Commodity Special Feature

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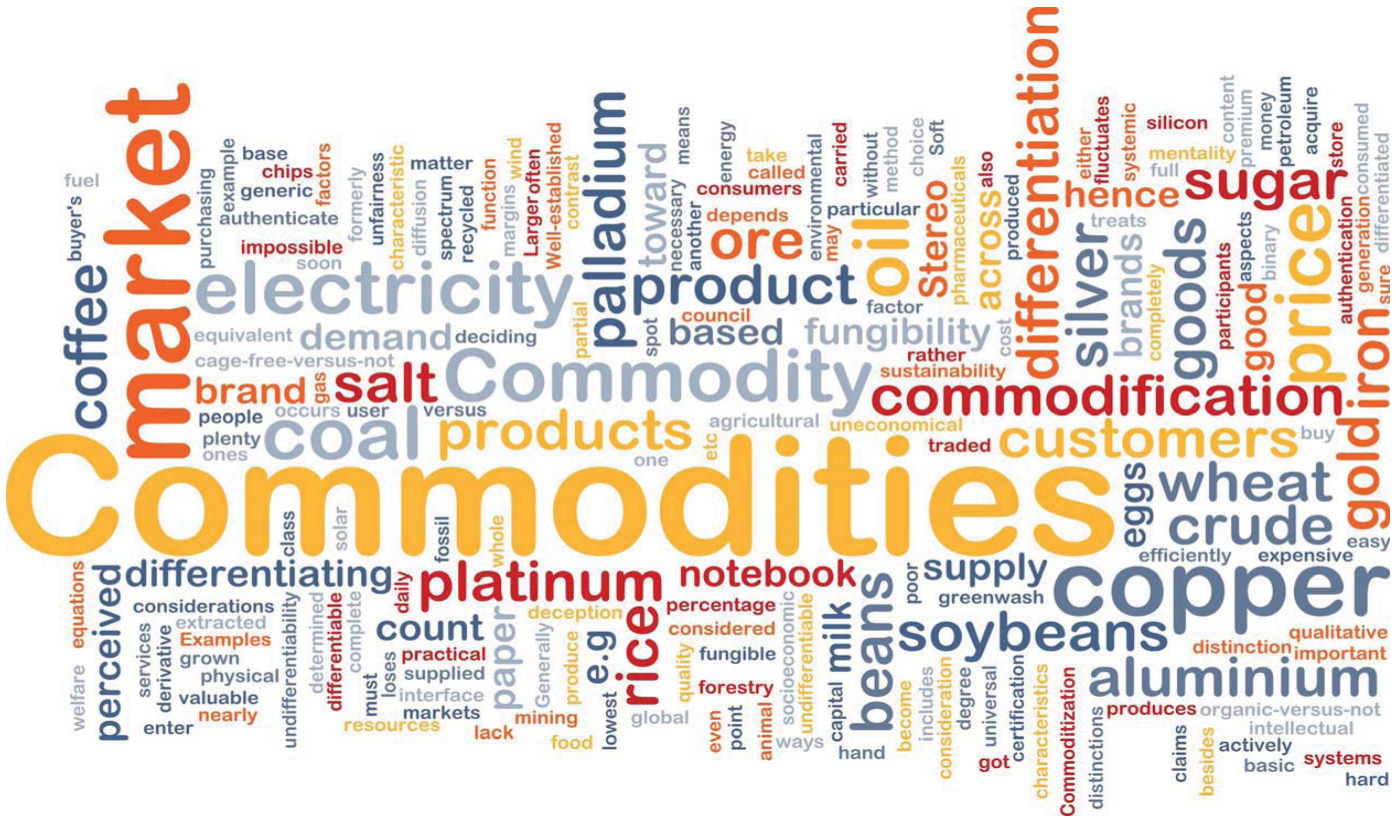


International Monetary Fund

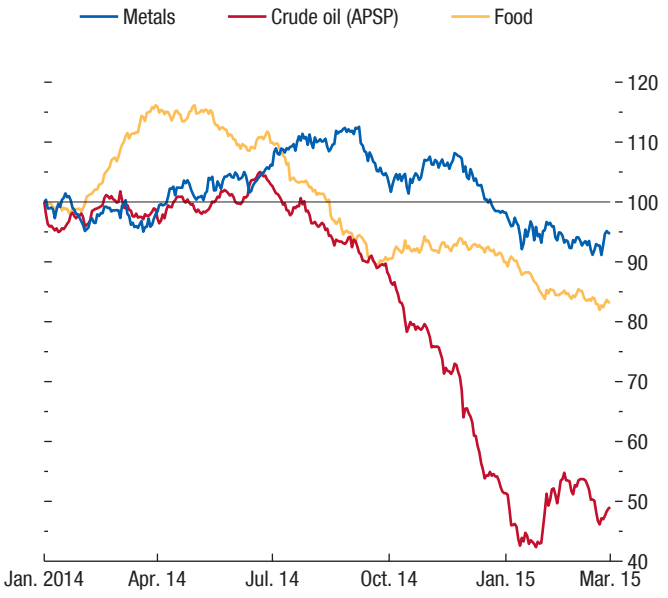
Special Feature: Commodity Market Developments and Forecasts, with a Focus on Investment in an Era of Low Oil Prices

Commodity prices have fallen markedly since the release of the October 2014 World Economic Outlook (WEO), *led by a dramatic drop in crude oil prices driven by both supply and demand factors. Metal prices have fallen because of slowing demand growth in China and significant increases in the supply of most metals. Food prices have declined mostly on account of favorable harvests.*

Commodity prices have declined 28 percent since September 2014, mainly owing to a 38 percent drop in energy prices (Figure 1.SF.1). Much of that decline is the result of a 43 percent decrease in crude oil prices; natural gas and coal prices declined by less, partly because contracts are indexed to oil prices with a lag. Nonfuel commodity prices also fell: those for metals by 15 percent and those for agricultural commodities by 6 percent.

The authors of this feature are Rabah Arezki (team leader), Akito Matsumoto, Shane Streifel, and Hongyan Zhao with research assistance from Vanessa Diaz Montelongo and Rachel Fan. The authors are grateful to Rystad Energy and Per Magnus Nysveen in particular for kindly providing proprietary data on capital expenditures and cost structures.

Figure 1.SF.1. Commodity Price Indices
(January 1, 2014 = 100)



Sources: Bloomberg, L.P.; and IMF, Primary Commodity Price System.
Note: Metals index is a weighted index of aluminum, copper, lead, nickel, tin, and zinc. Food index is a weighted index of barley, corn, wheat, rice, soybean meal, soybeans, soybean oil, swine, palm oil, poultry, and sugar. Data are through March 25, 2015. APSP = average petroleum spot price—average of U.K. Brent, Dubai, and West Texas Intermediate, equally weighted.

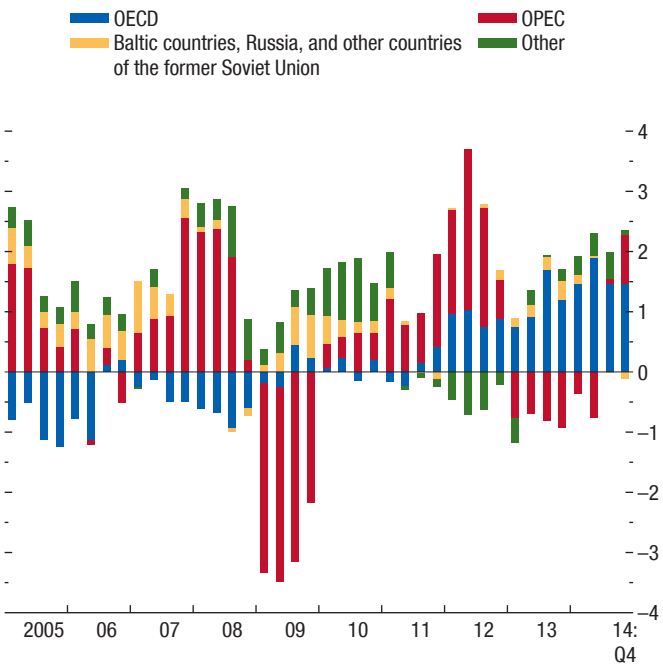
The large fall in oil prices was driven by both demand and supply factors, as discussed in Arezki and Blanchard 2014 (see also Box 1.1). On the supply side, three factors were particularly relevant:

- *Surprise increases in oil production of the Organization of the Petroleum Exporting Countries (OPEC):* These increases resulted in part from the faster-than-expected recovery of oil production in some OPEC members, including Iraq and, at times, Libya, after earlier outages and declines (Figure 1.SF.2).
- *Production increases outside OPEC:* Although these increases were broadly in line with expectations in the second half of 2014, they surpassed expectations in 2013 and early 2014. Overall, production outside OPEC rose by nearly 1.3 million barrels a day (mbd) in 2013 and more than 2.0 mbd in 2014. Most of the supply increases reflect growing production in North America, led by shale oil in the United States.
- *An unexpected shift in the OPEC supply function:* In November 2014, OPEC members decided not to lower production in response to the emergence of a positive net flow supply (the difference between global production and global consumption). Instead, they decided to maintain their collective production target of 30 mbd, despite increasing oil inventories (associated with the positive net flow supply).

Global growth in oil consumption slowed significantly during 2014 to about 0.7 mbd (a 0.7 percent increase from 2013), about half the growth recorded in 2012–13. The slowdown primarily reflects renewed consumption declines in Organisation for Economic Co-operation and Development (OECD) countries (mainly in Europe and the Pacific) after an unusual increase in consumption in 2013 (OECD oil demand has generally been declining since 2005). Oil consumption growth in emerging market economies remained low at about 1.1 mbd (2.5 percent increase from previous year) but accounted for the entire net growth in consumption.

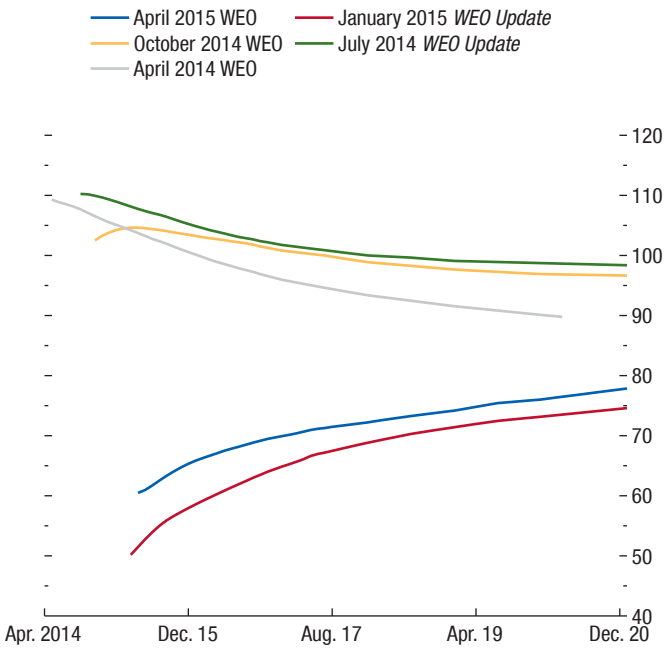
With supply running well ahead of demand, OECD crude oil inventories have increased, particularly in North America. Stocks at Cushing, Oklahoma, the pricing point of New York Mercantile Exchange West Texas Intermediate (WTI) futures, have surged this

Figure 1.SF.2. Oil Supply Growth
(Million barrels a day; year-over-year percent change)



Sources: International Energy Agency; and IMF staff calculations.
Note: OECD = Organisation for Economic Co-operation and Development; OPEC = Organization of the Petroleum Exporting Countries.

Figure 1.SF.3. Brent Futures Curves
(U.S. dollars a barrel; expiration dates on x-axis)



Sources: Bloomberg, L.P.; and IMF staff estimates.

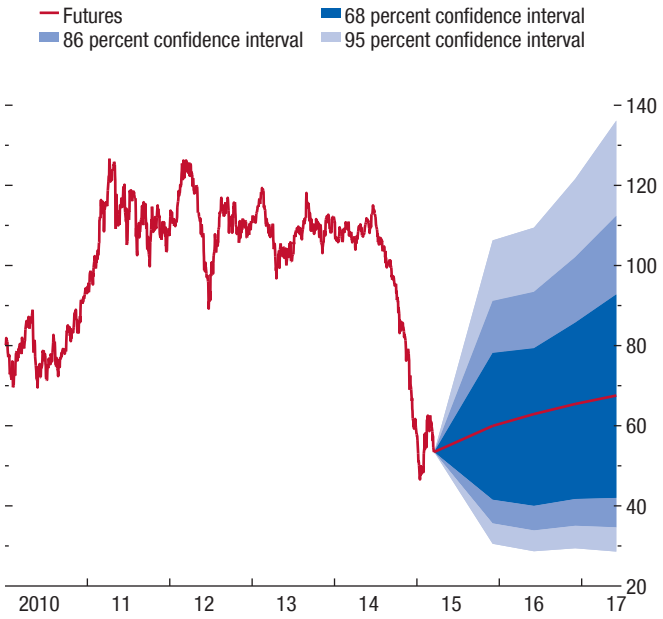
year, and WTI is again trading at a large discount to internationally traded Brent.[1] The inventory buildup at Cushing has resulted from continuing increases in U.S. production and Canadian imports, a decline in refinery activity because of maintenance, and the seasonal drop in oil consumption with the approach of spring. According to the International Energy Agency (IEA), OECD oil inventories may approach all-time highs in mid-2015, but global oil balances are expected to tighten in the second half of the year and into 2016.

Prices of oil futures point to rising prices (Figure 1.SF.3). The baseline assumptions for the IMF's average petroleum spot price, which are based on futures prices, suggest average annual prices of $58.10 a barrel in 2015, $65.70 in 2016, and $69.20 in 2017 (Figure 1.SF.4). This pattern of increases likely reflects market perceptions that production growth will slow as weak oil prices dampen incentives for oil investment and drilling.

There is substantial uncertainty around the baseline assumptions for oil prices. On the upside, changes to

[1]Incidentally, the U.S. Department of Energy recently announced that it will resume Strategic Petroleum Reserve purchases.

Figure 1.SF.4. Brent Price Prospects, March 17, 2015
(U.S. dollars a barrel)



Sources: Bloomberg, L.P.; and IMF staff estimates.

OPEC policy could be a major factor. In addition, oil demand could be somewhat higher with stronger economic growth after the oil price decline in 2014. Geopolitical risks remain ever present, with added stress for troubled oil-producing countries arising from lower oil export revenues. Risks to the downside include a prolonged surplus due to more subdued aggregate demand growth and sustained oil production growth. Should the industry adjust more quickly than anticipated to lower oil prices and reduce costs, production may exceed expectations, and the market could remain in surplus into 2016.

A key factor in the oil market adjustment to lower prices is the response of investment and, in turn, future oil production. Capital expenditures on oil development have already started to fall. According to Rystad Energy, overall capital expenditure among major oil companies was 7 percent lower in the third quarter of 2014 compared with average quarterly levels in 2013. Projections from the same source indicate that such capital expenditures will fall markedly throughout 2017. Moreover, production from some high-cost sources of supply may not be sustained if current oil prices do not cover variable costs. The second part of this special feature is dedicated to the response of investment to low oil prices.

Metal prices have declined 15 percent since September 2014 following slower demand growth in China and substantial supply increases for most metals, notably iron ore. The higher supply reflects additional increases on top of an already substantial increase in capacity during the past few years, and metal prices are now 44 percent below their 2011 peak. The slowdown in growth in China is occurring in most sectors, but most notably in construction. China consumes about 47 percent of the world's base metals (up from 13 percent in 2000) and accounted for the bulk of global consumption growth during 2000–14. Global metal consumption is expected to continue growing moderately, with slowing growth in China partly offset by higher demand growth in the rest of the world as economic activity recovers. Average annual metal prices are expected to decline 17 percent in 2015, largely on account of the decreases in the second half of 2014, and then fall slightly in 2016. Subsequently, prices are expected to broadly stabilize as markets rebalance, mainly from the supply side. The largest price decline in 2015 is expected for iron ore, which has seen the greatest increase in production capacity from Australia and Brazil.

Prices of agricultural commodities have declined by 6 percent overall. Food prices have decreased 7 percent relative to September 2014, with declines in all main indices except that for seafood, which increased slightly. Relative to their 2011 peak, food prices have declined by 23 percent following record or near-record harvests for major crops. Prices of beverages and agricultural raw materials are also down relative to September 2014 and their highs in 2011. A notable exception is tea prices, which have climbed because of dry-weather concerns in Kenya. Arabica coffee prices rose sharply in 2014 as a result of weather-related supply shortfalls in Brazil, but production is expected to rebound this year, and prices have moderated. Meat prices also jumped last year on tight supply in the United States but have since dropped because of the impact on demand and with expected expansion of herds.

Annual food prices are projected to decline by 16 percent in 2015 and 3 percent in 2016 with expected further improvement in supply conditions for many food commodities—assuming favorable weather. Large declines are expected for principal cereal and vegetable oil prices, particularly those for wheat and soybeans. Lower fuel costs will also improve agricultural producer profitability and curb demand for biofuels, particularly for biodiesel from sugar and palm oil. Ethanol production from corn in the United States is largely driven by government mandates. The one exception to the otherwise downward price trajectory is for meat prices, which are expected to rise moderately during the forecast period on strong demand and relatively tight supply.

Investment in an Era of Lower Oil Prices

Against the backdrop of lower oil prices, global investment in the oil sector—in which oil is an output—has decreased noticeably during the past nine months, reflecting lower investment in oil sands, deepwater oil, and to a lesser extent shale oil.[2] Low oil prices render exploration and extraction activities less profitable and, at times, not economical, leading to a reduction in investment. Growth in global oil production is expected to decline moderately, but with a significant delay. In some instances, oil production could be halted in fields with marginal costs that exceed oil prices—a possibility for some oil sand and

[2]The analysis presented in this subsection focuses on crude oil production and excludes natural gas liquids and condensate and refinery gains.

deepwater oil production. Low oil prices are, nevertheless, expected to lead to significant efficiency gains that will bring down costs and limit somewhat the adjustment in investment and production.

Understanding the dynamic response of investment in the oil sector to the fall in oil prices is important for at least two reasons. First, at the global level, the response of oil investment conditions the response of oil production and in turn feeds back into oil prices. Given the expected delayed response of oil production, oil prices will, all else equal, rebound to higher levels—but only gradually. Second, for selected countries, investment in the oil sector can be a large portion of total investment and may have important macroeconomic consequences.

In the non-oil sector—in which oil is an input—lower oil prices translate into lower costs, boosting profits and investment. Obviously, the more energy intensive the non-oil sector in a particular country, the bigger the boost for that country. For instance, oil consumption as a share of GDP is 3.7 percent in Japan, whereas it is 12.4 percent in Thailand. This implies that the Thai economy might benefit more from lower oil prices than might the Japanese economy. Chapter 4 covers the issue in more depth. Notwithstanding the policy response to the fall in international oil prices, the economic structure of any given country will determine the relative strength of the consumption and investment channels.

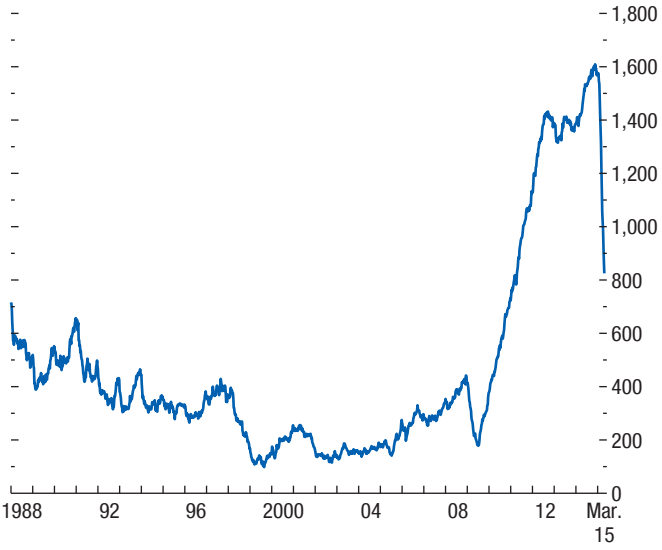
The next subsection addresses the following questions:

- How does investment in the oil sector respond to the decline in oil prices?
- How does oil production respond to the decline in oil prices?

Investment in the Oil Sector

Investment in the oil sector has fallen as a result of the recent oil price slump. Press reports since September 2014 indicate that firms in the upstream sector around the world are cutting back on capital expenditures and laying off workers. In the United States, the number of oil rigs—apparatuses for on-land oil drilling—in use has fallen markedly since September 2014, albeit by far less than the increase in the number of rigs during the past few years (Figure 1.SF.5). A cursory exploration of these data suggests that the lag between the onset of the fall in oil prices and the change in rig count is between three and six months.

Figure 1.SF.5. United States: Weekly Rig Count
(Number of rigs in operation)



Source: Baker Hughes Inc.

Historically, global investment in the oil sector has closely followed oil price developments (Figure 1.SF.6).[3] The increase in global capital expenditure in the oil sector in the 2000s is unprecedented and reflects a prolonged era of high oil prices. Indeed, the rapid increase in oil demand, especially from large emerging market economies such as China and India, has driven up oil prices and encouraged further investment in tight oil formations that were previously uneconomical at lower oil prices.[4]

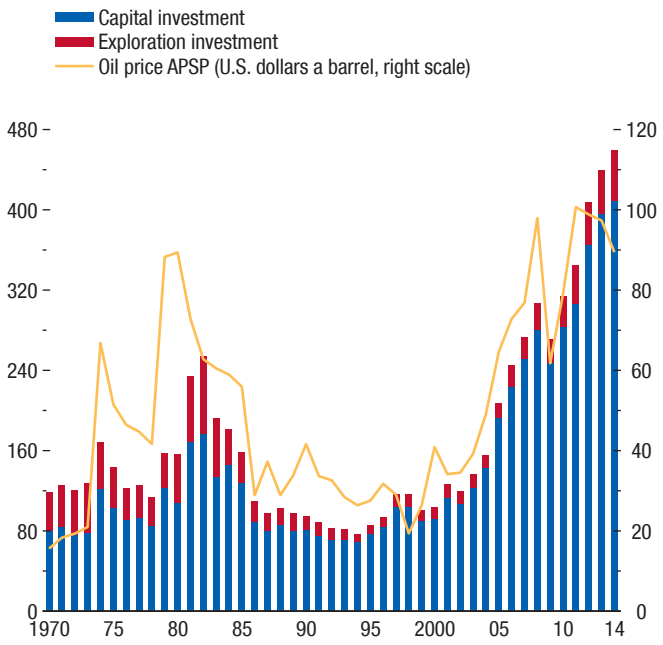
During previous episodes of dramatic price declines, investment in the oil sector has plummeted—particularly in the 1980s, when Saudi Arabia voluntarily stopped being the swing producer, which sent oil prices plunging from $27 to $14 a barrel.[5] At the outset of that episode, exploration spending, a risky activity, dropped more than nonexploration expendi-

[3]Investment and oil price series are deflated using a price index for private fixed investment in mining and oil field machinery in the United States obtained from the Bureau of Economic Analysis website.

[4]See, for instance, Blanchard and Galí 2009, Hamilton 2003, Kilian 2009, and Cashin and others 2014 for systematic investigations of the relative role of demand and supply factors in oil prices. See Aastveit, Bjørnland, and Thorsrud, forthcoming, for a study focusing on the role of demand from emerging markets.

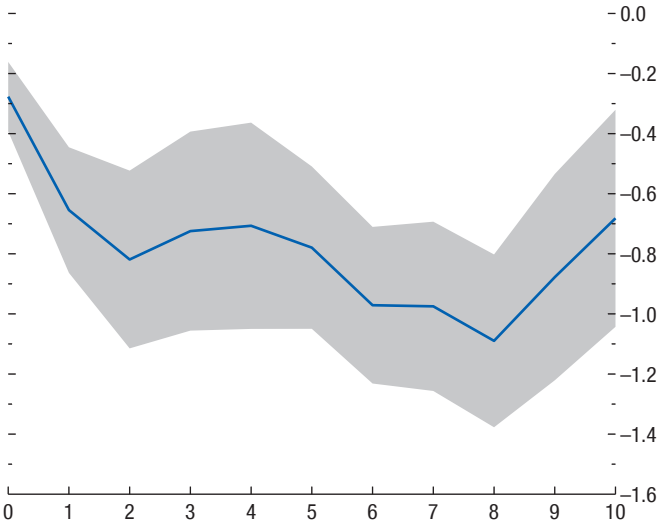
[5]A swing producer is a supplier that adjusts production with the aim of achieving a target price for a particular commodity.

Figure 1.SF.6. Global Oil Investment and Oil Price
(Billions of constant 2010 U.S. dollars, unless noted otherwise)



Sources: IMF, Primary Commodity Price System; Rystad Energy research and analysis; and IMF staff calculations.
Note: APSP = average petroleum spot price—average of U.K. Brent, Dubai, and West Texas Intermediate, equally weighted.

Figure 1.SF.7. Response of Oil Investment to Oil Prices
(Percent change; years forward on x-axis)



Source: IMF staff estimates.
Note: The figure shows the deviation of oil investment from trend in response to a change in oil prices. The computed cumulative response is based on the regression of the first difference in the logs of oil investment on the distributed lags (10) of the first difference in the logs of oil prices after country fixed effects are controlled for. Shaded areas correspond to 95 percent confidence intervals.

ture. Another dramatic (but more transitory) decline in prices occurred in late 2008 during the global financial crisis. Oil investment dropped markedly then but rebounded sharply the following year.

An empirical investigation using annual and historical data from Rystad for the period 1970 to 2014 including 41 countries—representing more than 90 percent of the world's oil investment and production—confirms the rapid and quantitatively large effect of lower oil prices on investment in the oil sector. Results are obtained from a simple panel distributed-lag regression that includes the growth rate of real investment as the dependent variable and the growth rate of the price of crude oil among the explanatory variables (Figure 1.SF.7). According to the estimates, a 1 percent reduction in the price of crude oil is associated with a decrease of more than 0.6 percent in the deviation from trend investment after three years. These results suggest that the impact of lower oil prices on investment is felt within one year,[6] confirming that the recent decline in oil prices is already having a marked impact on investment in the oil sector.[7]

Uncertainty about the future course of oil prices has also increased. Documenting increased uncertainty is not easy, but a basic measure of uncertainty based on information derived from oil futures options between July 2014 and January 2015 suggests that in recent months, markets have anticipated a significantly higher probability of extremes in oil prices.[8] This increased uncertainty may reduce investment growth in the oil sector and could even limit investment growth in non-oil

[6]These estimates imply that the decline in oil prices in the WEO baseline would be associated with a 14 percent decline in investment relative to trend in the first year and cumulative declines of 30 percent over three years and 20 percent over five years.

[7]This specification controls for country-specific fixed effects, which in turn control for time-invariant characteristics such as cross-country differences in oil endowment and institutions. For instance, Deacon and Bohn (2000) present empirical evidence that ownership risk slows resource use in some circumstances. The regression thus relies solely on variation in oil prices to explain within-country variation in investment. The results should be interpreted with some caution, however, given that they represent correlations rather than a causal relationship.

[8]Other measures of uncertainty about oil prices include indices of oil volatility, which have recently increased sharply, even though the increase is in part mechanical and has resulted from the fall in oil prices.

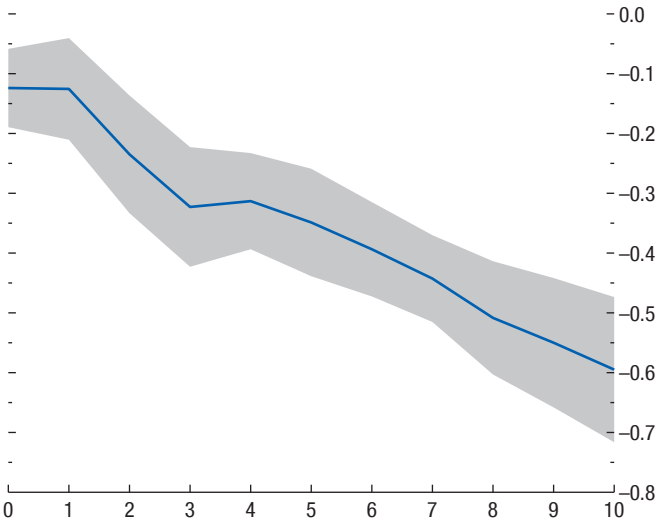
sectors that use oil intensively.[9] The effect of uncertainty is compounded by the largely irreversible nature of investment in the conventional oil sector.[10] The literature on aggregate investment has documented, both theoretically and empirically, the importance of uncertainty in raising the option value of waiting to invest, especially in a context of partial irreversibility (see, for instance, Bertola and Caballero 1994; Bloom, Bond, and Van Reenen 2007). There is also direct evidence that uncertainty reduces investment in the oil sector.[11]

This special feature now turns to the impact that reduced investment in the oil sector may have on oil production.

Production in the Oil Sector

Growth in oil production is not expected to slow significantly in the short term as a result of the recent oil price slump. Historically, episodes of falling oil prices and, in turn, falling oil investment have not been immediately followed by a decrease in production. The response of oil production is typically delayed because of the long gestation period involved in translating new investment into production. More precisely, falling oil prices do little to change the incentives of producers that have already installed their production capacity. Instead, lower oil prices affect future production through lower exploration expenditures and less investment in the development of new fields.[12]

Figure 1.SF.8. Response of Oil Production to Oil Investment
(Percent change; years forward on x-axis)



Source: IMF staff estimates.
Note: The figure shows the deviation of oil production from trend in response to a change in oil investment. The computed cumulative response is based on the regression of the first difference in the logs of oil production on the distributed lags (10) of the first difference in the logs of oil investment after country fixed effects are controlled for. Shaded areas correspond to 95 percent confidence intervals.

Empirical evidence—from the same sample of 41 countries for the period 1970–2014 referred to earlier—confirms the slow response of production to the fall in investment in the oil sector. Results from a simple panel distributed-lag regression including oil production as a dependent variable and oil investment as an explanatory variable suggest that a 1 percent reduction in investment is associated with a 0.4 percent downward deviation in production from its trend, but only after five years (Figure 1.SF.8).[13] There are caveats to interpreting these results as reflecting a causal relationship, although investment changes naturally precede changes in production. The implications of lower oil prices for investment and future production are already reflected in market participants' expectations; the oil futures curve is upward sloping, which implies higher expected future spot prices. The IEA also lowered its forecasts for non-OPEC

[9]For an investigation into the effect of oil price uncertainty on world real economic activity, see, for instance, Soojin 2014 and Elder and Serletis 2010. The latter suggests that the effect of uncertainty is both economically and statistically significant, even though methodological challenges remain in the measurement of uncertainty and in determining its impact independent of lower oil prices.

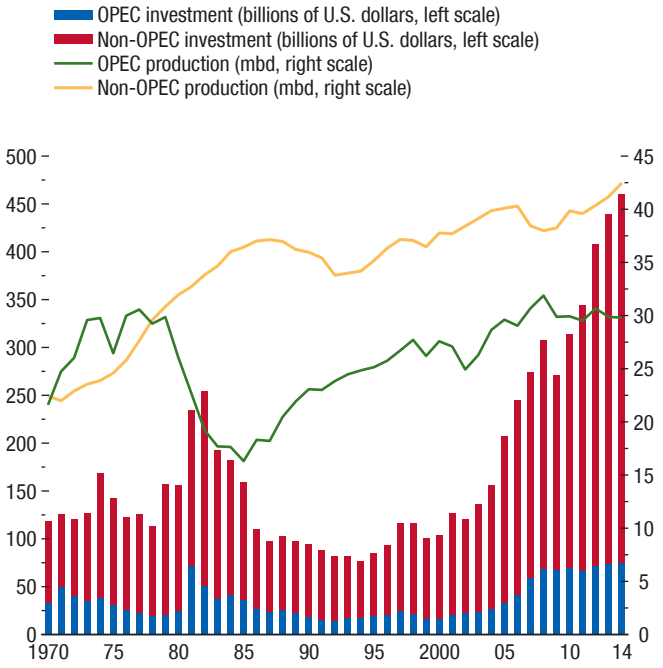
[10]Unconventional oil production, in particular tight oil production, requires less in the way of sunk costs and thus may be less subject to uncertainty about future oil prices.

[11]For instance, Kellogg (2014) estimates the response of investment to changes in uncertainty using data on oil drilling in Texas and the expected volatility of the future price of oil. The author finds that drilling activity responds to changes in price volatility on a scale consistent with the optimal response prescribed in theory and that the cost of failing to respond to volatility shocks is economically significant.

[12]Anderson, Kellogg, and Salant (2014) document empirically that changes in oil prices affect producers' incentives at the extensive margin rather than at the intensive margin. In other words, changes in oil prices affect exploration expenditures and the decision to invest in new fields but do not substantially affect production from existing fields. To explain these facts, Anderson, Kellogg, and Salant (2014) reformulate Hotelling's (1931) classic model of exhaustible resource extraction as a drilling problem: firms choose when to drill, but production from existing wells is constrained by reservoir pressure, which declines as oil is extracted. The model incorporates a modified Hotelling rule for drilling revenues net of costs and explains why production is typically constrained.

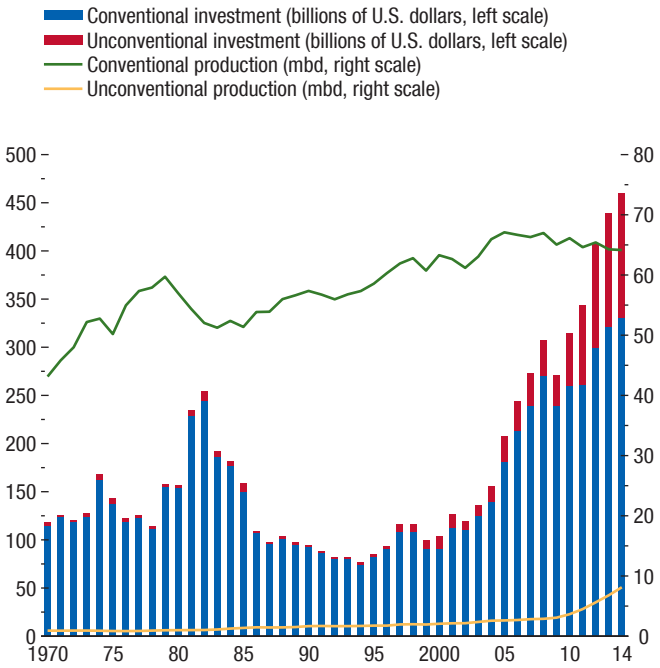
[13]These estimates imply that the fall in investment induced by the decline in oil prices in the WEO baseline would be associated with a 4.4 percent decline in production relative to trend over three years and a decline of more than 10 percent over five years.

Figure 1.SF.9. OPEC and Non-OPEC Oil Production and Investment



Sources: Rystad Energy research and analysis; and IMF staff calculations.
Note: mbd = million barrels a day; OPEC = Organization of the Petroleum Exporting Countries.

Figure 1.SF.10. Conventional and Unconventional Oil Production and Investment



Sources: Rystad Energy research and analysis; and IMF staff calculations.
Note: mbd = million barrels a day.

oil production—as a result of reductions in capital expenditure growth—in its latest *Medium-Term Oil Market Report* (IEA 2015), although sizable changes in future production are not expected for a few years. For the near term, the IEA raised its production forecast for 2015; however, production growth is expected to slow noticeably in North America.

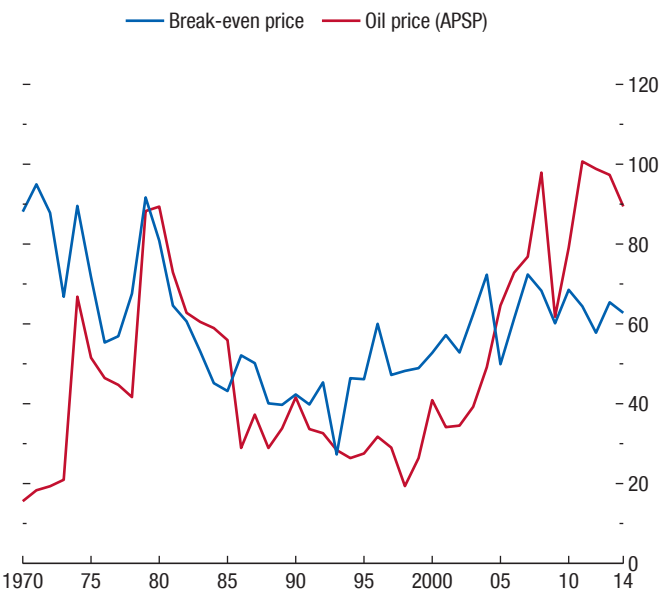
The production of OPEC members and in particular of Saudi Arabia—the biggest oil producer within OPEC—is also guided by strategic considerations. OPEC has explicitly sought to influence oil prices, which suggests that the oil market is not a fully competitive market in which producers are atomistic and take prices as given. For example, faced with the increase in production from non-OPEC sources in the 1980s, Saudi Arabia reduced production significantly during the course of a few years (Figure 1.SF.9). The production cuts were not sufficient to curb the fall in oil prices, and Saudi Arabia changed course in 1986, which led to a further decline in oil prices (see Gately 1986). A similar situation seems to have played out with the increase in production in unconventional oil from North America (Figure 1.SF.10). In the past few months, Saudi Arabia has openly stated that it will not cut production in the face of growing production from non-OPEC countries and in turn lower oil prices, despite pressures from other OPEC members. Some commentators have argued that this strategy is aimed at easing relatively costlier oil extraction activities out of the market. As discussed later in this subsection, U.S. oil production will be somewhat affected by oil prices at their current lower levels but less so than some non-OPEC production.

There is a possibility that oil production may respond more quickly to lower prices than it has in the past. The evolution of global break-even prices—oil prices at which it becomes worthwhile to extract—shows that prices during the 2000s were hovering well above break-even prices until the recent slump, when it became unprofitable for some fields to operate (Figure 1.SF.11). Despite relatively large decommissioning costs, the sizable gap that has emerged between current (approximately $52 a barrel as of March 2015) and break-even oil prices will eventually lead to a halt in production in some fields that are no longer profitable. Of course, active cost-reduction measures and other efficiency gains, including from consolidation in the oil industry,

will limit the effect of lower oil prices on oil investment and, in turn, on oil production. In addition, average production costs for shale oil, which has been driving global production growth, are now likely to be closer to marginal costs because field depletion rates tend to be higher than those of conventional oil. The spatial distribution of operating costs per barrel suggests that Canada, the North Sea, and the United Kingdom are among the most expensive places to operate oil fields (Figure 1.SF.12).[14] As a result, the oil price slump will affect production in those locations earlier and more intensely than in other locations. A detailed investigation of the cost structure associated with U.S. shale oil production suggests that shale oil production has experienced rapid efficiency gains, considering that it is still relatively early in the investment cycle. Projections from Rystad show that lower oil prices are expected to have a smaller impact on production of shale oil in the United States than on deepwater and oil sand production, especially in Brazil, Canada, and the United Kingdom.

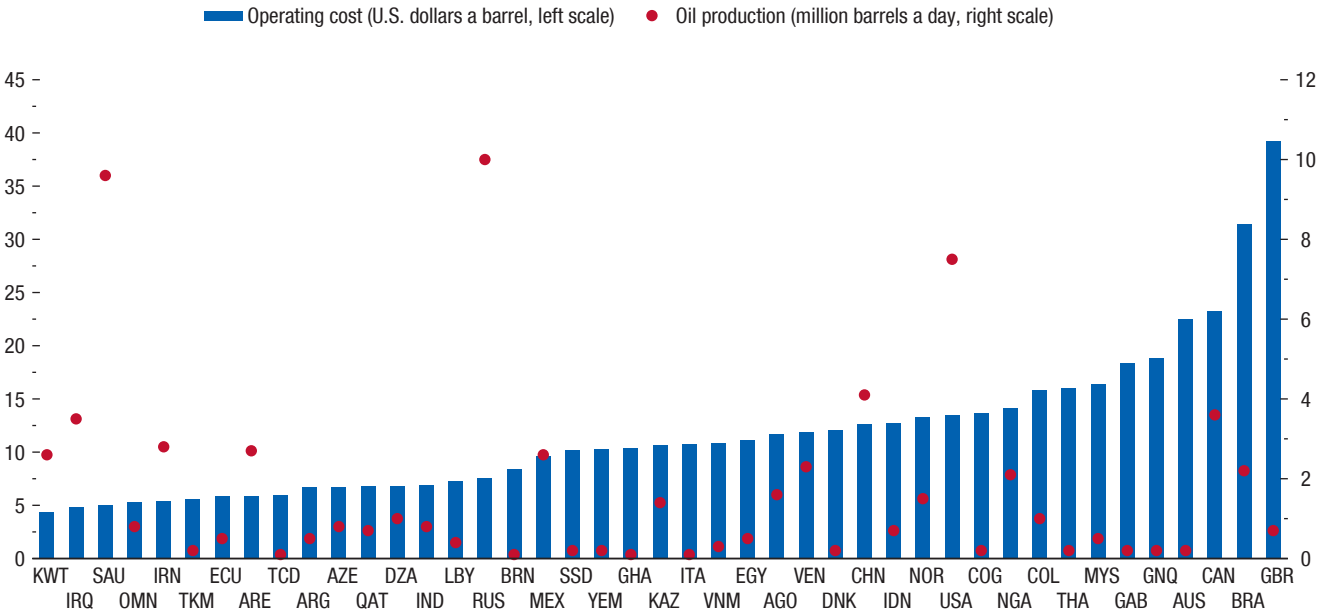
[14]Shale oil production in the United States appears to be more resilient to falling oil prices, considering growing efficiency gains. Rates of return will be significantly lower, however, and some highly leveraged firms that did not hedge against lower prices are already under financial stress and have been cutting their capital expenditures significantly and laying off substantial numbers of workers.

Figure 1.SF.11. Evolution of Break-Even Prices
(Constant 2010 U.S. dollars a barrel)



Sources: IMF, Primary Commodity Price System; Rystad Energy research and analysis; and IMF staff calculations.
Note: APSP = average petroleum spot price—average of U.K. Brent, Dubai, and West Texas Intermediate, equally weighted.

Figure 1.SF.12. Oil Production and Operating Costs by Country



Sources: Rystad Energy research and analysis; and IMF staff calculations.
Note: Data labels in the figure use International Organization for Standardization (ISO) country codes.

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