was **formed on the basis of analysing several supply growth scenarios. A future demand assessment was based on forecast data in the BP Energy Outlook 2018.** A more detailed analysis of available data on the productivity of projects for which FIDs were taken after 2010 showed that **the balance of supply and demand in the period to 2023 depends, to a considerable degree, on the total rates of natural decline in production from fields currently in production, as well as on investment levels post 2017.** Because investment levels currently **are causing a natural decline in oil output that exceeds 5.8% a year from fields currently in production**, a significant deficit of around 1 million barrels a day is likely to be observable in 2018 or shortly thereafter. After 2020, this trend becomes noticeably more pronounced. However, **if the rates of natural production decline are below 5.5% a year**, no supply deficit is observed in the period to 2021, though **after 2021 a shortage of supply is possible if after 2017, investment remains insufficient.**
- Namely, **there is a risk of a supply deficit of crude oil after 2021**. Its **prevention** requires making certain that investment in the oil industry after 2017 is enough to **bring onstream as many fields as necessary to ensure an annual production gain of around 6 million barrels a day in the period to 2023 (allowing for investment in exploration and technology).**

Items for discussion

- How could the connection between changes in the volume of world crude oil production and changes in the amount of investment be described most informatively?
- What set of factors affecting the gain structure in crude oil production matches the current status of the energy sector most? Can any quantitative characteristics of these factors and their relations be established?
- What is the corresponding set of factors affecting the rates of natural decline in crude oil production? Can any quantitative characteristics of these factors and their relations be established?

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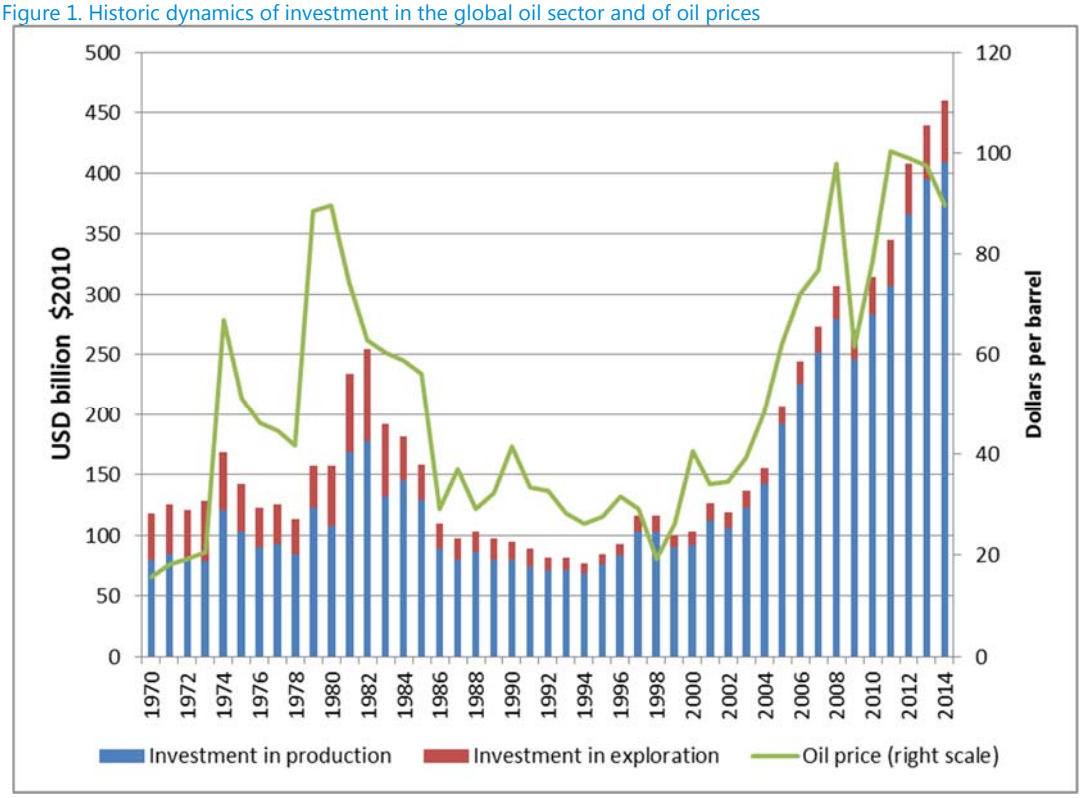
General assessment of the dynamics of investment in the global oil industry and their impact on production levels

The appearance of feasible opportunities for quick and diverse development of technology has a seriously stabilising influence on the level of hydrocarbon production and, in particular, on the global oil market.

According to the International Monetary Fund, and in accordance with general economic laws, the level of investment activity in the oil sector is directly connected with the level of oil prices (Fig 1).

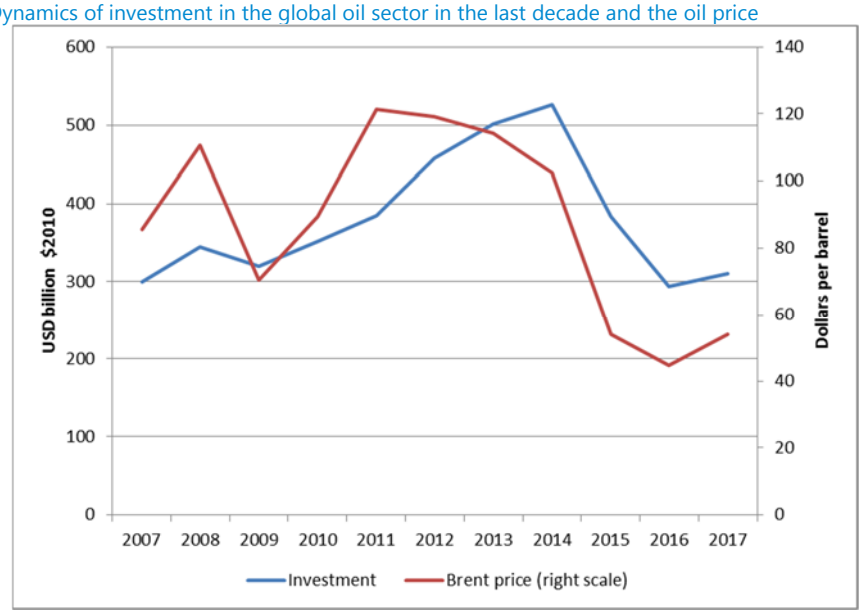
Figure 1. Historic dynamics of investment in the global oil sector and of oil prices



Source: IEF based on IMF data

The oil price in Fig 1 is an average weighted spot price for UK Brent, Dubai, and WTI crudes. There is an obvious correlation between the levels of oil prices and investment. Additionally, a relatively low level of expenditure on exploration after 1984 should be noted. The nature of investment over the last few years is reflected in Fig 2 according to OPEC data. The above-stated correlation is evident here as well. It should be noted that the fall in prices in 2008 was rather brief. It was reflected in a relatively moderate slump in investment activity that can be seen in both Fig 1 and Fig 2.

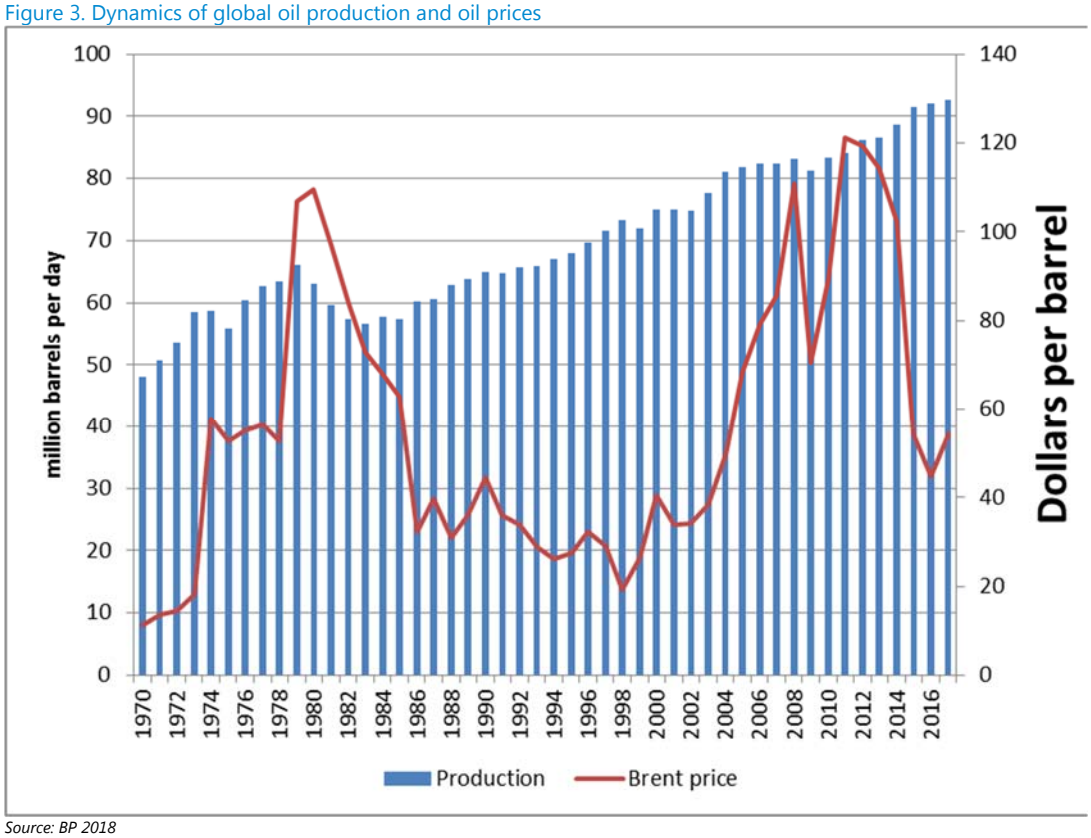
Figure 2. Dynamics of investment in the global oil sector in the last decade and the oil price



Source: IEF based on OPEC and BP data

If we take a look at a chart of crude oil production during the period in question (Fig 3), we can nonetheless note that the influence of declines in oil prices on production levels has continuously diminished over the years.

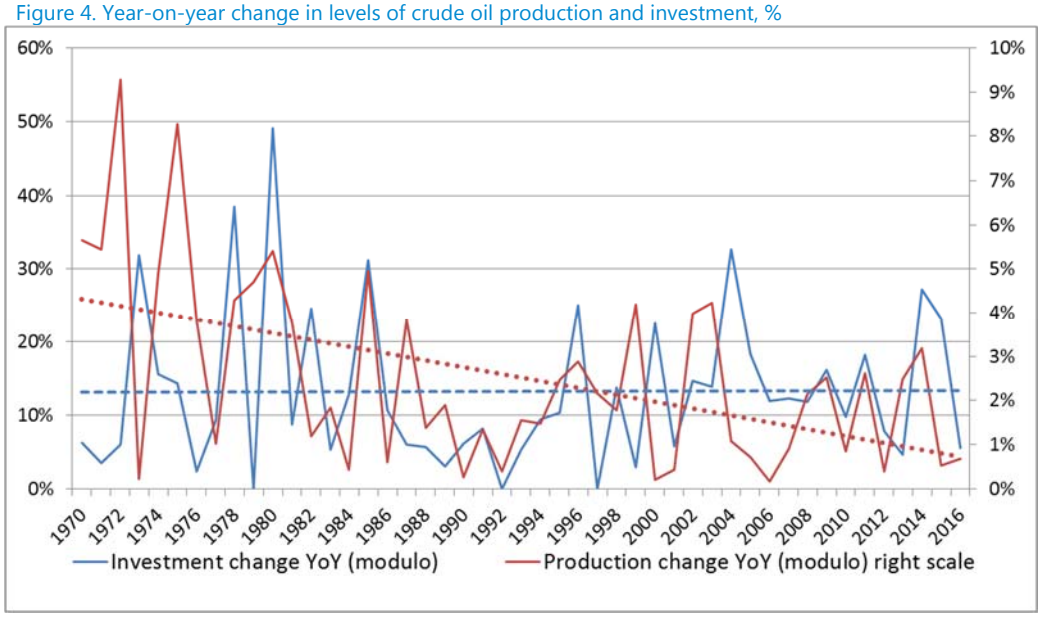
Figure 3. Dynamics of global oil production and oil prices



Source: BP 2018

It can be visually noticed (Fig 3) that the degree of production decline becomes progressively smaller, while the variability of prices remains pretty much stable. Generally speaking, the variability of investment volumes reflects the variability of oil prices. As a consequence, there is an indicative weak connection between the dynamics of global production and the dynamics of investment volumes (the correlation factor for the period from 1980 to 2016 is less than 0.4) (Fig 4).

Figure 4. Year-on-year change in levels of crude oil production and investment, %



Source: IEF based on IMF, OPEC 2017, BP 2018 data

The dotted and dashed lines on the Chart indicate the trends showing changes in production and investment dynamics. One can see that the trend reflecting the range of relative change in production volumes decreases over time (the red dotted line). Meanwhile, the same indicator for investment remains virtually unchanged (the blue dashed line).

Also, according to the BP Statistical Review 2018, the relation between global reserves and global oil production changes quite insignificantly. This is indirect evidence that the dependence of the dynamics of technical gross indicators on the dynamics of financial indicators is relatively weak.

This result can be interpreted in terms of growth in the efficiency of management of the oil industry and continuing technological development. For instance, oil companies have restructured their project portfolios to prioritise projects that have shorter payback periods; and companies have also begun to target strata that are more cost-effective to develop, sometimes sacrificing completeness of extraction of resources. Also, companies cut their development costs successfully, and this is true not only for shale projects, for example, but for conventional production projects as well (Fig 5). The International Energy Agency estimates that costs declined by over 40% from 2014 to 2016, or slightly less than the reduction level in investment (about 45%).

Per unit capital expenditure on developing new oil fields was 42% lower in 2016 than in 2014, the IEA estimates.

The biggest contribution to the decline in unit costs (24%, or about 60% of the decline) was made by reducing the cost of equipment and services, with its dynamics determined to a great

extent by demand for, and supply of, these services. As for technological development, it enabled unit cost reductions by only 5%.

The decline in oil prices forced operators to cut costs in order to remain competitive. This led in 2015-2016 to a decline in demand for oilfield services in conventional production and, accordingly, to a decline in prices of such services. In addition, this led to a suspension of a number of projects that had become unprofitable, thus also reducing unit costs.

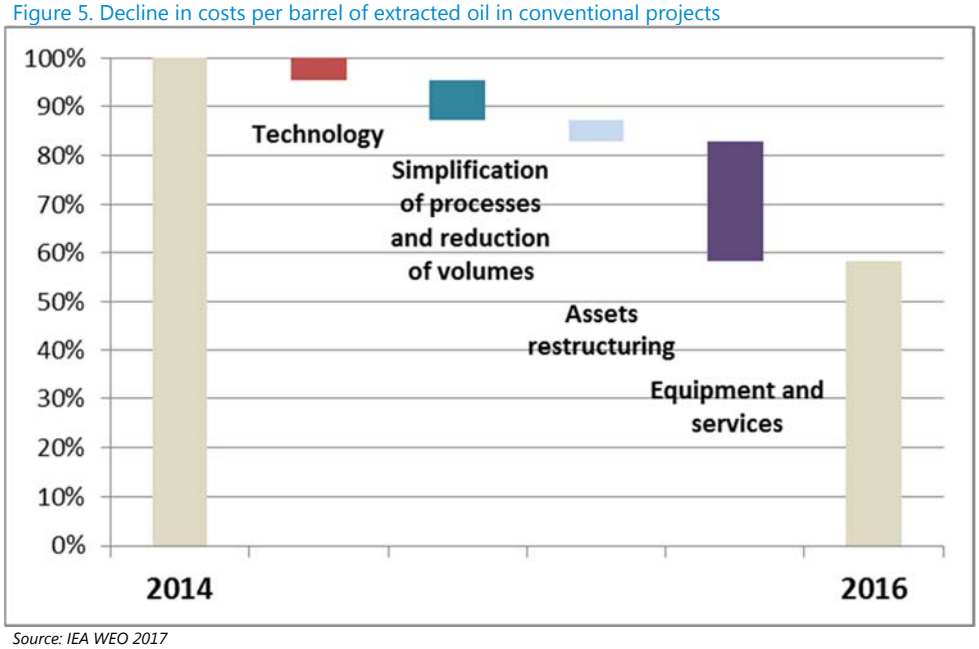
The current growth in oil prices is already leading to a resumption in growth in demand for oilfield services and for reconsideration of suspended projects. In consequence, the IEA estimates that unit costs will increase along with the increase in demand.

It appears that further technological development will continue at sufficiently fast rates, but it will still not be able to compensate fully for growing difficulties in oil recovery. The IEA expects that, in the case of significant growth in demand, capital expenditure per barrel on developing new oil fields will rise by 26% in 2025 compared with 2015 levels.

Thus, companies are beginning to maximise the NPV of their projects, rather than focus on the volume of extracted oil, (i.e. they continue, for instance, to drill only in the most productive areas, so called sweet spots), leaving further drilling for the future when the investment climate may be more favourable. Along with reducing costs, this makes it possible to maintain the necessary production level. It means that, on the basis of macro analysis, no decline in global crude oil production can be expected until 2020; rather minor, gradual growth is most likely.

On the whole, this strategy is efficient in the short term but it indicates an unfavourable period in the primary industry because sustainable production requires fields to be developed to the fullest extent possible so that appropriate exploration and enhancement techniques are used.

Figure 5. Decline in costs per barrel of extracted oil in conventional projects



Source: IEA WEO 2017

However, a more accurate analysis requires considering in greater detail the structure of both investment and production. In fact, several categories of oil resources can be identified that will be affected differently by changes in the investment flow. It should be clarified that the analysis to be presented in the following sections uses only publicly available data for the sake of

greater transparency of the research. This should be taken into account in evaluating the conclusions made below. Besides, one should keep in mind that the amount of production and investment data broken down by categories of oil resources is very limited in the public domain. A number of interesting conclusions can nevertheless be drawn, as will be demonstrated below. Let us first consider the investment structure.

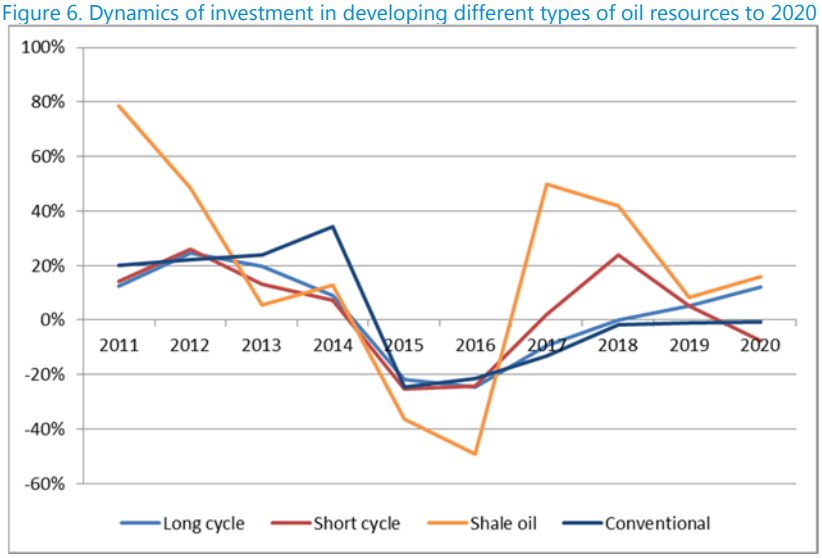
Investment by types of resources corresponding to different durations of the investment cycle

Contemporary production projects can be divided into projects of long and short investment cycles. Short investment cycle projects are mostly projects to produce shale oil and some conventional production projects (for example, some projects in the OPEC countries). Most conventional and offshore projects have a long investment cycle. This division, though somewhat arbitrary, is convenient because it generally corresponds to data quoted in publicly available sources.

Absolute investment figures (already made and projected) as a rule depend heavily on the accounting methodology employed by various authors and organisations. Therefore, in terms of production of different categories of resources, only year-on-year percentage changes are considered in this report, and the impact of these changes on the production dynamics is assessed.

Figure 6 shows year-on-year investment dynamics for production projects of long and short cycles in the period to 2020, and separately for shale projects and conventional oil production projects. It can be seen that the decline in investment volumes is roughly the same for both short and long cycles. Investment for the short cycle recovers much more quickly but this recovery is also much more volatile. It can be concluded on the basis of available data that starting from the 2014 crisis, investment in the global oil industry in the period to 2020 will mostly go to shale oil production and long-cycle projects associated with deep-water production. The interest in deep-water production seems to be based on the following: firstly, new large fields can be discovered in this sector, and recently discovered major reserves can be exploited at fields already explored, without the need to increase the recovery factor as is the case for onshore fields; secondly, countries possessing extended offshore areas can noticeably increase their production; and thirdly, new technologies make such production cost-effective even when finances are rather tight.

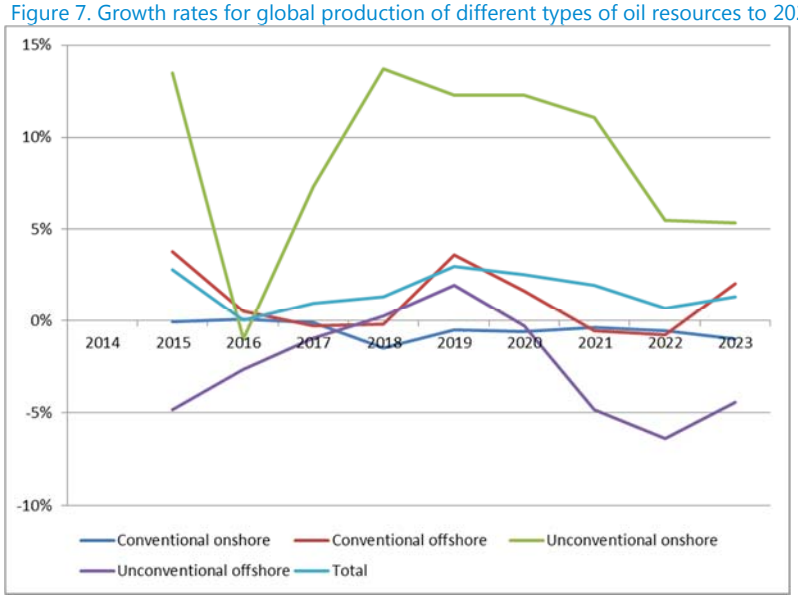
Figure 6. Dynamics of investment in developing different types of oil resources to 2020



Source: IEF based on Wood Mackenzie, Rystad Energy, and IHS data

Figure 7 shows estimates of production growth rates for different types of oil resources in the period to 2023. Global production is forecast to grow moderately at an average rate of slightly less than 2% a year. At the same time, growth rates are expected to slow down after 2020. Steady growth is only expected for shale projects in accordance with the investment dynamics in Figure 6. Production remains stable for conventional oil projects, but a downtrend is imminent, also reflecting the investment dynamics. Production in unconventional offshore projects (in particular, deep-water ones) will decline after 2020, but at the same time investment will increase and begin to pay off after 2023. Offshore projects in coastal areas show similar dynamics.

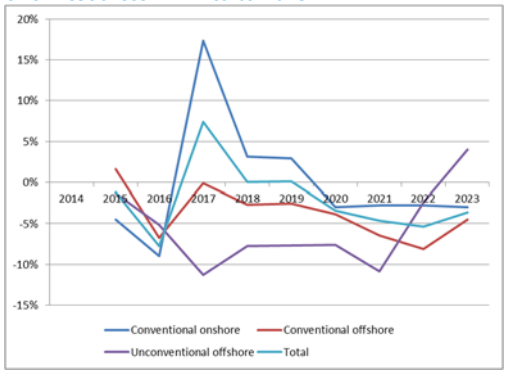
Figure 7. Growth rates for global production of different types of oil resources to 2023



Source: IEF based on Rystad Energy, McKinsey, and BP data

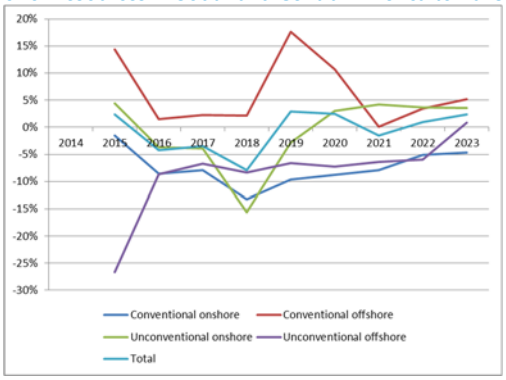
Figures 8-11 below show qualitative estimates of production growth rates for certain regions of the world.

Figure 8. Growth rates for production of different types of oil resources in Africa to 2023



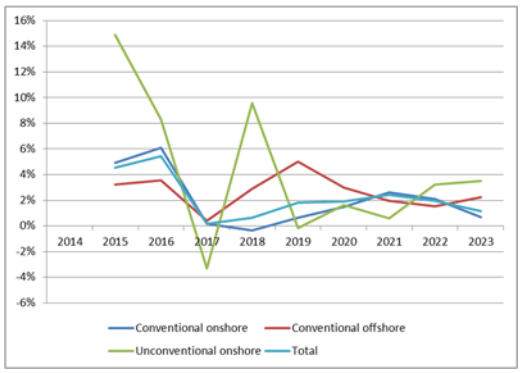
Source: IEF based on Rystad Energy, McKinsey, and BP data

Figure 9. Growth rates for production of different types of oil resources in South and Central America to 2023



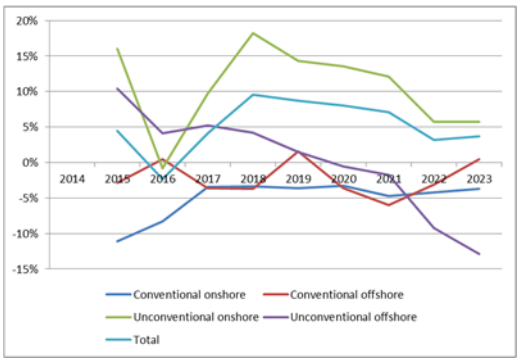
Source: IEF based on Rystad Energy, McKinsey, and BP data

Figure 10. Growth rates for production of different types of oil resources in the Middle East to 2023



Source: IEF based on Rystad Energy, McKinsey, and BP data

Figure 11. Growth rates for production of different types of oil resources in North America to 2023

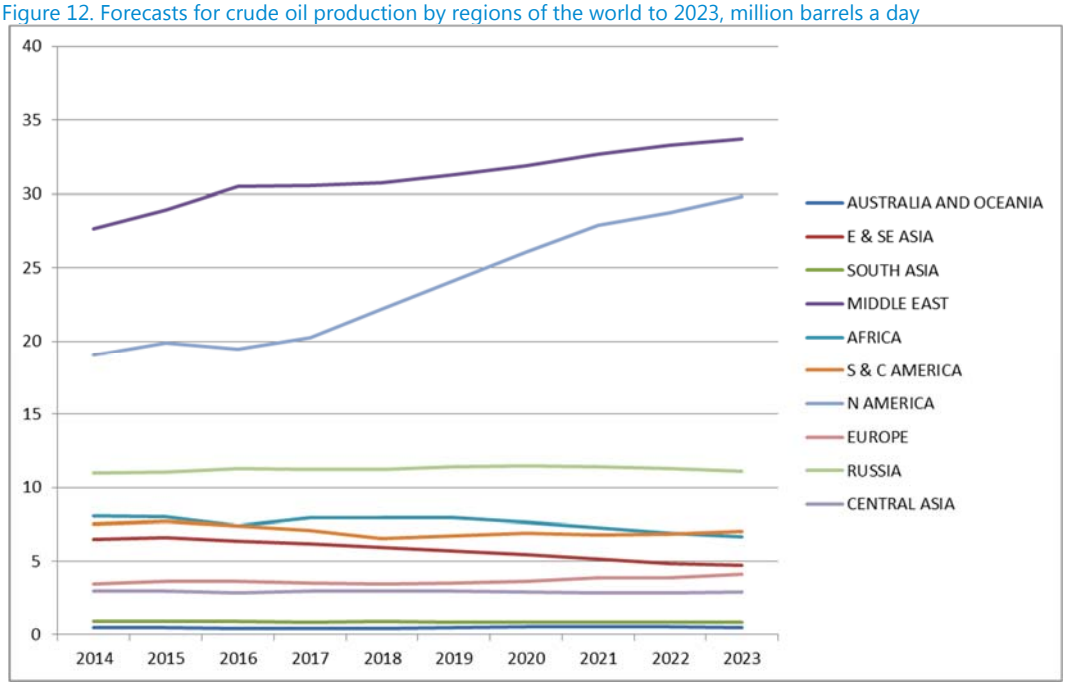


Source: IEF based on Rystad Energy, McKinsey, and BP data

Based on the above analysis, it can be concluded that steady growth in crude oil production is expected in the period to 2020. Conventional projects determine the basis of production, but have little impact on its growth dynamics. In the period to 2023, growth dynamics will be mostly influenced by projects that are not related to conventional production. The slowdown in conventional production growth rates causes the total production rate of growth to decline to below 1%. Therefore, any possible shortage on the oil market is not expected until after 2020.

Crude oil production forecasts by regions of the world are shown in Figure 12. It can be seen that the Middle East, North America, and Russia account for the "lion's share" of production. At the same time, only the Middle East and North America are expected to demonstrate serious dynamics after 2018. Russia and other regions generally seem to be stable, with an incipient downtrend in production.

Figure 12. Forecasts for crude oil production by regions of the world to 2023, million barrels a day



Source: IEF based on Rystad Energy, McKinsey, and BP data

It should be noted that internal Russian estimates of the dynamics of oil and gas condensate production in Russia in the period of 2018-2023 are much more optimistic than international forecasts (quoted above). The difference is from +0.2 million barrels in the baseline to +0.9 million barrels a day in the maximum scenario[1].

The balance between production of and demand for crude oil in the period to 2020 and in the period to 2023 will be assessed in the next section based on more detailed available information about the quality of FID-approved projects.

Assessment of the impact of the investment amount on future production based on FID data

The year 2017 generally saw the beginning of a gradual recovery of investment activity. Thus, McKinsey quotes the following data on the number of FID-approved production projects around the world (Table 1).

Table 1. Number of FID-approved projects in 2014-2017

YEARS	2014	2015	2016	2017
Number of FID-approved projects	335	203	158	190

Source: McKinsey Energy Insights

To assess the impact of investment on production growth based on publicly available model production profiles (production volumes for new projects by year after FID approval) of projects that have gotten a FID in recent years, let us consider annual production gains in such projects year on year (see Table 2).

Table 2. Expected production gains (year on year) in projects that got a FID in a given year, million barrels a day*

[1] Based on the draft General Scheme for Russian Oil Industry Development to 2035

YEAR AFTER FID	0	1	2	3	4	5	6
Average for FIDs in 2010-2014	0	0.05	0.16	0.24	0.35	0.55	0.47
FIDs in 2015	0	0.04	0.09	0.13	0.19	0.2	0.33
FIDs in 2016	0	0.02	0.06	0.11	0.13	0.14	0.09
FIDs in 2017	0	0	0.04	0.08	0.15	0.26	0.44

Source: IEF calculations based on McKinsey Energy Insights data

** Excluding onshore projects in North America and the Persian Gulf states*

The data in Tables 1 and 2 show that after the fall in oil prices in 2014, the expected gain in global production volumes for projects that were FID-approved in 2015 and 2016 consistently moved downwards. In 2017, however, when oil prices began to recover, the number of FIDs began again to grow, and production gains at FID-approved fields increased accordingly.

However, as Table 2 indicates, the trend towards recovery of growth rates falls short of the pre-2014 values. For example, supposing that demand for oil in the near future will continue to rise at the same rate as in 2016 and 2017, the decline in FIDs in 2015 and 2016 may cause the level of recovery of production growth rates to be insufficient to match the growth in demand. This would cause an imbalance on the market. Therefore, to assess the situation, it is necessary to model the behaviour of the key factors that will influence crude oil production gains in the next five years.

To assess the possible effect of the decline in FIDs in 2015-2016, we will do the following. Let us suppose that two fundamental factors influence changes in the growth of supply: gains in global production at new fields and decline in production at old fields. The latter situation happens to be more complicated because it results from the combined effect of two processes: natural decline in production and production gains stimulated by measures taken at the field.

That is, future supply is determined by balancing production gains from the launching of new fields, production gains earned by additional exploration, and natural declines in production from developed fields.

Considering available data, let us assume that total production gains result from the combination of the following elements:

- Gains in projects that got a FID in 2010-2014 (an average value), in 2015, 2016, and 2017 (according to the data in Table 2). This data is modified (Table 3) below based on Rystad Energy information about production profiles and the Hubbert curve theory, so the contribution of the Gulf States omitted in the Table 2 data is also taken into account.
- Gains in shale oil production according to IHS Markit data (Table 4).
- Expert assessment of gains resulting from investments made before 2010 and further exploitation of fields by means of exploration and additional development drilling.
- Expert assessment of gains on future investment to be made after 2017.
- Growth decline at developed fields due to a natural decrease in production.

Now let us describe the above-stated elements separately.

Production gains in projects that received a FID in 2010-2017 is shown in Table 3.

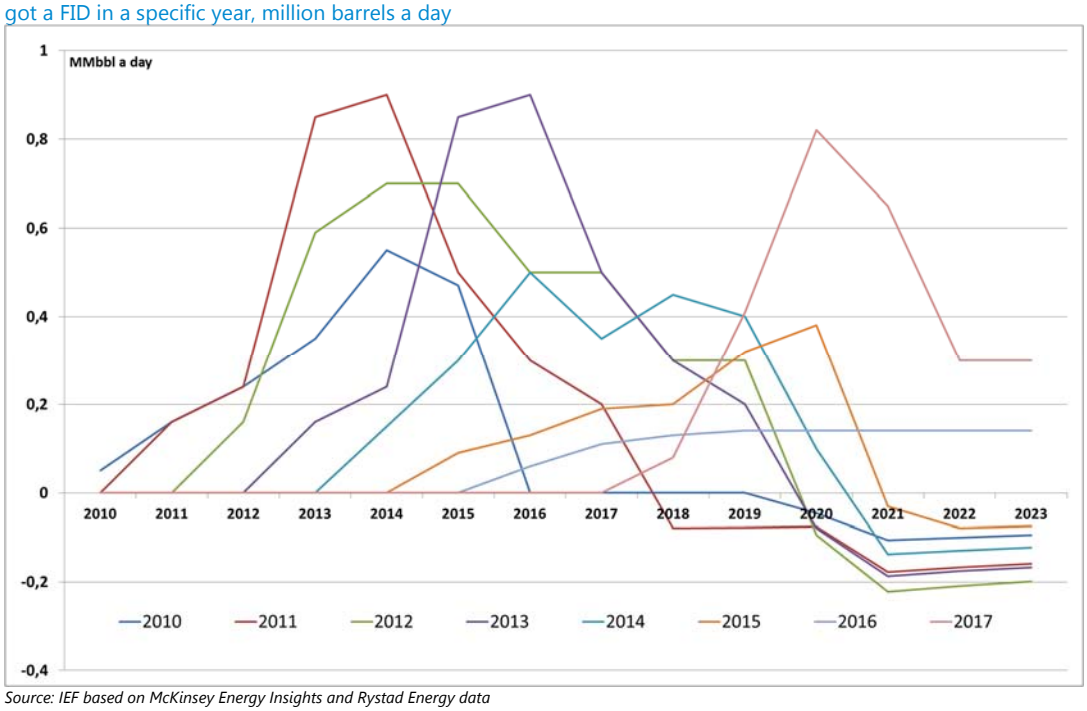
Table 3. The impact of production from projects that got a FID in a given year on the change of global oil production, million barrels a day

FID passing year	Production gains on launching new fields (year on year)													
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
2010	0.05	0.16	0.24	0.35	0.55	0.47	0.00	0.00	0.00	0.00	-0.05	-0.11	-0.10	-0.10
2011	0	0.16	0.24	0.85	0.90	0.50	0.30	0.20	-0.08	-0.08	-0.08	-0.18	-0.17	-0.16
2012	0	0	0.16	0.59	0.70	0.70	0.50	0.50	0.30	0.30	-0.10	-0.22	-0.21	-0.20
2013	0	0	0	0.16	0.24	0.85	0.90	0.50	0.30	0.20	-0.08	-0.19	-0.18	-0.17
2014	0	0	0	0	0.15	0.30	0.50	0.35	0.45	0.40	0.10	-0.14	-0.13	-0.12
2015	0	0	0	0	0	0.09	0.13	0.19	0.20	0.32	0.38	-0.03	-0.08	-0.08
2016	0	0	0	0	0	0	0.06	0.11	0.13	0.14	0.14	0.14	0.14	0.14
2017	0	0	0	0	0	0	0	0.00	0.08	0.41	0.82	0.65	0.30	0.30
Total global production gains year on year	**0.05**	**0.32**	**0.64**	**1.95**	**2.54**	**2.91**	**2.39**	**1.85**	**1.38**	**1.69**	**1.14**	**-0.07**	**-0.42**	**-0.38**

Source: IEF calculations based on McKinsey Energy Insights and Rystad Energy data

The charts that characterise production dynamics for the projects specified in Table 3 are based on McKinsey data and their modification to allow for production profiles available from Rystad Energy. They are shown in Figure 13.

Figure 13. Estimated profiles of the evolution of annual production (gain/decline year on year) from fields that got a FID in a specific year, million barrels a day



Source: IEF based on McKinsey Energy Insights and Rystad Energy data

Data on shale oil production gains in the US are shown in Table 4.

Table 4. Rates of change of the ratio between production decline and growth for shale projects, million barrels a day (year on year)

YEARS	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Production decline rate	1	0.5	0.3	0.7	-0.2	-0.6	0.7	0.5	0.4	0.3	0.3	0.3
Production growth rate	2.1	0.5	0.8	-1	-0.5	1	0.7	0.5	0.3	0.4	0.4	0.4
Total production gains in shale projects	**1.1**	**0**	**0.5**	**-1.7**	**-0.3**	**1.6**	**0**	**0.0001**	**-0.1**	**0.1**	**0.1**	**0.1**

Source: IEF calculations and estimates based on IHS Markit data

The estimated profiles of gains on investment made before 2010 (Table 5) and on forecast investment after 2017 (Tables 6 and 7) are based on historic and forecast data on global oil production presented in the BP Energy Outlook 2018, allowing for the properties of Hubbert curves. The positive impact of projects launched before 2010 on the gains in global production volumes is expected to continue over the entire forecasting period to 2023. There are two scenarios for an estimated profile that characterises production gains after 2017: with slow recovery of investment (Table 6) and with quick recovery of investment (Table 7). The scenario of slow recovery of investment suggests that oil prices will not experience any major growth and that the number of FIDs in 2018 and in the following years will increase insignificantly versus the 2017 level. Accordingly, annual production gains due to the launch of such fields will be the same as production gains at fields launched in 2017. Thus the 2017 profile is used for every year after 2018. The scenario of quick recovery of investment uses the 2009 profile for each year because production gains at fields launched in that year were considerably higher: the effect of high prices in the first half of 2008 still lingered in 2009. This scenario is intended to reflect the possible situation when investors' interest in the sector will increase because of likely further growth in prices.

Table 5. Combined impact of natural decline in production and measures intended to increase oil production from fields launched before 2010, million barrels a day (year on year)

YEARS		2017	2018	2019	2020	2021	2022	2023
Quick recovery of investment	Effect of additional exploration and EOR, given 5.5% natural decline in production	-2,46	-1,47	-0,49	-1,17	-2,48	-2,63	-1,77
	Effect of additional exploration and EOR, given 5.8% natural decline in production	-2,68	-1,69	-0,71	-1,39	-2,70	-2,85	-1,97
Slow recovery of investment	Effect of additional exploration and EOR, given 5.5% natural decline in production	-2,46	-1,47	-0,49	-1,15	-2,45	-2,62	-1,72
	Effect of additional exploration and EOR, given 5.8% natural decline in production	-2,68	-1,69	-0,70	-1,37	-2,67	-2,83	-1,92

Source: IEF estimates based on data from McKinsey Energy Insights and Rystad Energy, BP, IHS Markit

Table 6. Production gains at fields launched after 2017 in the scenario of slow recovery of investment, million barrels a day (year on year)

YEARS	2018	2019	2020	2021	2022	2023
2018	0.08	0.41	0.82	0.65	0.3	0.3
2019	0	0.08	0.41	0.82	0.65	0.3
2020	0	0	0.08	0.41	0.82	0.65
2021	0	0	0	0.5	0.08	0.41
Total production gains (year on year) after 2017	**0.08**	**0.49**	**1.31**	**2.38**	**1.85**	**1.66**

Source: IEF estimates based on data from McKinsey Energy Insights and Rystad Energy, BP, IHS Markit

Table 7. Production gains at fields launched after 2017 in the scenario of quick recovery of investment, million barrels a day (year on year)

YEARS	2018	2019	2020	2021	2022	2023
2018	0.16	0.59	0.7	0.7	0.5	0.5
2019	0	0.16	0.59	0.7	0.7	0.5
2020	0	0	0.16	0.59	0.7	0.7
2021	0	0	0	0.16	0.59	0.7
Total production gains (year on year) after 2017	**0.16**	**0.75**	**1.45**	**2.15**	**2.49**	**2.4**

Source: IEF estimates based on data from McKinsey Energy Insights and Rystad Energy, BP, IHS Markit

With regard to the rates of natural decline in production, we have used several studies by CERA, the IEA, Wood Mackenzie, and the Uppsala University. On the whole, the papers in question agree that the average rate of decline in production from conventional fields, once they pass their production peak, is at 5-6.3% a year. However, this figure may somewhat differ depending on the specific study. Therefore, below we will present the results of calculations with different rates of natural production decline.

An estimate of year-on-year gain in global demand for crude oil is based on the BP Energy Outlook 2018 and shown in Table 8.

Table 8. Forecast for gains in global demand for crude oil, million barrels a day (year on year)

YEARS	2017	2018	2019	2020	2021	2022	2023
Rates of growth in demand for crude oil	1.25	1.25	1.25	1.07	0.66	0.66	0.66

Source: IEF estimates based on BP data

To sum up the above-quoted data, four scenarios have been calculated:

Scenario 1. The scenario of slow recovery of the investment process (presented in Table 6) with a 5.5% rate of natural decline in production from currently operated fields.

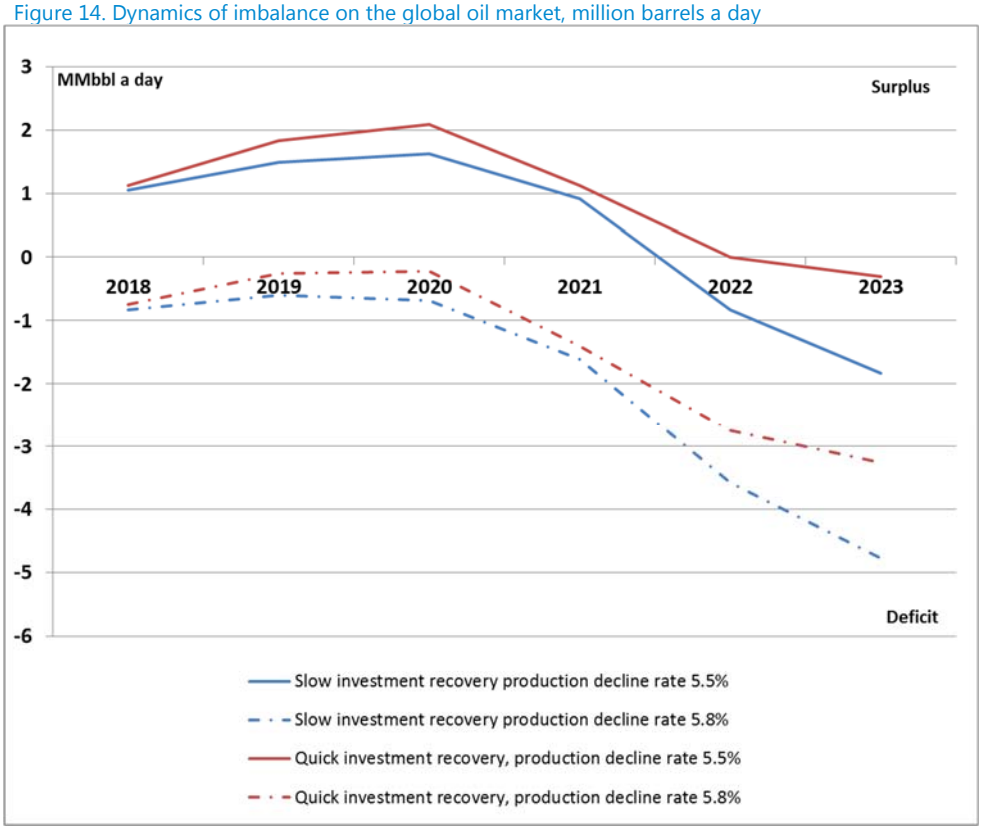
Scenario 2. The same scenario with a 5.8% rate of natural decline in production from currently operated fields.

Scenario 3. The scenario of quick recovery of the investment process (presented in Table 7) with a 5.5% rate of natural decline in production from currently operated fields.

Scenario 4. The scenario of quick recovery of the investment process with a 5.8% rate of natural decline in production from currently operated fields.

These scenarios were used to estimate the spread between the expected gain in crude oil production and demand gain. The results of the analysis are shown in Fig 14. It should specially be noted that the data available in the public domain allow for analysing trends only, rather than producing any accurate estimates of the imbalance.

Figure 14. Dynamics of imbalance on the global oil market, million barrels a day



Source: IEF estimate

Figure 14 clearly demonstrates that the rates of natural decline in production from old fields have a decisive impact on the market imbalance. In the scenarios with high rates of production decline (5.8%), a significant deficit of around 1 million barrels a day is observed as soon as 2018. This trend noticeably grows after 2020. The scenarios with relatively low rates of production decline (5.5%) show that there is no supply shortage in the period to 2020, but a supply shortage is possible on the market after 2022 if there is an insufficient recovery of the investment process.

Thus the results of modelling lead to the conclusion that even with relatively low rates of natural decline in production from old fields (5.5%), preserving a balance on the oil market after 2020 requires increasing investment in crude oil production approximately to the level that existed before the fall in oil prices in 2014. Otherwise, given the current number of FIDs and production gains at newly launched fields, the global market may face an oil supply shortage of approximately 1.9 million barrels a day by 2023. If the estimate of the level of natural production

decline is more pessimistic, preventing a serious imbalance after 2020 will require a considerably higher level of investment in assets that will pay off quickly.

Conclusion

1. A comparison of the dynamics of investment in the oil industry and the dynamics of crude oil production for the period starting from 1970 makes it possible to identify a certain general trend. According to this trend, investment volatility has an ever-diminishing impact on the variability of production volumes. In recent decades, technology has begun to play an ever-increasing role leading to the appearance of an economically feasible potential for quick and diverse development of technology related to hydrocarbon production. This has resulted in a qualitative change of the production structure and made the primary sector more flexible and resistant to a variety of external influences.
2. Analysis of publicly available data on the level of investment in different types of oil resources and its impact on the level of production of the respective type of resources has demonstrated the following: on the whole, stable growth in crude oil production is expected in the period to 2020; conventional projects determine the basis of production, but have almost no serious influence on its growth dynamics; at the same time, unconventional production has a significant potential to influence global production rates. Production gains at unconventional oil fields are volatile enough and the range of their fluctuations can be very significant and cause total production growth rates to decrease to below 1%. Therefore, in conditions of neutral or negative dynamics of production gains at unconventional fields, the oil market could experience a supply shortage after 2021.
3. A more detailed analysis of available data on the productivity of projects that received a FID after 2010 has shown that the balance of demand and supply for the period to 2023 depends to a considerable degree on the overall rates of natural decline in production from currently operated fields as well as on the level of investment after 2017. If natural production decline rates are high (5.8%), a significant shortage of around 1 million barrels a day is observed as early as 2018. This trend noticeably escalates after 2020. The scenarios with relatively low rates of natural decline in production (5.5%) indicate that there is no supply shortage in the period to 2021, but a supply shortage is possible on the market after 2021 if recovery of investment is insufficient.

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Additional information can be provided upon request.