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Oil Supply Balances:
The Four Cycles of the OPEC Oil Output Policy

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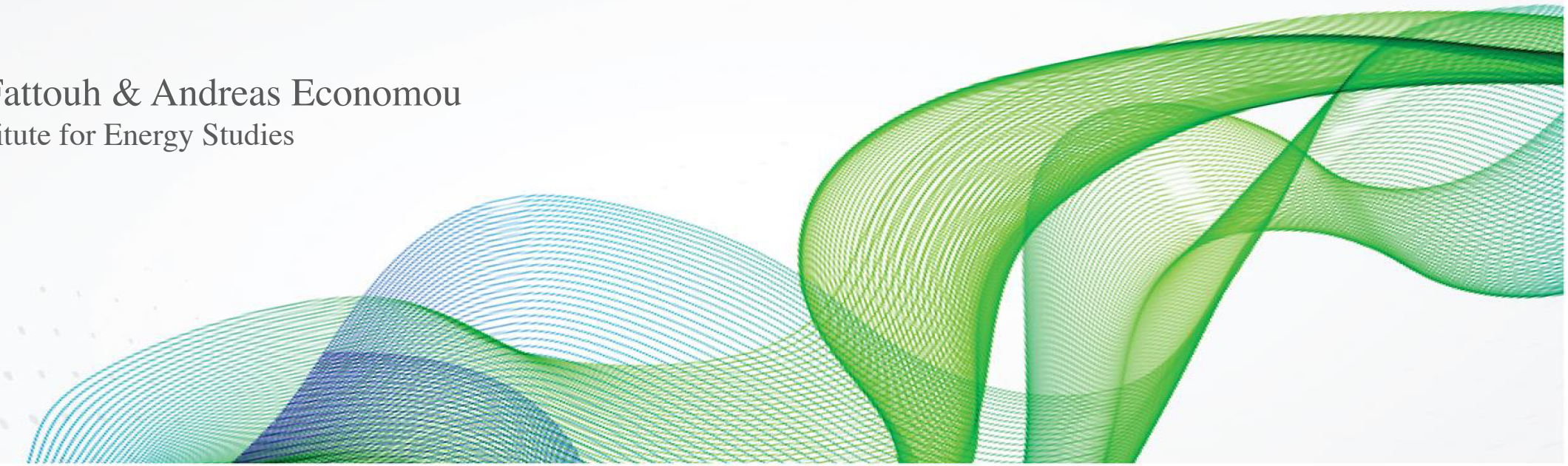
Oxford Institute for Energy Studies



OIES, Oxford UK, APRIL 2018

OPEC's balancing act

Looking back and looking ahead

At first glance, the historic Declaration of Cooperation between OPEC and non-OPEC oil producing countries to curb their output by 1.8 mb/d offered some encouragement ensuring that the balancing of the oil market is underway.

2017 ended on a positive note with the monthly Brent price stabilising above $60/b, increasing by nearly $20/b since the Vienna Agreement in November 2016, and OECD commercial stocks declining by more than 100 mbbls for the first time since December 2013.

A mere quarter in 2018 however and the OPEC exit strategy has been one of the key uncertainties engulfing the oil market

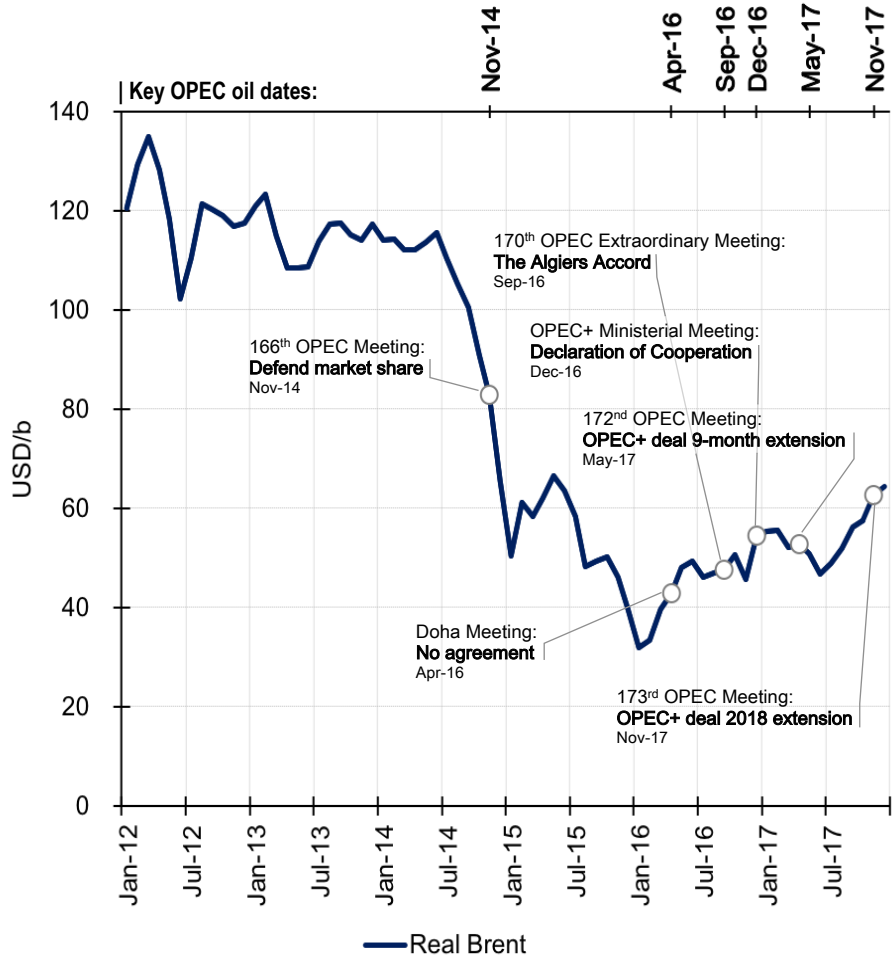
- To the upside, bullish views warn that OPEC overshoots on tightening the market.
- To the downside, bearish views warn that fast rising production in non-OPEC countries ending-2018 could grow by more than demand and hence, cause a supply glut anew.

The problem is that with the market focusing on the level of global oil stocks, this uncertainty remains unresolved. Understanding in retrospect the sensitivity of the key market parameters to OPEC behaviour, is key to anticipate what could lie ahead.

Specifically we explore:

- How did the global oil supply glut evolve since 2014 vis-à-vis OPEC behaviour ?
- How did the underlying market parameters respond in shaping price dynamics?
- What are the some of the lessons that can be drawn from the previous OPEC cycles?

Real Brent price (in 2017.12 USD)



Data: U.S. Energy Information Administration (EIA), U.S. Bureau of Labor Statistics

Are we there yet?

The elusive role of OECD commercial stocks

The stated key-objective guiding OPEC's current oil policy is cutting global commercial oil stocks down to a five-year average level.

This benchmark has never been defined and hence, the current OPEC oil output policy is missing both an optimal-target guide and a destination.

- **Against which five-year average target?**

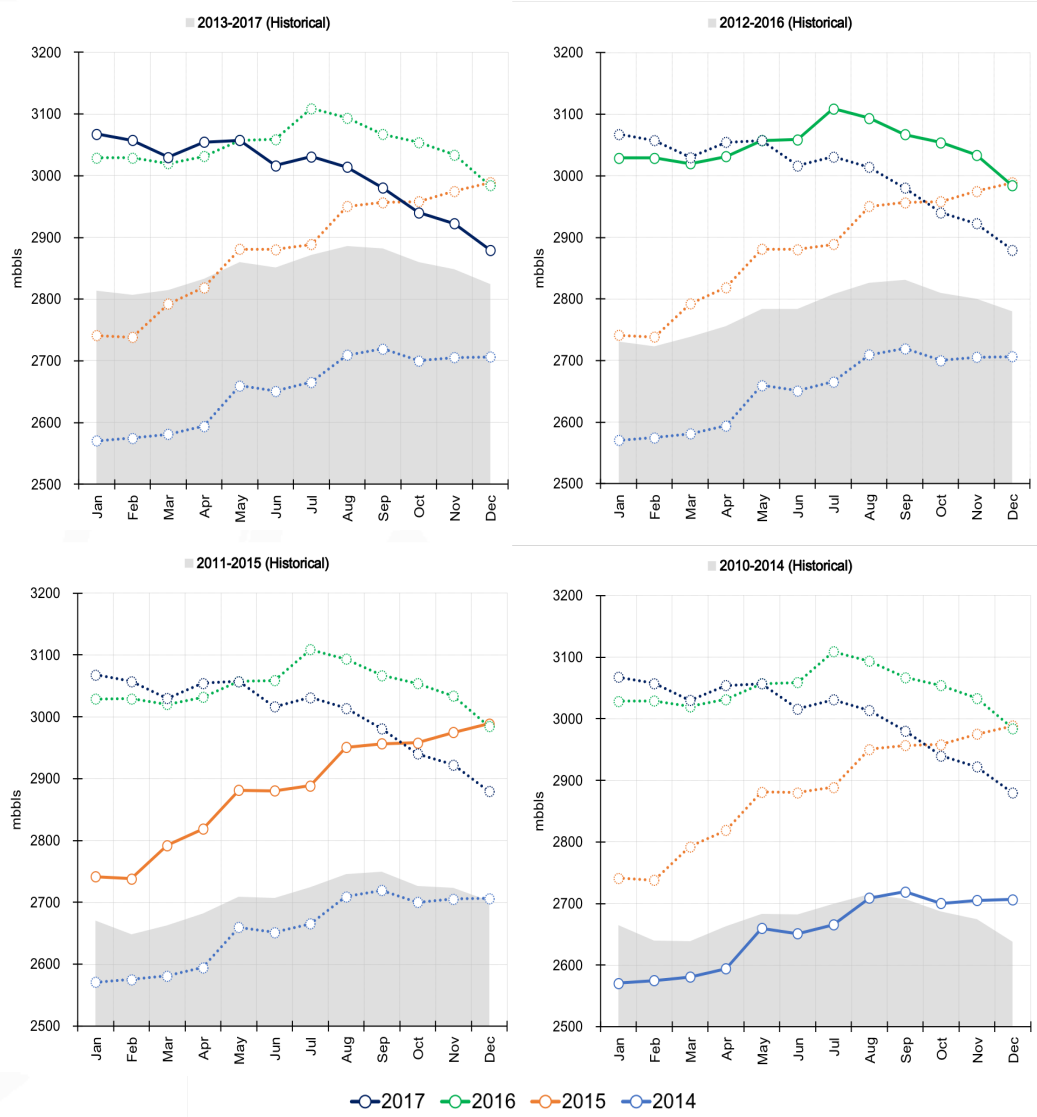
If we consider the 2013-17 monthly five-year average then oil stocks in December 2017 drew about 55 mbbls above target, indicating a market tightening. Moving this target however to the pre-shock 2010-2014 five-year average, the December 2017 stock levels remain about 241 mbbls above target. In fact, since 2014 the historical stock levels grew on average by about 60 mbbls y-o-y, moving the goalposts much closer to OPEC's stock-cut target without much effort from the oil-producers.

- **Which stocks to begin with?**

Most visible indicator of global oil stocks are the OECD commercial stocks as reported by the IEA. Yet, OECD oil stocks paint a very incomplete picture of global supply-demand picture:

- Over 80% of demand growth is in developing countries.
- OECD commercial stocks are a backward-looking measure, available only with a two-month lag and subject to significant revisions.
- Short-run stock movements not indicative of market fundamentals nor explicit to their true dynamics, as other important components of stock demand are associated with expectations about future supply-demand conditions and price movements, as well as seasonal demand.

OECD commercial oil stocks vs. historical 5-yr average



Data: International Energy Agency (IEA)

Assessing the impact of the OPEC+ deal

Drivers of the oil price in 2017

Direct price impact of the OPEC+ output cutbacks in 2017 was limited. That said, indirectly there was a significant contribution to the Brent price in both directions:

- To the upside, capped production from OPEC+ helped prices increase in response to the large positive shocks to flow demand, insofar as the market could absorb another 0.3 mb/d of new non-OEPC production without prices weakening.
- To the downside, larger-than-expected response of US shale triggered by OPEC output policy reversal kept the monthly Brent price lower by at least $5/b year-end.

Supply shocks driven by geopolitical disruptions (*exogenous supply*)

The unexpected easing of the supply disruptions, particularly from Libya and Nigeria both of which are excluded from the OPEC+ deal, contributed to around $1/b decline in the Brent price.

Supply shocks associated with output decisions (*endogenous supply*)

Strong response of non-OPEC supplies, dominated by the return of about 1.0 mb/d of new US shale barrels, more than offset the price gains from the OPEC+ output cutbacks ($9/b), resulting in a net decrease of the Brent price by about $10/b.

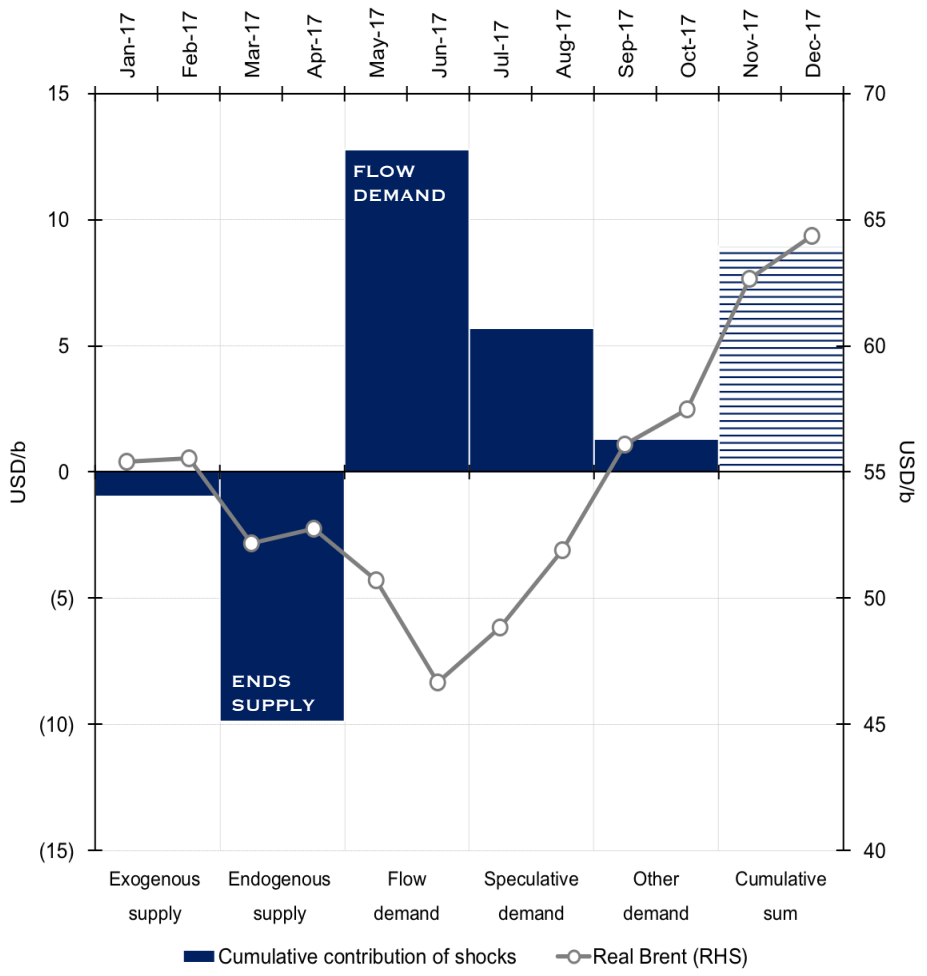
Demand shocks associated with immediate consumption (*flow demand*)

Robust growth of global oil demand been a catalytic factor in 2017 counteracting strong recovery of US shale and adding to Brent price about $13/b year-end.

Stock demand shocks reflecting forward-looking behaviour (*speculative demand*)

Speculative demand shocks driven by concerns of unexpected geopolitical supply disruptions in second half of 2017 contributed by $5/b to the cumulative price increase.

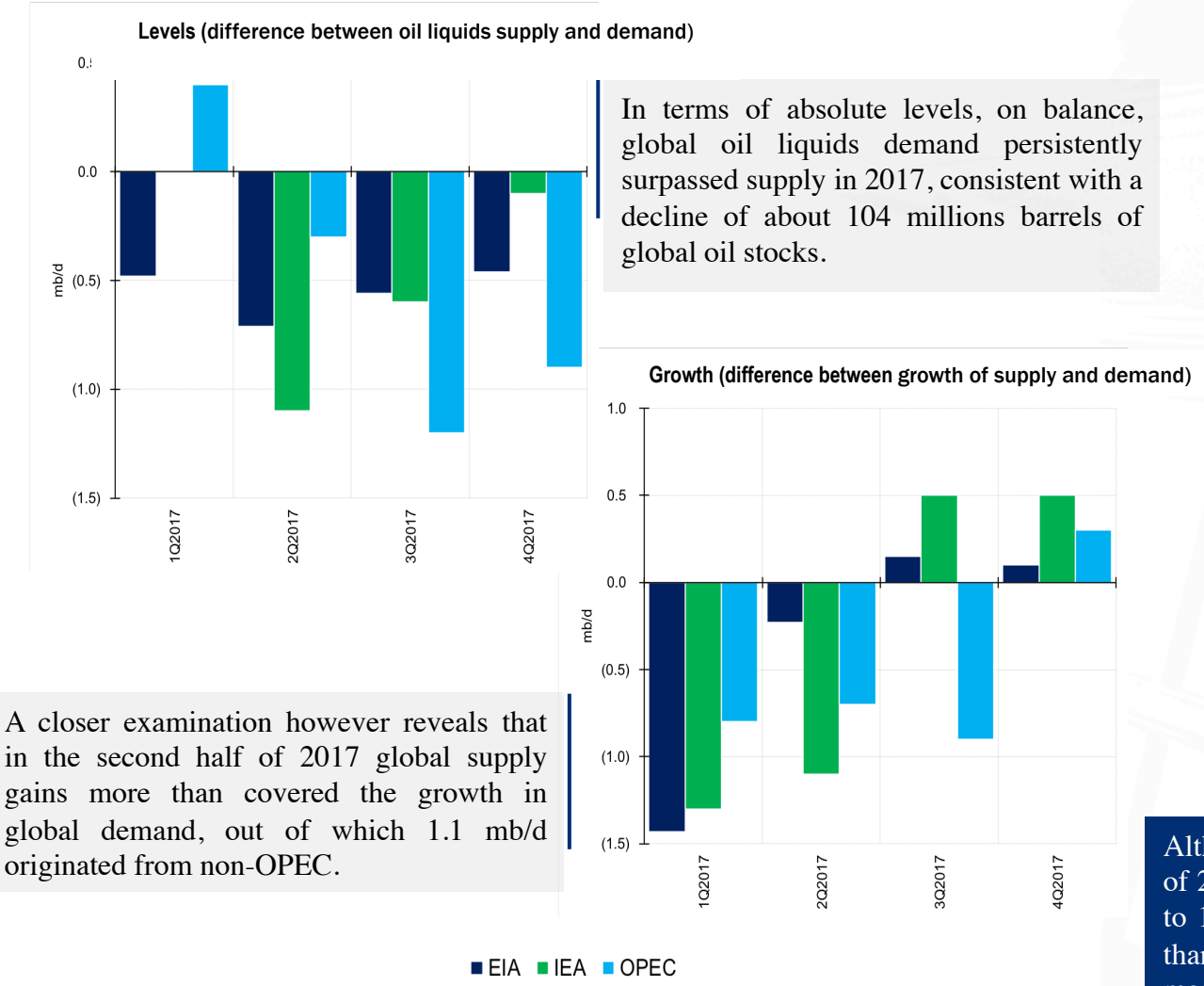
Cumulative contribution of the structural shocks to the Brent price in 2017



Data: Authors' estimations

More than meets the eye

Global oil liquids supply-demand balances

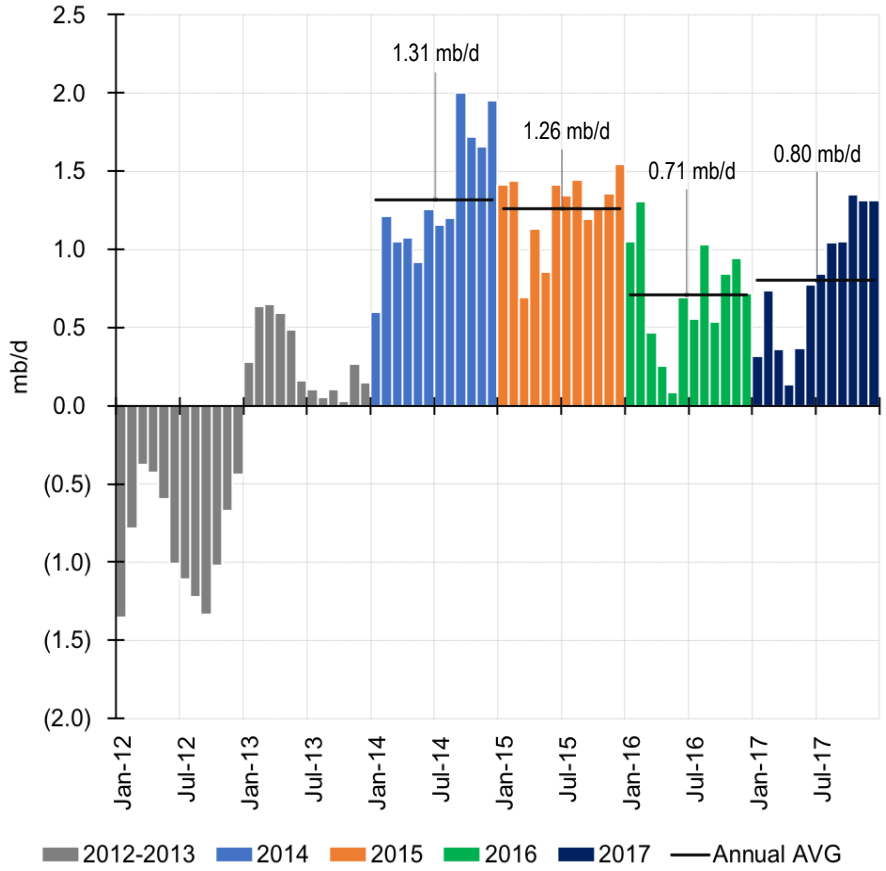


In terms of absolute levels, on balance, global oil liquids demand persistently surpassed supply in 2017, consistent with a decline of about 104 millions barrels of global oil stocks.

A closer examination however reveals that in the second half of 2017 global supply gains more than covered the growth in global demand, out of which 1.1 mb/d originated from non-OPEC.

Measure of global crude oil production balances

(henceforth referred to as *index of global oil supply balances*)



Although global output overhang was momentarily nearly drained in first half of 2017 (to 0.3 mb/d), by December 2017 it returned near its 2015-levels close to 1.2 mb/d. Annually, excess production in 2017 was about 0.1 mb/d higher than a year before, during which OPEC's high output-low price strategy managed to gradually drain over half of the 2014 supply glut.

Data: EIA's, IEA's and OPEC's *Monthly Oil Market Reports* as of February 2018, Authors' estimations

Alternative metrics

A measure of global crude oil production balances

Saudi Arabia's oil minister HE Khalid Al-Falih recently called for the need to explore alternative metrics to measure the impact and effectiveness of the OPEC+ deal before the Ministers next meet in June 2018 to discuss future of the current OPEC oil policy.

This analysis employs one such metric, specifically designed to capture any fluctuations of global oil production from the equilibrium production path in response to unexpected changes in the price of oil, or oil demand, or both; that in turn affect the output decisions of oil producers.

Clear advantage of this measure, henceforth referred to as *index of global oil supply balances*, is that it tracks in real-time the actual magnitude (in mb/d) and sign (+/-) of the market imbalances from a point of view of global oil production pressures that arise explicitly from within the crude oil market (as opposed to geopolitical disruptions). Implicitly, such risks relate to an array of economical, geological and technological factors that combined shape the behaviour of oil producers and determine the rate of investment in future oil production that affects supply.

In particular, the index is a forward-looking measure of the following two market-states:

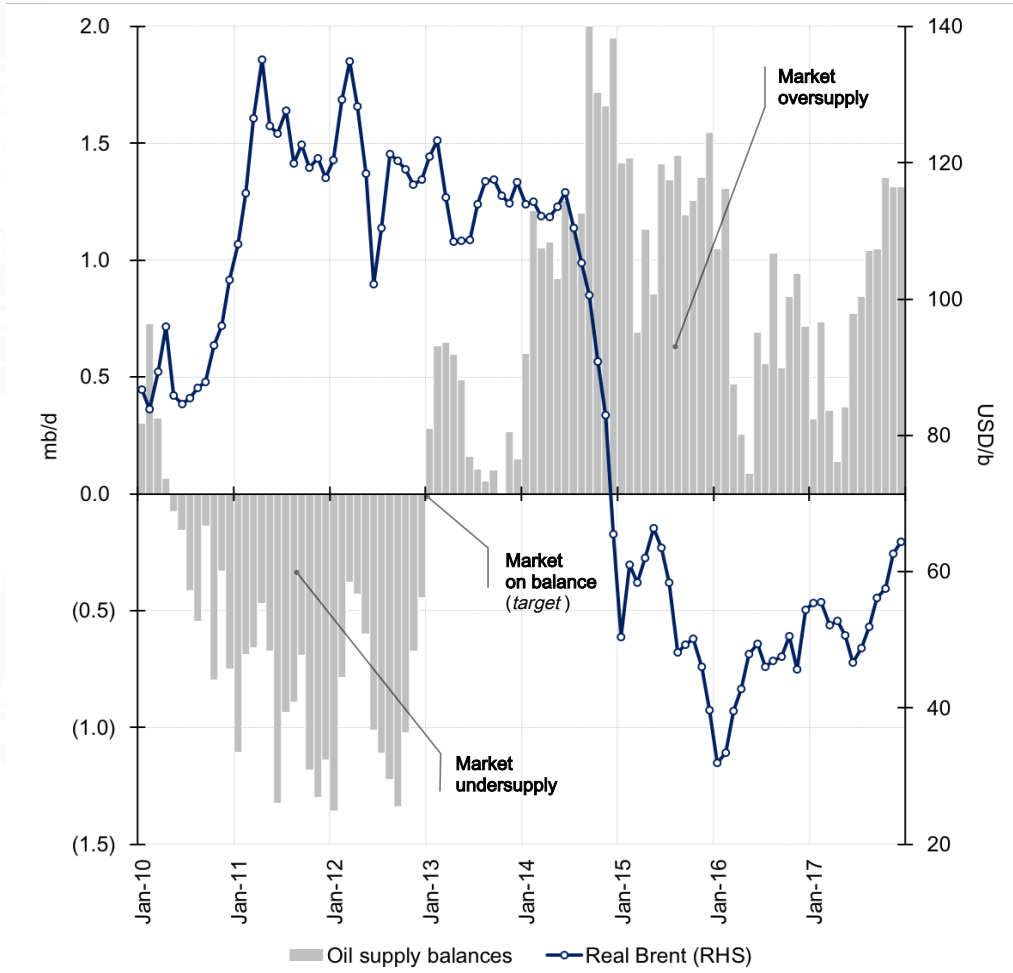
- **Oversupply**

Defined as a situation in which current and expected increases in global oil production run ahead of the current and expected increases in global demand, associated with the unwillingness of oil producers to defer excess production driven by the fact that shutting-in operating capacity is costly, as well as the heightened uncertainty about the sensitivity of the underlying supply-demand conditions to a higher price.

- **Undersupply**

Defined as a situation in which current and expected global oil production unable to meet current and expected increases in global demand, associated with the inability of oil producers to maintain and expand production due to long-lead times and long gestation periods from the point at which a Final Investment Decision (FID) is made and the start of first-production.

Index of global oil supply balances

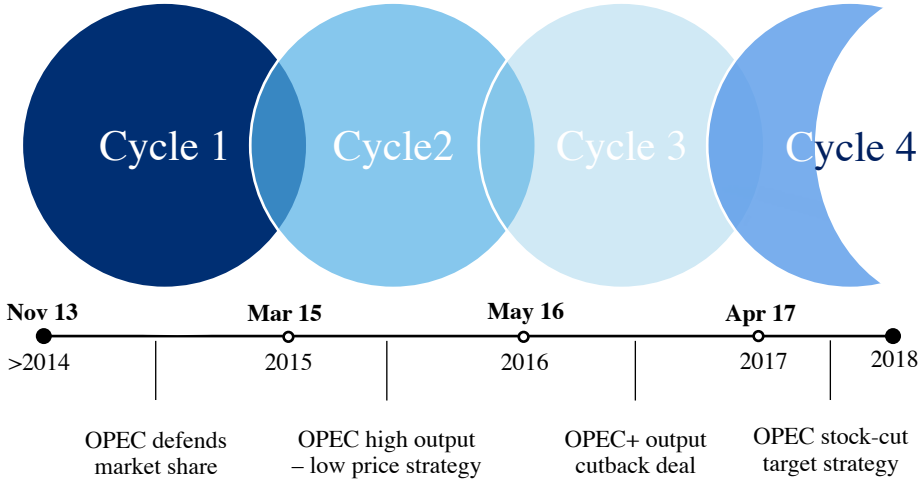


NOTE: Further explanatory details relating to the oil supply balances index can be found in the *Appendix*.

Data: Authors' estimations

The four cycles of the OPEC oil output policy

Since 2013, global oil supply balances experienced four short-run cycles in line with the moving dynamics of OPEC's oil output policy:

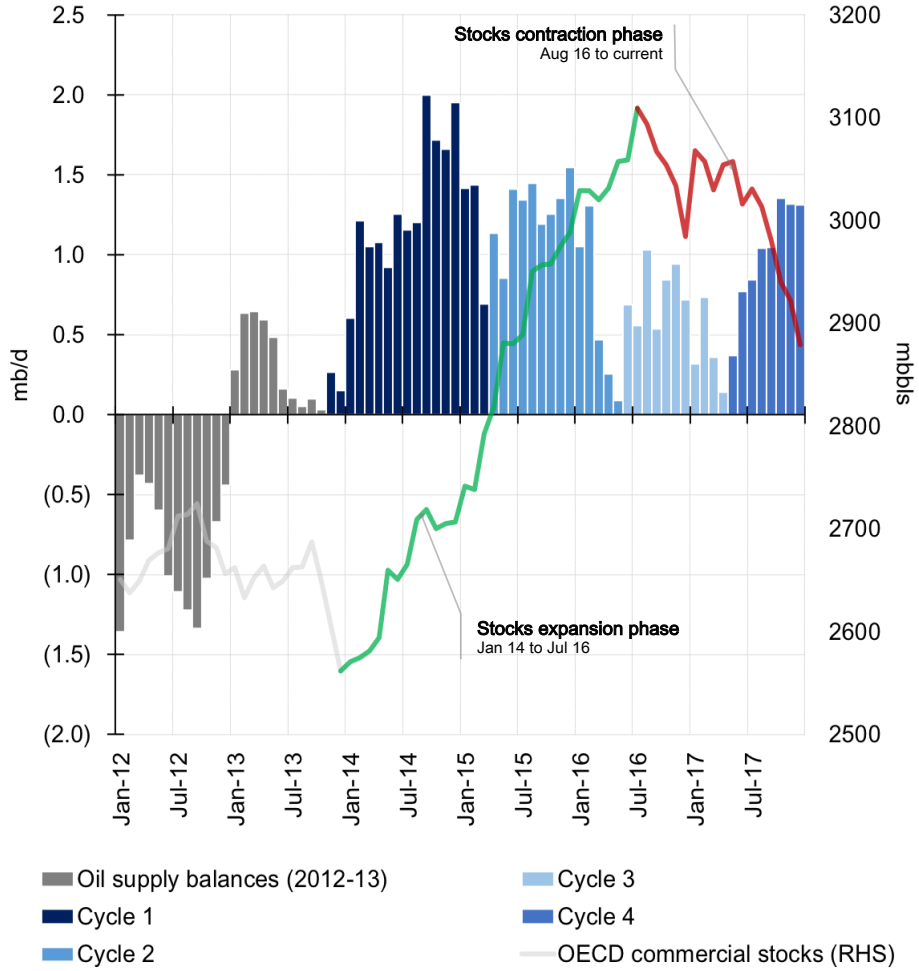


Cycle 1
Nov 13 - Mar 15
The large oil supply overhang and OPEC's historical decision to leave it to the price mechanism to clear the imbalance.

Cycle 2
Apr 15 - May 16
OPEC's pursue of a high output – low price strategy aimed at driving high-cost oil production out of the market.

Cycle 3
Jun 16 - Apr 17
OPEC shift in output policy and the long journey to reaching an agreement on output cuts with oil producers within and outside the bloc.

Cycle 4
May 17 – On-going
OPEC's strong commitment to the agreement and its decision to target the level of global oil stocks to bring them down to 'normal' levels.



Data: Authors' estimations

The cycles of the OPEC oil output policy

Cycle 1: OPEC defends its market share (1/3)

OPEC makes a key decision

Expansion (+1.7 mb/d):

The very rapid US shale production growth (1.2 mb/d year-end) and easing of geopolitical supply disruptions contributed to the expansive cycle of global oil supplies that predominated throughout 2014.

Peak (at 2.0 mb/d):

In November 2014, OPEC opted for not adjusting its output to support the falling price and leaving it to the market mechanisms to clear the imbalance.

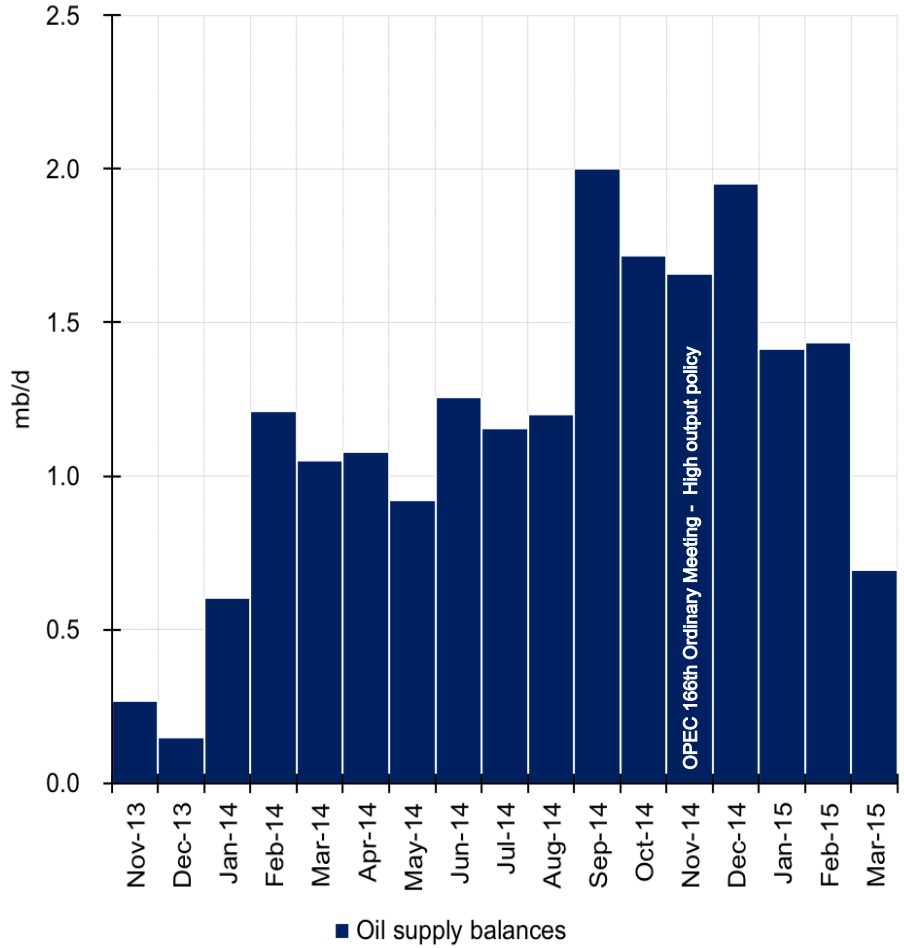
Contraction (-1.3 mb/d): :

OPEC's decision sent a clear signal to the market with the US shale producers reacting swiftly; by March 2015 drilling activity in the US declined by about 45% relative to November 2014 and US shale oil production at the time recorded its highest ever m-o-m decline on record (close to 0.1 mb/d).

Trough (at 0.7 mb/d):

With growth of US shale oil production slowing-down below 1% in 1Q2015, relative to 3% in 4Q2014, and an increase in oil consumption, supply balances in March 2015 returned to their levels similar to January 2014 but only temporary.

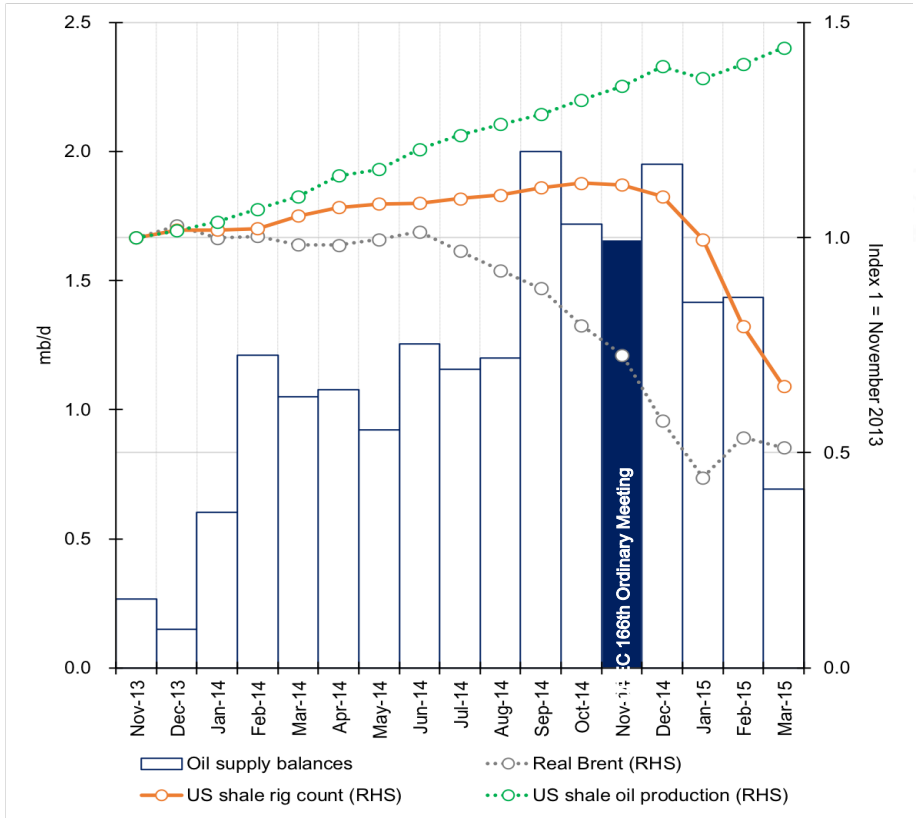
November 2013 – March 2015



Data: Authors' estimations

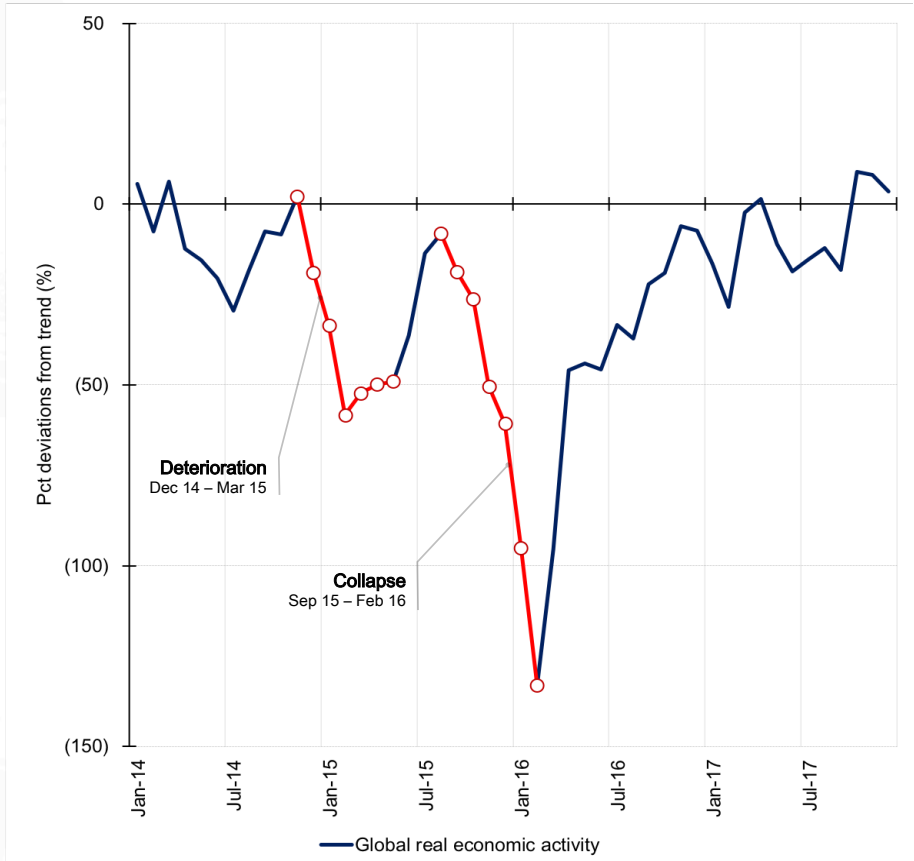
Cycle 1: OPEC defends its market share (2/3)

Short-run responsiveness of US shale supply



Unprecedented growth of US shale production in 2014, increasing by 1.2 mb/d year-end, was largest contributor to expansive cycle. Thereafter, US producers responded swiftly to downcycle, but only after it became clear that OPEC was to pursue a high output-low price strategy. In Q12015, drilling activity in US shale plays was slashed by 545 rigs (-45%), although production kept rising.

Global real economic activity index



Weaker-than-expected global economic performance in final quarter of 2014, reflecting growth concerns in emerging and advanced economies, aggravated supply glut contributing to Brent price decline as of January 2015. Temporary recovery of global economic activity was followed by a renewed episode of continuing headwinds for emerging market economies ending-2015.

Data: U.S. EIA, Baker Hughes, Kilian (2009) "Not All Oil Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market"

Cycle 1: OPEC defends its market share (3/3)

The great oil price collapse

Although the positive endogenous supply shocks (represented mainly by the rapid increase in US shale) were the main contributors to the $57/b decline in the Brent price between November 2013 to March 2015, the synchronisation of several other unfavourable supply and demand shocks in the second half of 2014 combined to produce a 'perfect storm' that led to the oil price collapse.

-38 /b / -57 /b

Endogenous supply shocks accounted for more than half of the cumulative Brent price decline, by $38/b, out of which $27/b or 70% of the total are accounted for between August 2014 to January 2015.

-26 /b / -57 /b

Although positive flow demand shocks prior July 2014 kept the market in balance, the unexpected slowdown in global economy in the second half of 2014 resulted in a net negative contribution to the Brent price by $26/b.

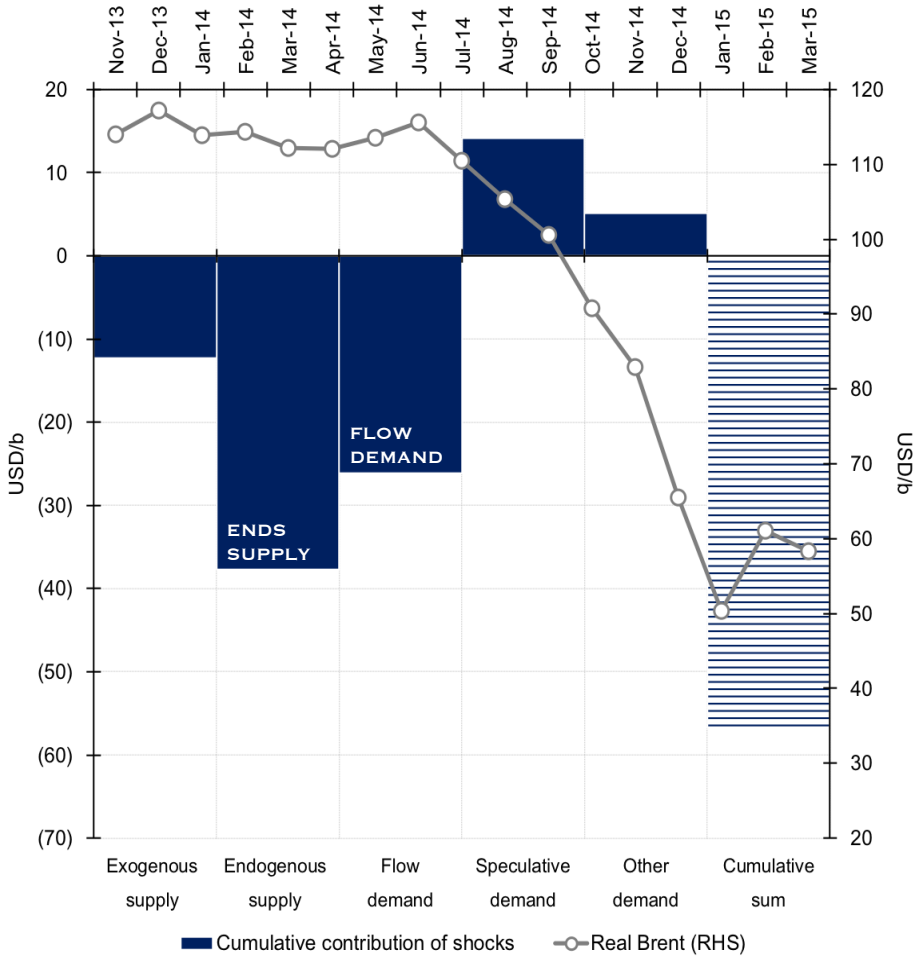
-12 /b / -57 /b

The temporary easing of geopolitical tensions in Libya and Iraq, the former doubling its production to 0.8 mb/d in the second half of 2014 despite the ongoing internal conflict, caused the Brent price to decline by $12/b.

+14 /b / -57 /b

Speculative demand pressures being a reflection of the premature halt of US shale supply in the first quarter of 2015 in conjunction with the heightening of the ongoing geopolitical tensions, added to the Brent price about $14/b.

Cumulative contribution of the structural shocks to the Brent price (November 13 – March 15)



Data: Authors' estimations

Cycle 2: OPEC's high output-low price strategy (1/3)

Expansion (+0.8 mb/d):

Abided by its November 2014 decision, OPEC ramped-up its output sharply in 2015. Saudi Arabia and Iraq were the main contributors to the supply growth with these two producers alone increasing their output by 1.4 mb/d year-end.

Peak (at 1.5 mb/d):

Big story in 2015 was the resilience of US shale producers in price downcycle, driven by cost deflation, high grading and strong productivity performance. By December 2015 US shale production declined only by a mere 0.1 mb/d y-o-y.

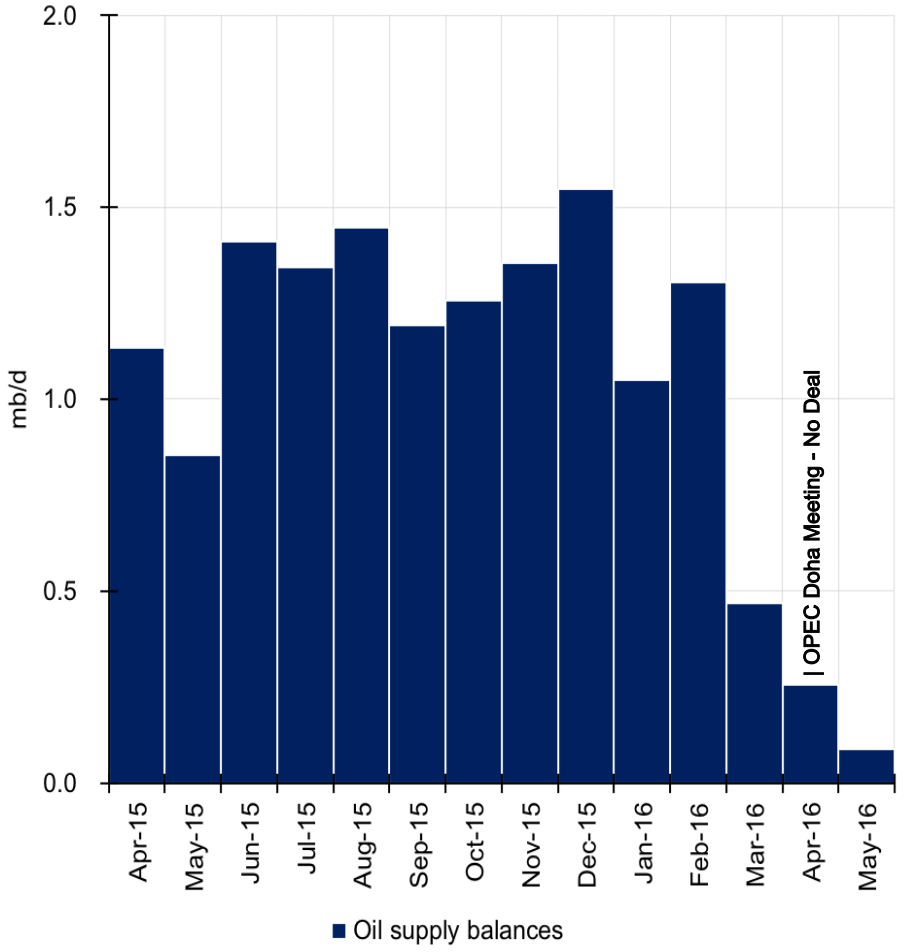
Contraction (-1.4 mb/d): :

Generalized slowdown in emerging market economies, particularly China, in conjunction with tightening of monetary policies in advanced economies led to an unexpected worsening of global economic activity in the second half of 2015; plunging the oil price close to $31/b in January 2016 and hence, aggravating the operational environment for high-cost oil producers.

Trough (at 0.1 mb/d):

By May 2016, non-OPEC crude oil production was nearly 1.3 mb/d below year earlier, with the US shale production recording its highest m-o-m losses that totaled close to 0.3 mb/d. That said, despite OPEC production suffering from unplanned outages, the return of Iranian barrels after the sanctions lift offset that decline and kept OPEC output standing 0.5 mb/d above a year ago.

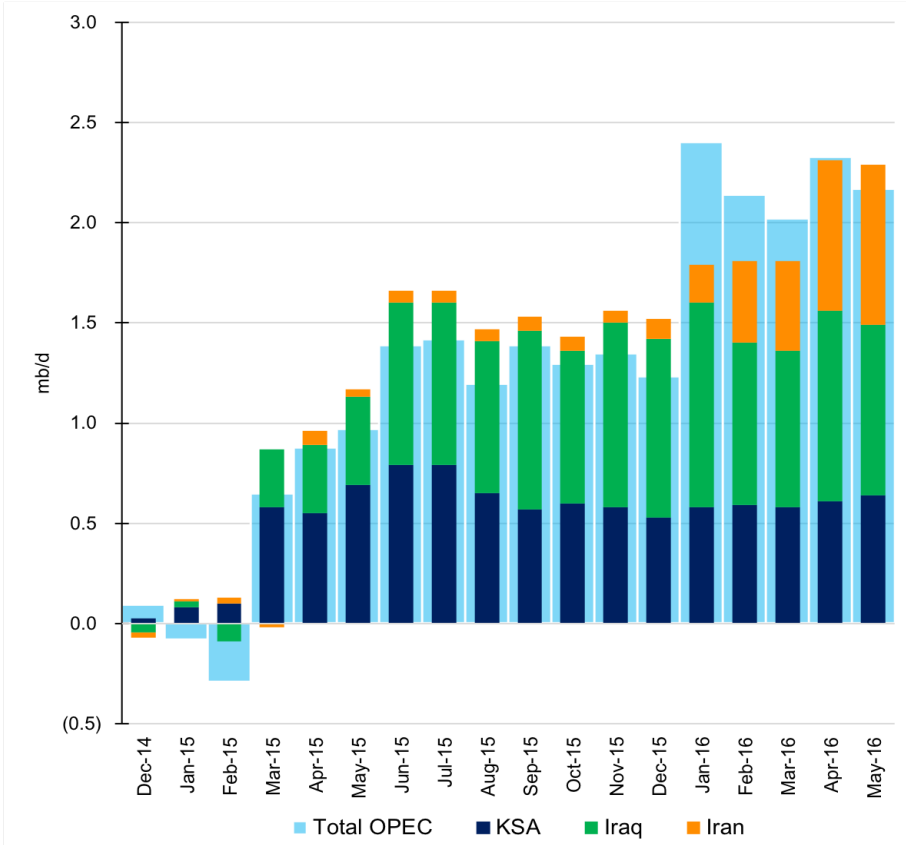
April 2015 – May 2016



Data: Authors' estimations

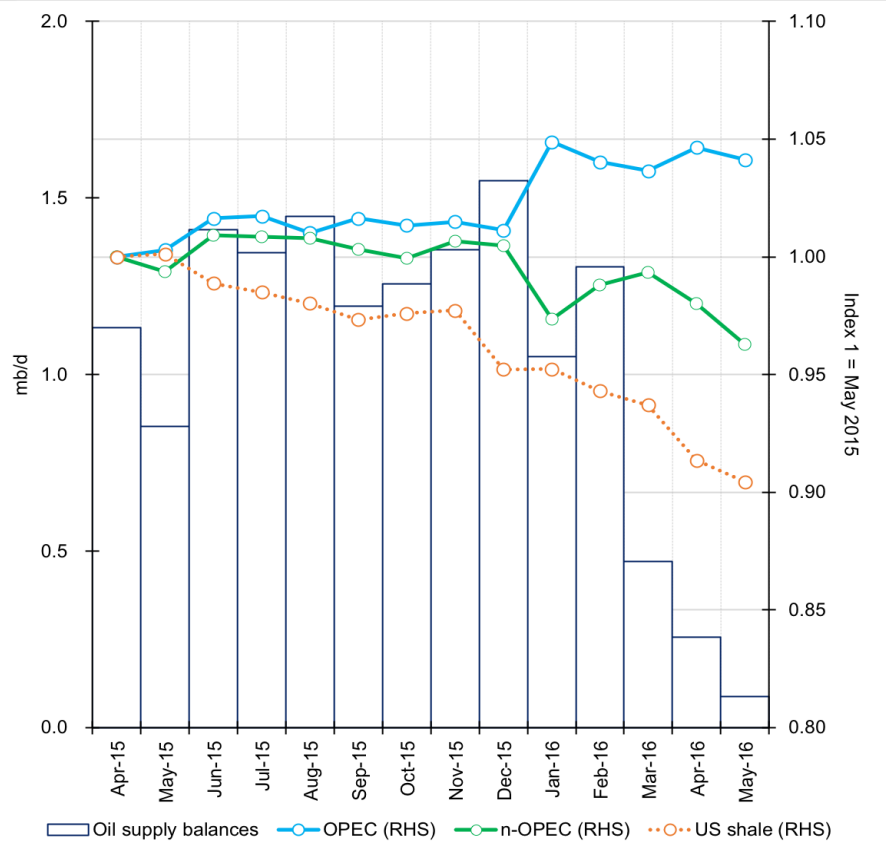
Cycle 2: OPEC's high output-low price strategy (2/3)

OPEC oil production gains since November 2014



Since declaration of its high-output oil policy, OPEC oil production surged by more than 2.0 mb/d as of May 2016. In 2015, KSA and Iraq were largest contributors to the output increases by 0.5 and 0.9 mb/d respectively. In wake of the nuclear sanctions lift, Iranian production grew rapidly to near pre-sanction levels (3.6 mb/d), adding a further 0.8 mb/d to the total.

OPEC vs non-OPEC oil production growth



Renewed price plunge in December 2015 down to $30/b accelerated declines in non-OPEC production, which for first time saw a significant amount of US shale production exiting the market (about 0.5 mb/d from its peak). To make matters worse, unplanned outages from Canada and elsewhere deepened global output losses that as of May 2016 grew only by a mere 0.05 mb/d, compared to 3.5 mb/d a year earlier.

Data: IEA, Authors' estimations

Cycle 2: OPEC's high output-low price strategy (3/3)

So close yet so far

OPEC aggressive output strategy did work in the sense that non-OPEC production did adjust sharply to low oil prices and the market was showing strong signs of rebalancing. However, a negative demand shock reflected in the slowing and fragile global economic performance ending-2015 resulted in a 14-year low for oil prices. The sharp oil price fall induced an OPEC response and the abandonment of its high-output policy in favour of a pricing strategy.

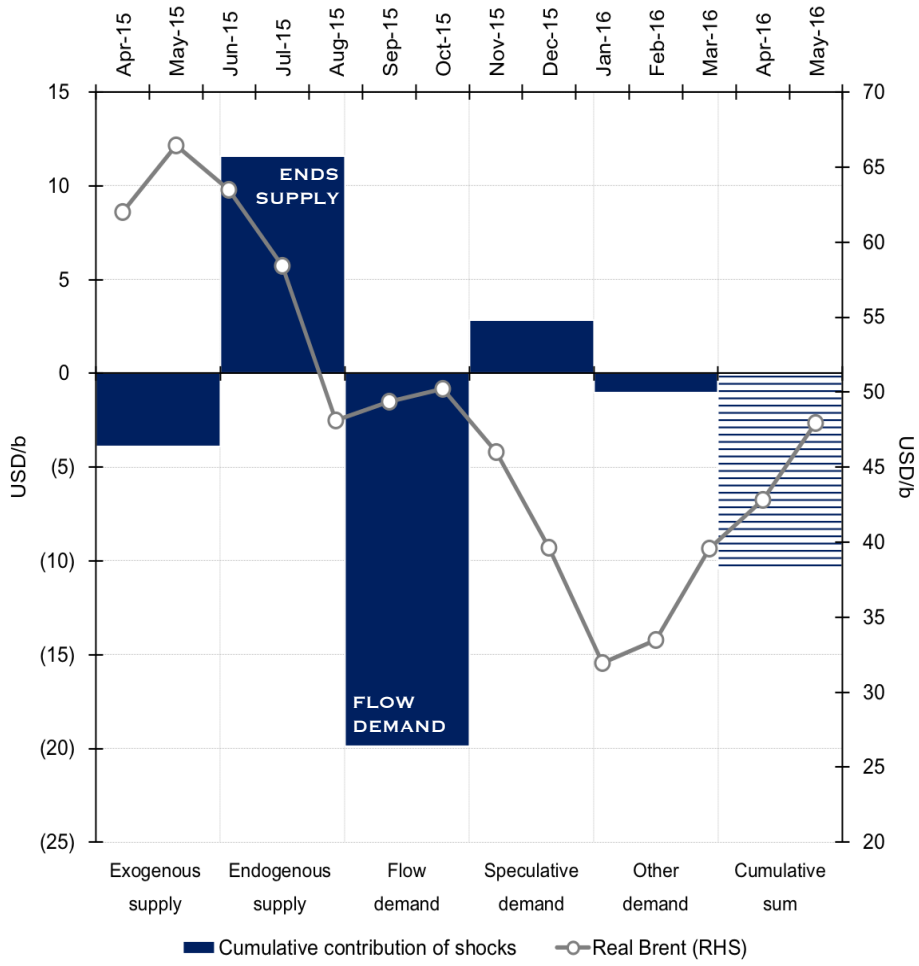
$+12_{/b}$ / $-10_{/b}$ Despite higher OPEC production in the entire period, cumulative endogenous supply pressures added about $12/b to the Brent price by May 2016. These were driven by the deepening non-OPEC declines within and outside the US that totalled to 1.7 mb/d.

$-20_{/b}$ / $-10_{/b}$ The negative flow demand shocks were the main contributors to the net decline of the Brent price between April 2015 to May 2016 by $20/b.

$-4_{/b}$ / $-10_{/b}$ The return of Iranian production in the wake of the sanctions lift more than offset the supply disruptions from Libya, Nigeria and Venezuela that combined reached close to 0.7 mb/d, dragging the Brent price lower by about $4/b.

$+3_{/b}$ / $-10_{/b}$ Precautionary demand fluctuated rapidly throughout the second cycle and resulted in adding about $3/b to the Brent price via positive movements in stock demand. Further bullish sentiment was built in early-2016 in light of the Doha meeting.

Cumulative contribution of the structural shocks to the Brent price (April 15 – May 16)



Data: Authors' estimations

Cycle 3: OPEC+ output cutback deal (1/3)

The long journey to reaching an agreement

Expansion (+0.9 mb/d):

In the months before the agreement, OPEC crude oil production reached another record level close to 34.0 mb/d. OPEC members were positioning themselves for long and difficult negotiations and it is always better for individual countries to negotiate from a higher level of output. Even non-OPEC oil producers who joined the discussions increased sharply their output, with Russian flows gaining up to 0.5 mb/d above a year ago driven by robust investment and the start-up of new projects.

Peak (at 1.0 mb/d):

Global oil supplies in November edged up to a record high 98.2 mb/d. The OPEC negotiations culminated in an agreement the same month to cut production by 1.2 mb/d, joined in December by an additional cut of 0.6 mb/d from eleven non-OPEC oil producers led by Russia with 0.3 mb/d.

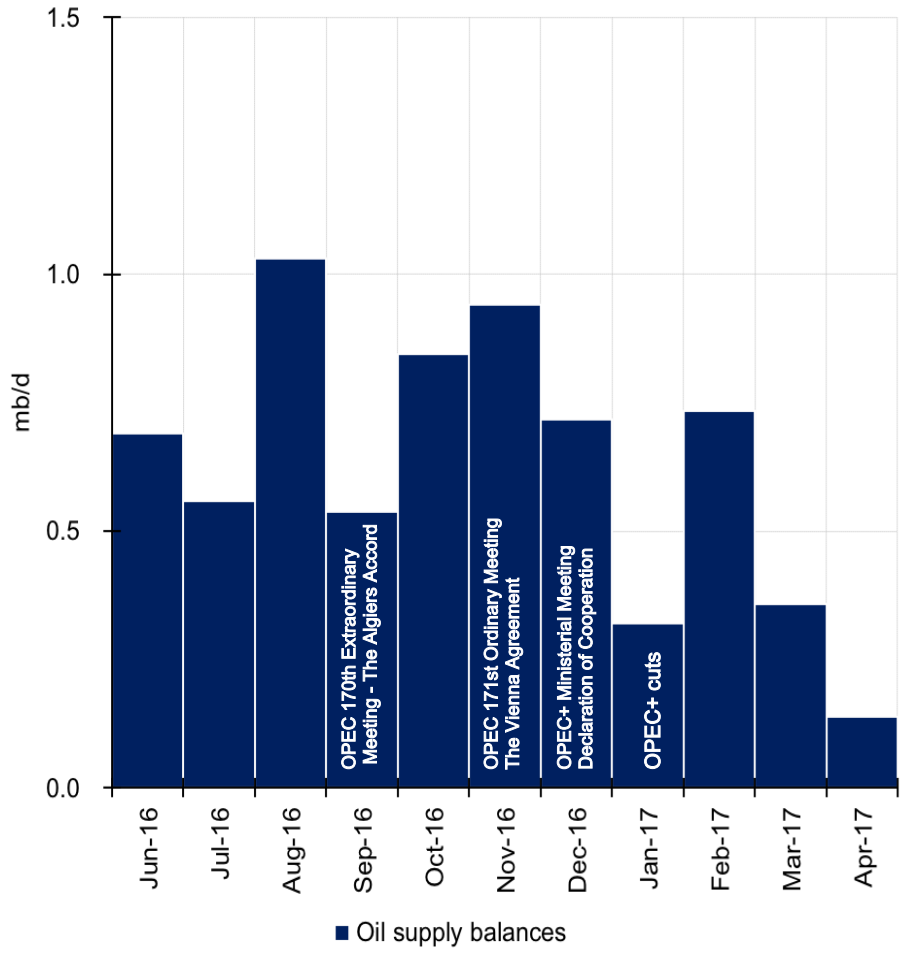
Contraction (-0.9 mb/d): :

Abided by their commitment to curb their production in January 2017, OPEC oil producers committed to cuts with unprecedented discipline followed by the less compliant but improving non-OPEC producers. Meanwhile, global economy kept picking up with a cyclical recovery in investment, manufacturing and trade that helped support the OPEC+ efforts to balance the market.

Trough (at 0.1 mb/d):

With non-OPEC compliance catching up and OPEC oil production continuing on target, the supply balances reached their tightest level for almost four years in April, falling below 0.1 mb/d. That said, downside risks originating from the return of US shale production were remaining unchecked.

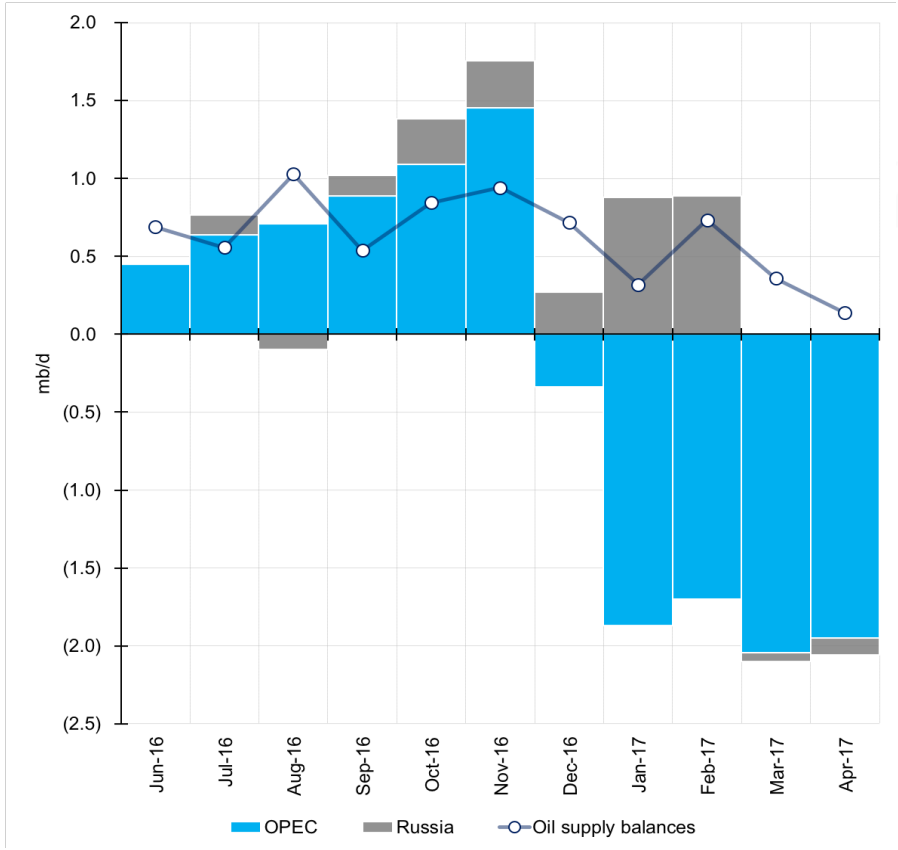
June 2016 – April 2017



Data: Authors' estimations

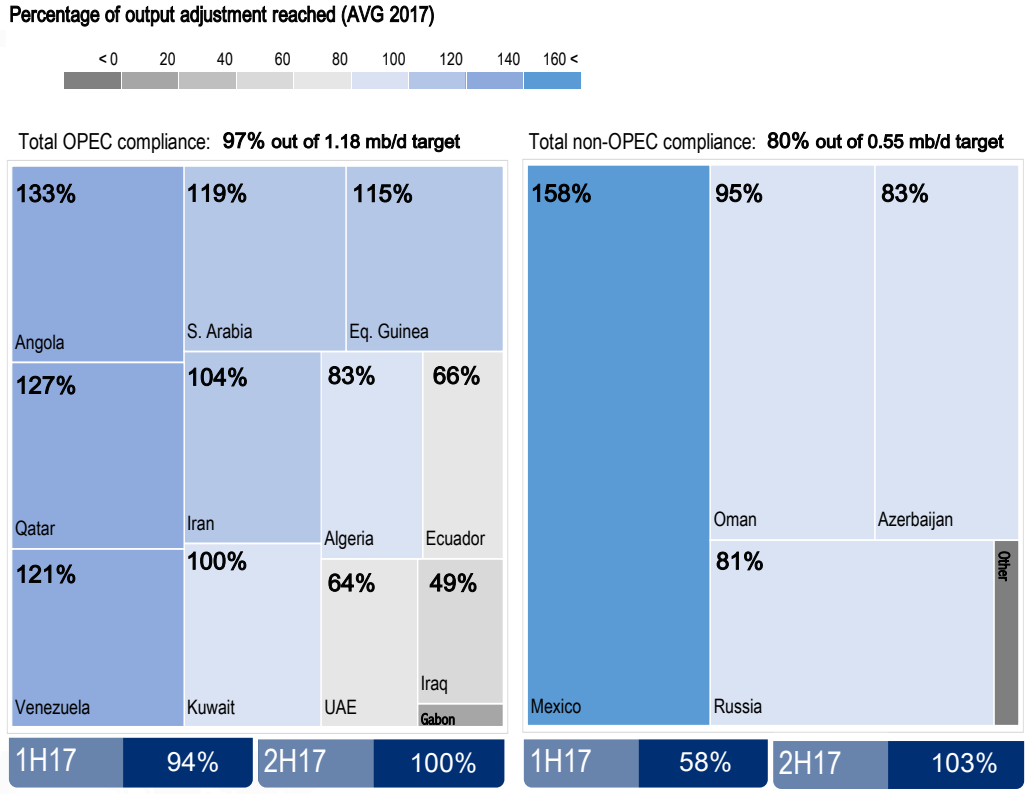
Cycle 3: OPEC+ output cutback deal (2/3)

OPEC and Russian crude oil production gains/losses



During build-up of the output-cut negotiations, OPEC oil producers boosted their production by nearly 1.5 mb/d, with half of that increase occurring in the course of three months between the 'Algiers Accord' in September and the 'Vienna Agreement' in November 2016 (0.75 mb/d). Outside OPEC, oil producers also prepared to join the agreement with an uplift to their output levels, with Russian production hitting a record-high above 11.0 mb/d.

OPEC and non-OPEC compliance levels



Unprecedented conformity levels achieved by OPEC oil producers in 2017 surprised the market and proved OPEC was fully committed in bringing market rebalancing forward. Seven out of the twelve participating OPEC producers curbed their output by more than pledged, although in some cases like for Venezuela the reductions were involuntary. Their non-OPEC counterparts performed relatively poorly in the first-half of 2017, but the majority followed suit in the remainder of the year.

Data: Authors' estimations, IEA

Cycle 3: OPEC+ output cutback deal (3/3)

OPEC means business

During build-up of output cut negotiations, increases from the OPEC+ producers kept prices relatively subdued, supported only by the increasing momentum of global economy. At the same time, the 18-months decline in US shale production unexpectedly halted near 4.1 mb/d in September 2016, before gaining slightly in the remainder of the year.

December 2016 price surge of about $9/b had little to do with a response to market fundamentals, but rather reflected a large speculative stock demand build-up in anticipation of the enforcement of the OPEC+ agreement in January 2017. As such, the price reacted only little to the upside in early-2017, as the response to the output cuts was already priced in. On the contrary, the price corrected to the downside in the following months reflecting the strong initial response from US shale production.

$-5/b

Despite the OPEC+ output cuts, the net cumulative impact of endogenous supply shocks on the Brent price was negative by $5/b. That is because the anticipated output declines were pre-channelled to the price through speculative demand and prices adjusted downwards due to the unexpected response of US shale production and lower non-OPEC compliance.

$+6/b

Global economic activity kept growth of global oil demand at a robust pace, adding to the Brent price near $6/b, despite fears that higher oil prices will trim back momentum. Annual demand growth remained above the 1.3 mb/d trend of 2010-2015, at 1.6 mb/d.

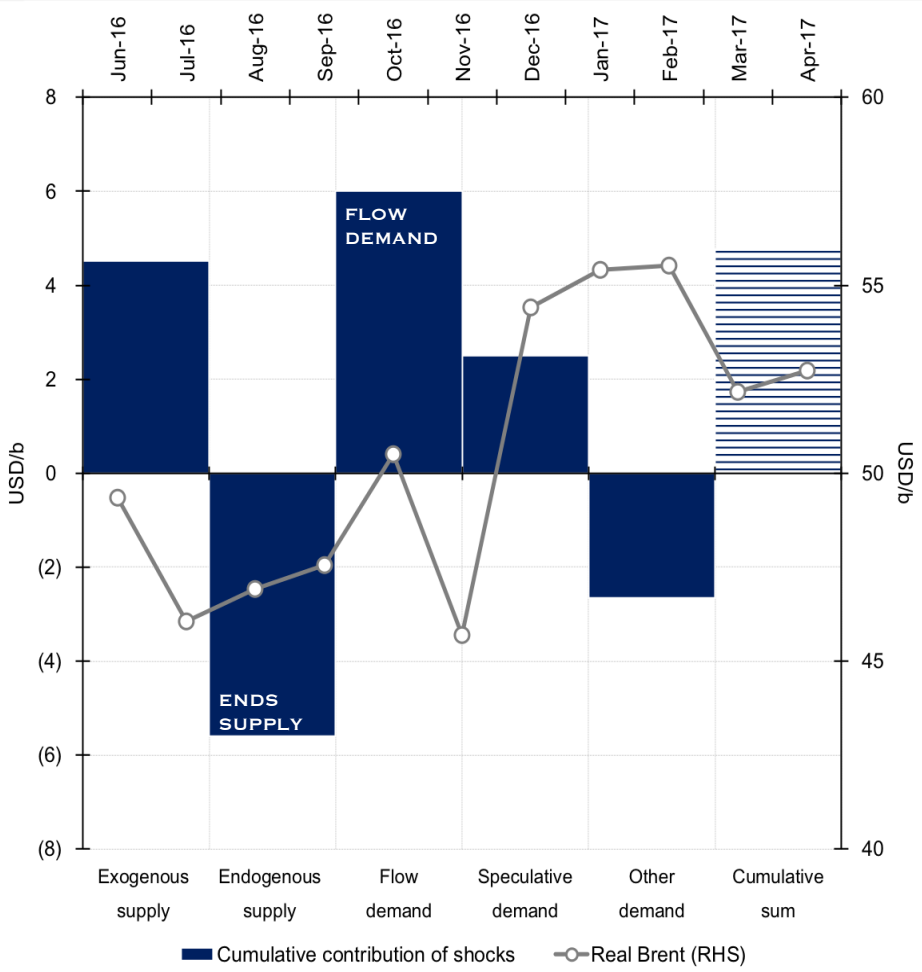
$+4/b

The accelerating declines in Venezuelan output that dropped by 0.3 mb/d relative to a year before and further intermittent losses in Nigerian and Libyan production accounted for $4/b to the cumulative price increase.

$+3/b

The one-time positive shock of speculative demand in anticipation of the OPEC+ cut enforcement was enough to turn around the bearish sentiment that prevailed after the unsuccessful Doha meeting and add about $3/b to the cumulative price increase.

Cumulative contribution of the structural shocks to the Brent price (June 16 – April 17)



Data: Authors' estimations

Cycle 4: OPEC's stock-cut target strategy (1/3)

The revival of US shale production

May 2017 – Ongoing

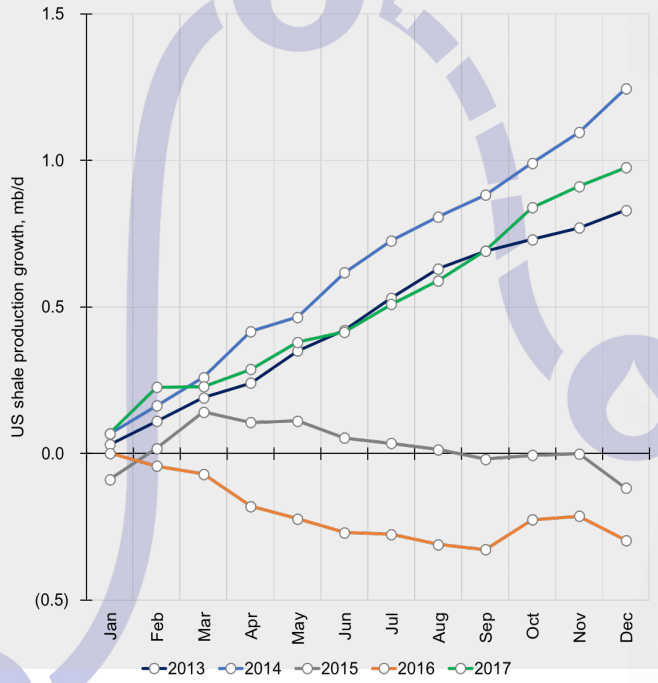
Expansion (+1.1 mb/d):

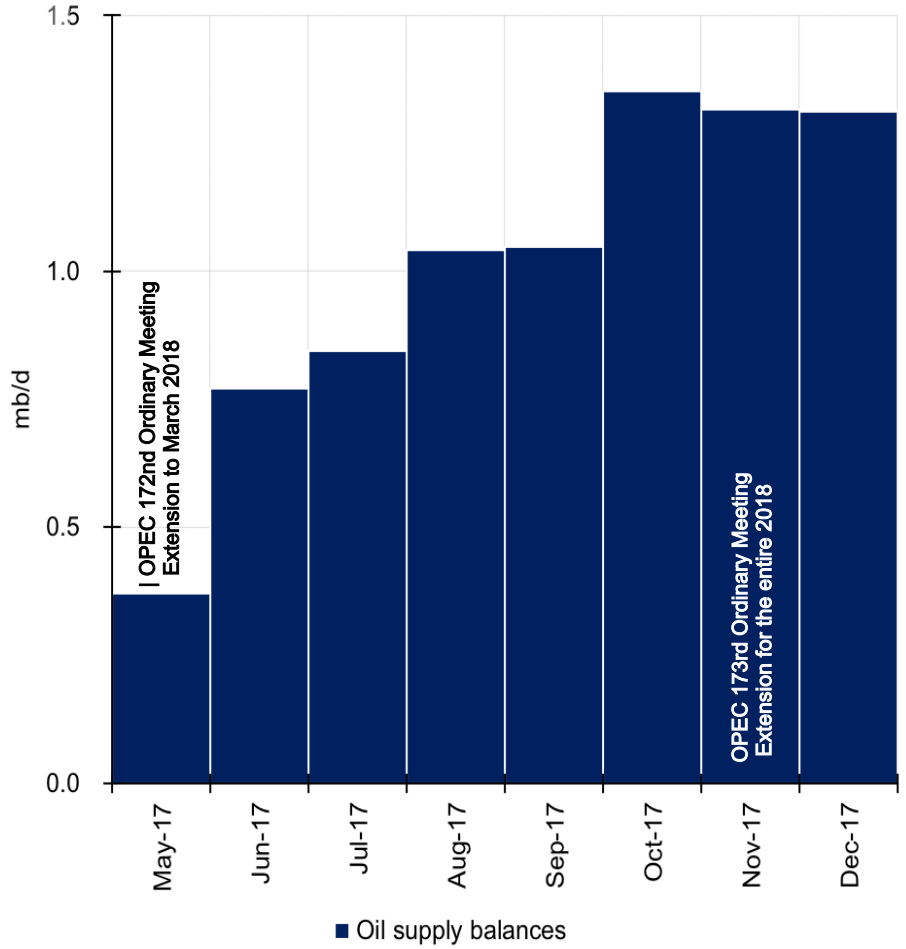
The growth in US shale production by another 0.6 mb/d in the remainder of 2017, which totaled near 1.0 mb/d year-end, marked the beginning of a new expansive cycle of excess oil supplies that surpassed 1.3 mb/d despite the OPEC+ output cuts. The short-run response of US shale producers was so strong that by the first-half of 2017, US shale production had already recovered above its previous peak in March 2015 (4.7 mb/d), offsetting around two-years worth of losses.

Annual growth of US shale production in 2017 been highest on record surpassed only in 2014. That said, total US crude oil production grew by nearly 0.5 mb/d, surpassing 10.0 mb/d.

Future growth of US shale output, however, remains highly sensitive to productivity performance, reduced costs, access to finance and oil prices.

Furthermore, with investors that backed-up US shale during the downturn now pushing for more cash to dividends, the US shale producers are faced with a stark dilemma: keep producing or start returning some cash.

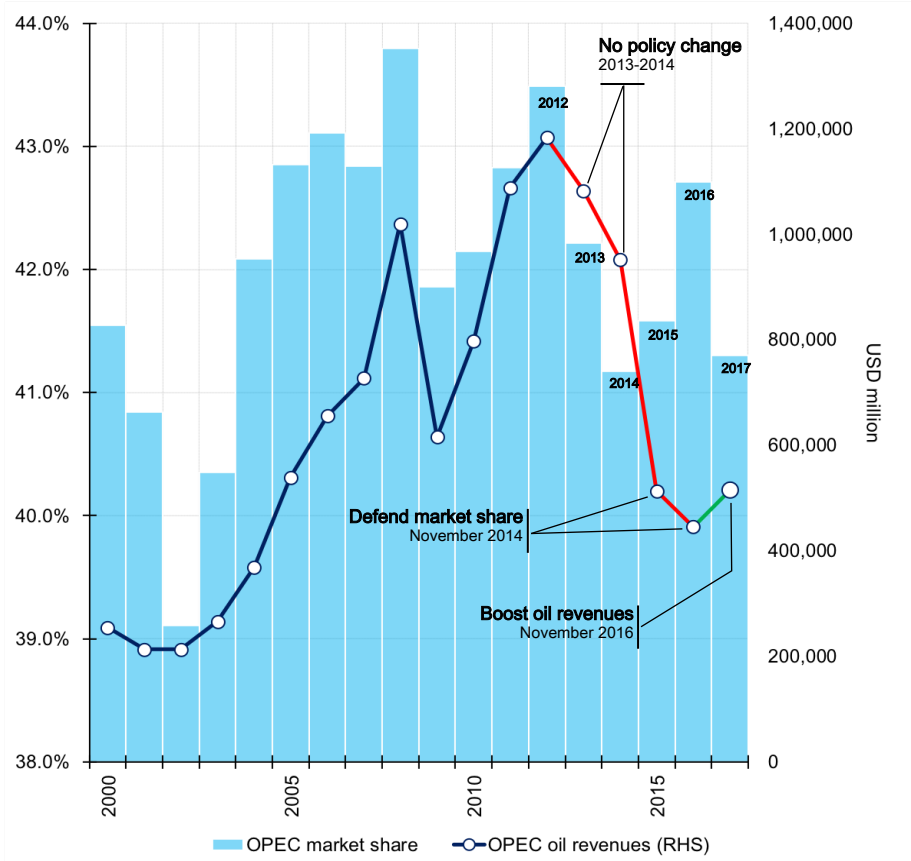




Data: U.S. EIA, Rystad Energy, Authors' estimations

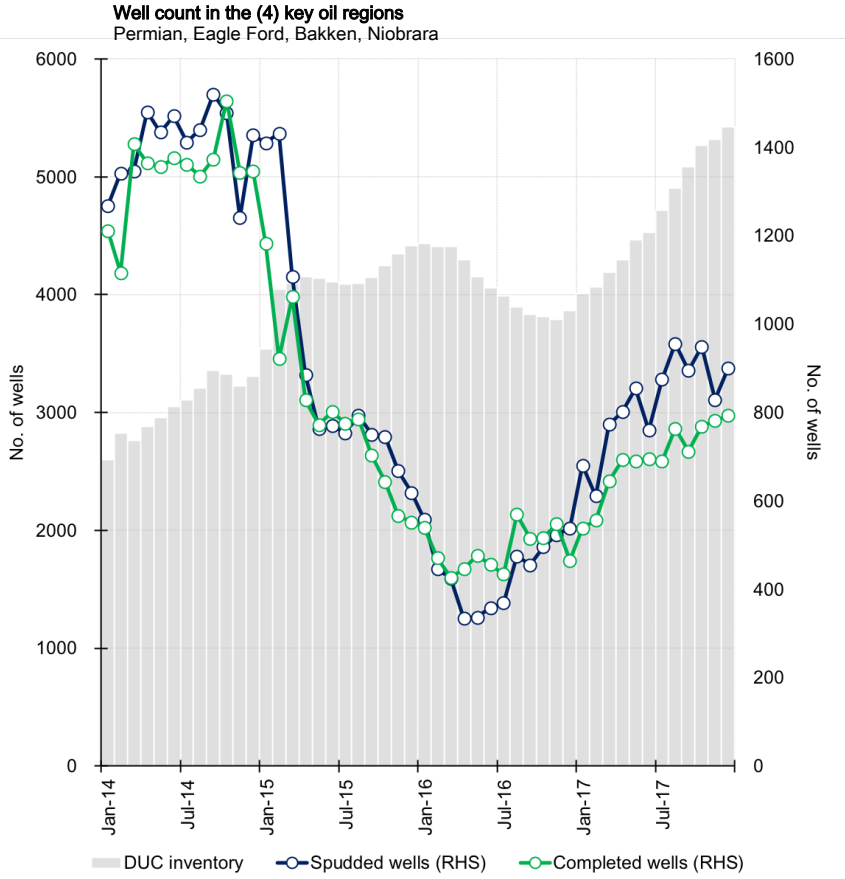
Cycle 4: OPEC's stock-cut target strategy (2/3)

OPEC market share vs oil revenues



Most important win for OPEC ending-2017 was reversing its oil revenues back to growth by 16%, albeit at expense of losing market share. At other end of the spectrum, the oil price run-up in 2017 also improved US shale outlook.

US shale wells drilled, completed and DUC inventory



The higher oil prices in 2017 amid a significant reduction in breakeven costs led to a sharp recovery in drilling activity, as well as to growth of DUC inventory.

Data: OPEC, U.S. EIA, Authors' estimations

Cycle 4: OPEC's stock-cut target strategy (3/3)

Conditional success

The rapid growth in US shale production by another 0.6 mb/d in the remainder of 2017 reaching near 1.0 mb/d year-end, marked the beginning of a new expansive cycle of excess oil supplies despite the subdued production from OPEC. The momentum of global oil demand to the upside is obscuring for now the impact from the return of shale production, but as we enter 2018 the risks to the downside remain unchecked. In the absence of strong demand and considering the high short-run responsiveness of US shale supply, it would have been difficult for the Brent price to brake the $50-55/b mark in 2017.

$-4_{/b}$ / $12_{/b}$

The strong ongoing US shale recovery kept contribution of endogenous supply shocks largely subdued in second half of 2017, resulting to a net negative cumulative impact of $4/b to the Brent price. However, higher compliance of OPEC+ oil producers to output cutbacks limited this negative impact by $1/b relative to the first half of the year.

$+12_{/b}$ / $12_{/b}$

Global economic activity kept surprising to the upside in 2017, growing by 3.7% y-o-y, which is 0.3 percentage points faster than projected a year before and hence, accounting for about $12/b to the cumulative Brent price increase.

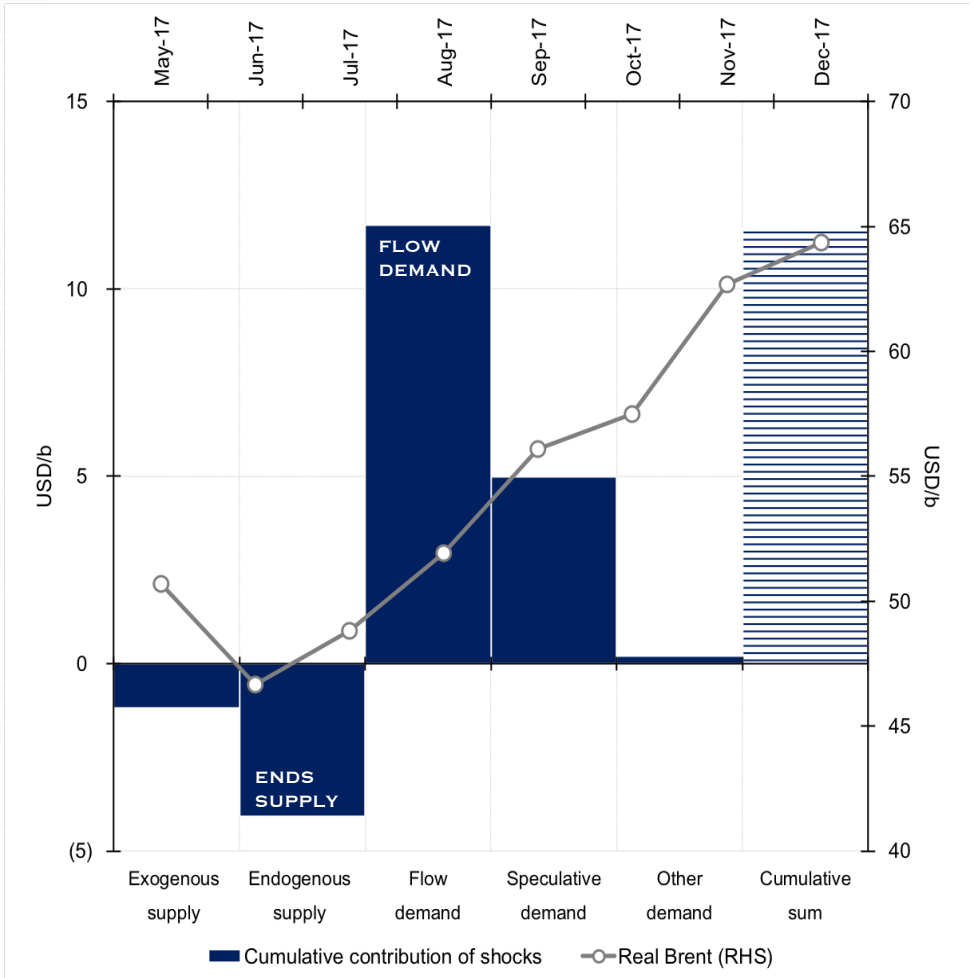
$-1_{/b}$ / $12_{/b}$

Unexpected gains in Libyan production close to 0.4 mb/d year-end continued to offset over 0.3 mb/d output losses from Venezuela and Nigeria combined, causing prices to undershoot by an additional $1/b.

$+5_{/b}$ / $12_{/b}$

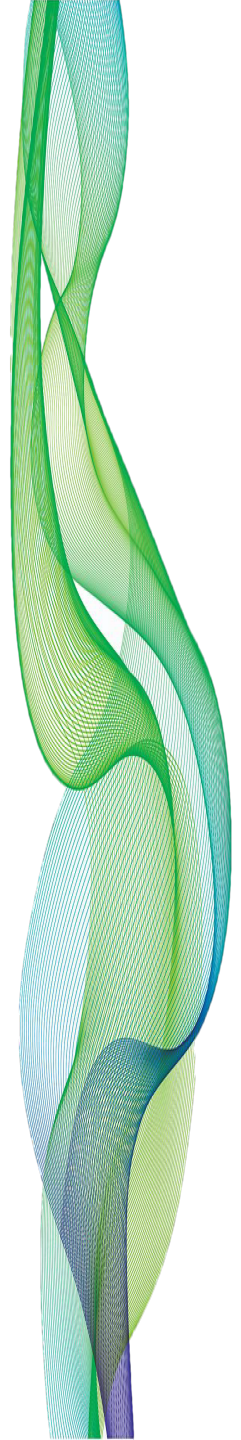
Despite the absence of significant supply disruptions, the geopolitical context in the MENA region deteriorated sharply due to a variety of armed conflicts and intra-regional tensions increasing storage demand and adding to the price about $5/b.

Cumulative contribution of the structural shocks to the Brent price (May 17 – Dec 17)



Data: Authors' estimations

OPEC oil output policy in prospect



OPEC oil output policy in prospect (1/2)

Lessons drawn from the recent cycles

1. Targeting the five-year average of stocks, however defined, is a weak guide for OPEC's oil output policy decisions.

The level of oil stocks is a backward-looking indicator and data outside OECD, oil stored at sea and oil in transit lack transparency. Most importantly targeting OECD oil stocks per se neglects important information about the global supply-demand conditions underlying the oil market. The decision as to whether OPEC should exit or not its current oil policy should be based on forward-looking measures.

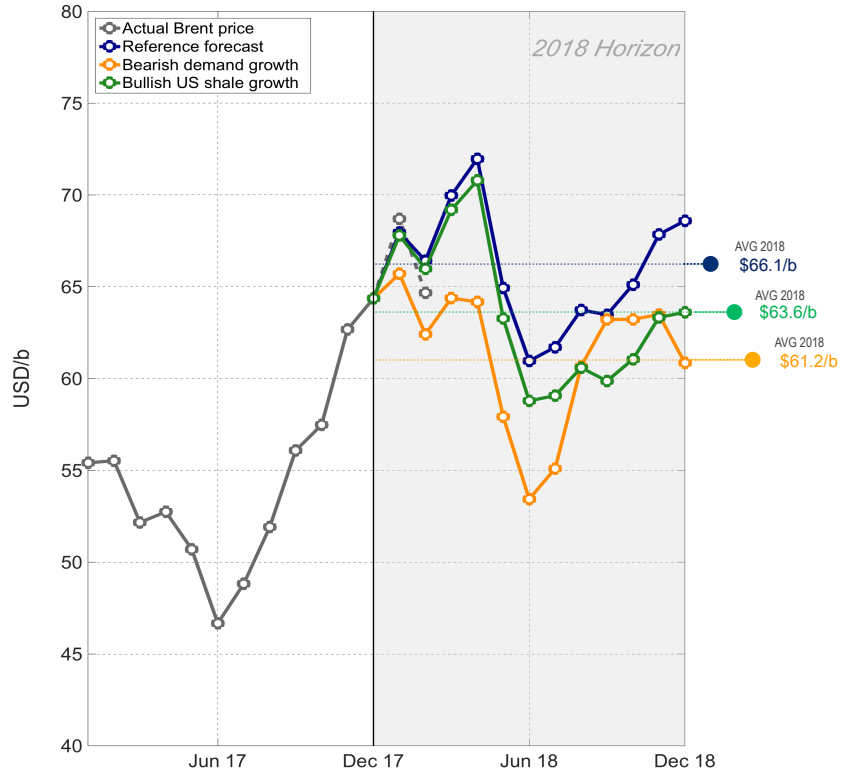
2. The 'success' of OPEC's current oil output policy has been largely demand-driven, as was the 'failure' of its previous high-output strategy during the 2015-2016 cycle.

OPEC's high-output strategy helped drained the global glut. Its failure to support prices however and in turn OPEC oil revenues, the latter prompting the policy reversal, was explicitly due to the bad timing of OPEC's high output strategy coinciding with a negative demand shock.

A key factor that should be shaping the current OPEC oil policy is the expected strength of global demand growth. The evidence from the latest cycles shows that in presence of a new source of supply which is highly responsive to price signals, demand related shocks become far more important for shaping price dynamics and OPEC behaviour.

Oil prices in 2018 more sensitive to the downside to a downward revision of global demand growth rather than an equivalent upward revision of US shale supply growth. All else remaining equal, a slower-than-expected pace of global growth to 1% would draw prices lower by $5/b relative to our reference case ($66/b), which is twice as much as the expected price decline caused by a stronger-than-expected US shale growth to 1.6 mb/d ($2.5/b).

Forecast scenarios of the Brent price in 2018



Assumptions for 2018	Reference	Bearish demand	Bullish US shale
Global demand growth (y-o-y)	1.3 mb/d (1.4%)	0.9 mb/d (1.0%)	1.3 mb/d (1.4%)
US shale growth (yr-end)	1.2 mb/d	1.2 mb/d	1.6 mb/d

Data: Authors' estimations

OPEC oil output policy in prospect (2/2)

Lessons drawn from the recent cycles

3. OPEC has resolved a key uncertainty regarding the US shale response to price signals in both directions, meaning that it can now set its price-target more cautiously.

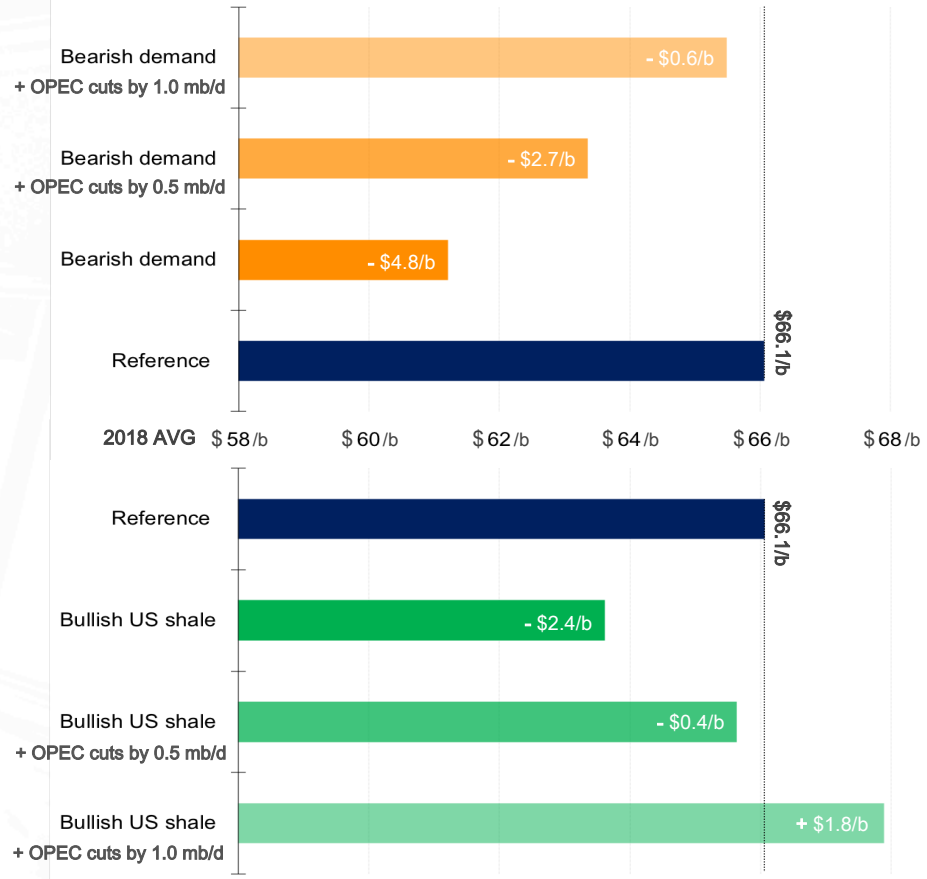
Choosing its future optimal output strategy, OPEC has resolved a key uncertainty pertaining to high short-run responsiveness of US shale supply. To the downside, US shale producers showed resilience and the declines were not as sharp as originally expected. To the upside, US shale response was stronger-than-expected having carried-forward from the previous downcycle all the perks: slashed costs, higher productivity and fiscal consolidation. Whatever strategic path OPEC decides to follow in the future, it can now anticipate with less uncertainty what would be the response to the supply-side.

4. OPEC's current oil policy hinges heavily on the prospects of future demand growth and downside risks to global economy constitute a key uncertainty for achieving its goals.

Current talk of potential 'trade wars' could dampen growth and hence it should constitute a serious source of concern for OPEC. If current demand growth momentum is lost and OPEC decides to deepen its output cuts to balance the market, it would need to curb over 1.0 mb/d on top of the current pledge for prices to return above $65/b (assuming global growth falls to 1%). On the contrary, it would only take 0.5 mb/d in case OPEC chooses to tackle higher-than-expected US shale growth to reach the same price target (assuming US shale growth reaches 1.6 mb/d year-end). This evidence further supports the importance of demand-specific risks shaping OPEC behaviour in the current cycle.

- If global demand continues to surprise on the upside, OPEC will most likely maintain current strategy and may decide to release some of the withheld crude back to market.
- If global demand growth surprises to the downside, OPEC choices become very stark: OPEC could either decide to cut output or shift towards a higher output strategy. Both choices carry hefty risks reflecting delicate situation that OPEC finds itself in.

Price responses to OPEC deepening its output cut as of July 2018, under alternative assumptions about prevailing s-d conditions



Data: Authors' estimations

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Bassam Fattouh, Director OIES
Andreas Economou, Research Associate OIES

March 2018

Oxford Institute for Energy Studies

Appendix

Understanding the index of global oil supply balances (1/5)

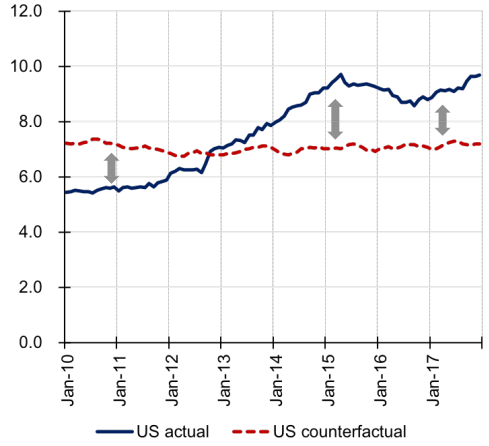
Constructing the index (example)

Thought experiment: Imagine a world with only two oil producers,

(1) **the United States** (US), being a net importer and price taker; and
(2) **Saudi Arabia** (KSA), being a net exporter and price maker.

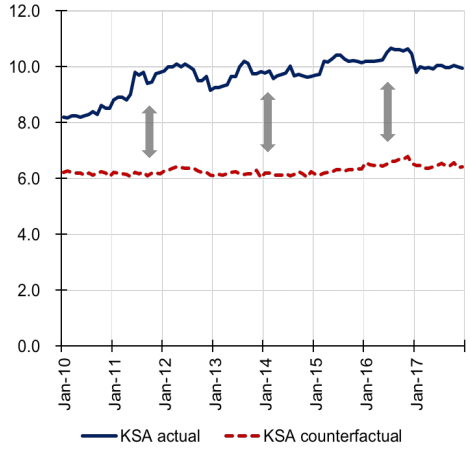
STEP 1: The counterfactual assumption *(what-if)*

- What-if, at each point in time, crude oil production from both these countries could grow at a rate approximately equal to the growth rate of their domestic consumption.



For the net importer (i.e. the US):

The objective is to estimate that *residual amount* of oil production that needs to be covered by imports drawn from KSA.

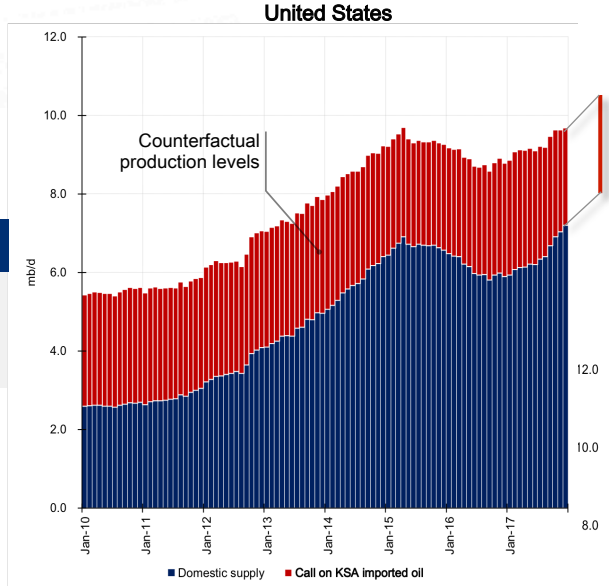


For the net exporter (i.e. KSA):

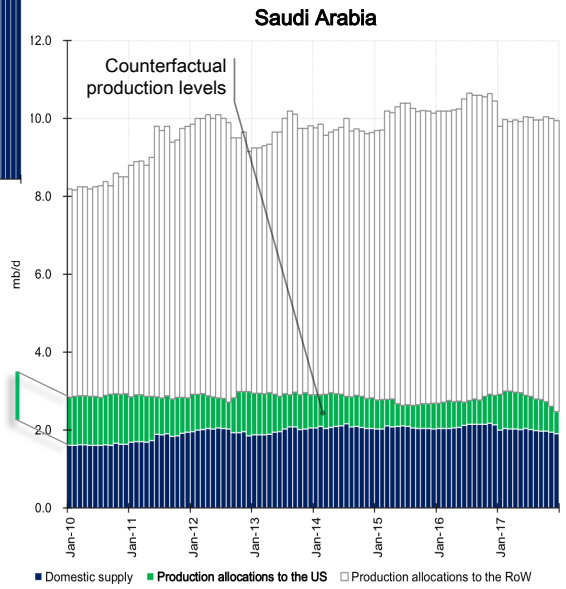
The objective is to estimate that *surplus amount* of oil production that is available for exports, given that it covers in principle its own domestic needs.

STEP 2: The equilibrium condition (*weights*)

- The intuition is straightforward: through petroleum inter-regional movements they should offset one another thus determining the equilibrium production path.



Amount of US oil consumption at month *t* that cannot be covered by US domestic oil production



Amount of KSA oil production at month *t* allocated for exports in the US

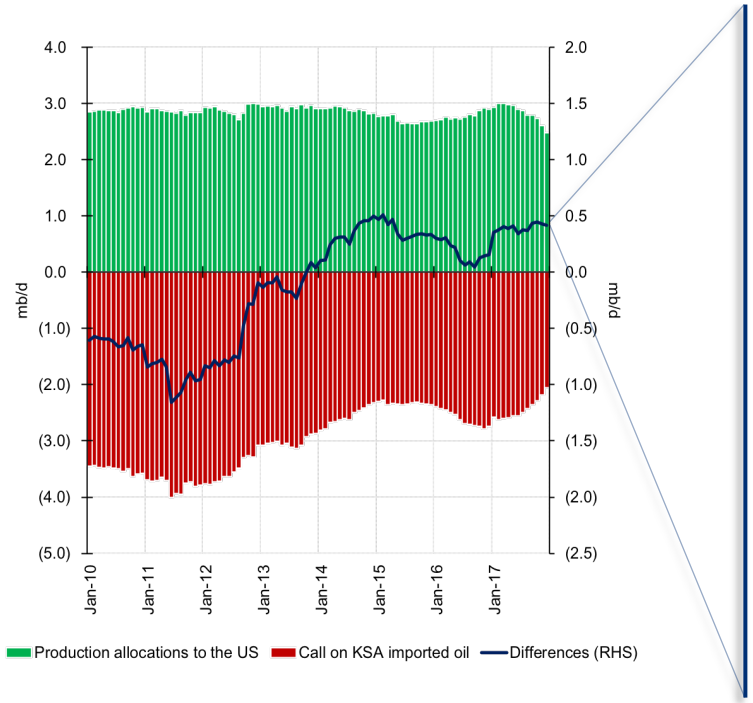
Data: All figures are based on exemplary data.

Understanding the index of global oil supply balances (2/5)

Constructing the index (example cont.)

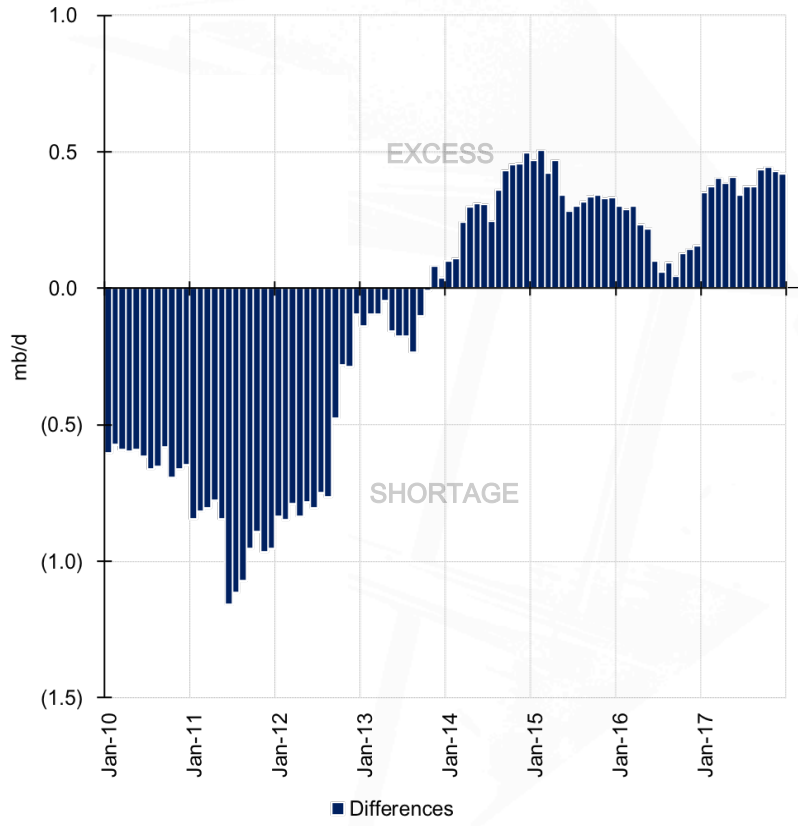
STEP 3: Constructing a measure of global crude oil production balances

Estimating the timing, magnitude and sign of any deviations of global oil production from the equilibrium production path.



By summing the KSA surpluses and US shortages of crude oil production derived by Steps 1 and 2, it is possible to construct an aggregate measure of global crude oil production balances at monthly frequency, referred to as *index of global oil supply balances*.

Index of global oil supply balances



(*def.*) Oversupply:

Current and expected increases in oil production run ahead of current and expected oil demand.

(*def.*) Undersupply:

Current and expected oil production is unable to meet the current and expected increases in oil demand.

Data: All figures are based on exemplary data.

Understanding the index of global oil supply balances (3/5)

The undersupply situation (example cont.)

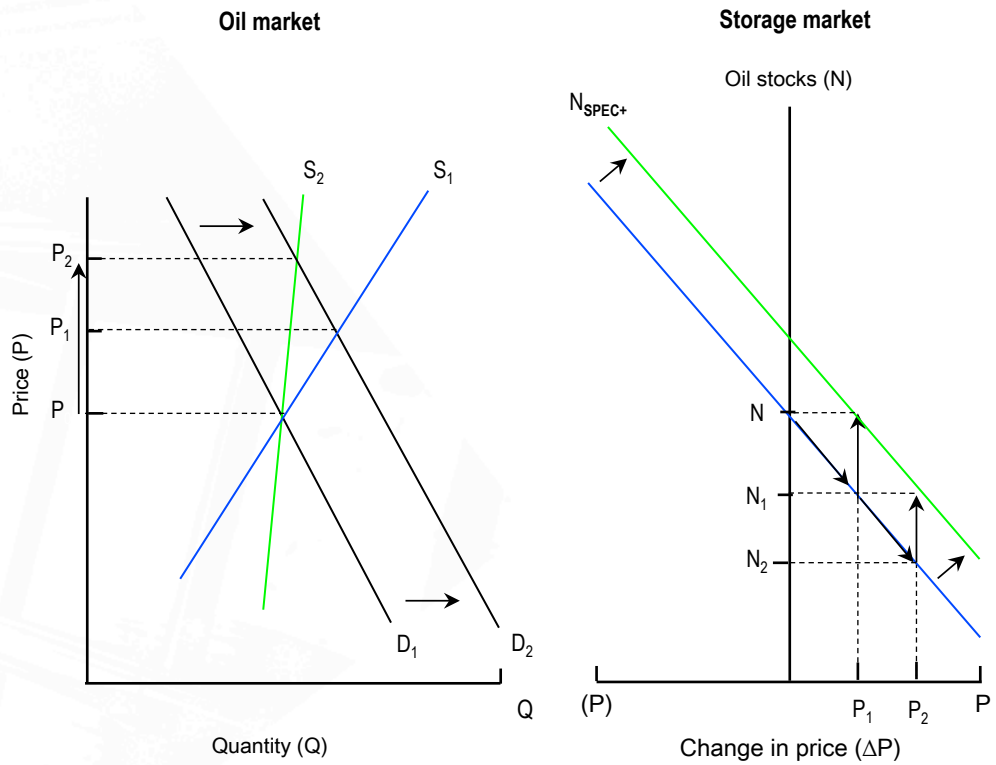
Consider in our example that the US experiences a positive demand shock represented by a shift to the right of the downward-sloping oil demand curve (D_2) along the upward-sloping oil supply curves (S_1 and S_2):

Given that KSA is a price-maker and has the ability to adjust its oil production by holding spare capacity, the ability and willingness of Saudi Arabia to expand its production and meet the US demand shock will effectively determine the impact on price and stocks. Indicatively,

- If KSA has enough spare capacity to serve the build-up in US demand, hence the supply curve is relatively elastic (S_1), both the price increase (P_1) and stocks withdrawn (N_1) will be modest.
- If however the supply curve is relatively inelastic (S_2), according to which KSA spare capacity is thin, the same positive shift of the demand curve will generate twice as large a price increase (P_2) and stocks withdrawn (N_2).
- Moreover, the tighter the future market conditions are expected to be (i.e. the steeper the supply curve), the higher the positive shift in precautionary demand (N_{SPEC+}), which will counteract the true impact of the market imbalance on actual stock levels insofar as oil stocks remain constant (N_1 returns to N), or move only to a small extent (N_2 returns to N_1).

Hence, a situation in which the market is under-supplied does not necessitate that oil inventories will decline unless a positive demand shock is strong enough to trigger such a response, or spare capacity is thin, or the price is known to have fully adjusted to the shortfall in crude oil production and the shortfall is known to be temporary.

Simulating the market responses in an undersupplied case



Source: Constructed by the authors

Understanding the index of global oil supply balances (4/5)

The oversupply situation (example cont.)

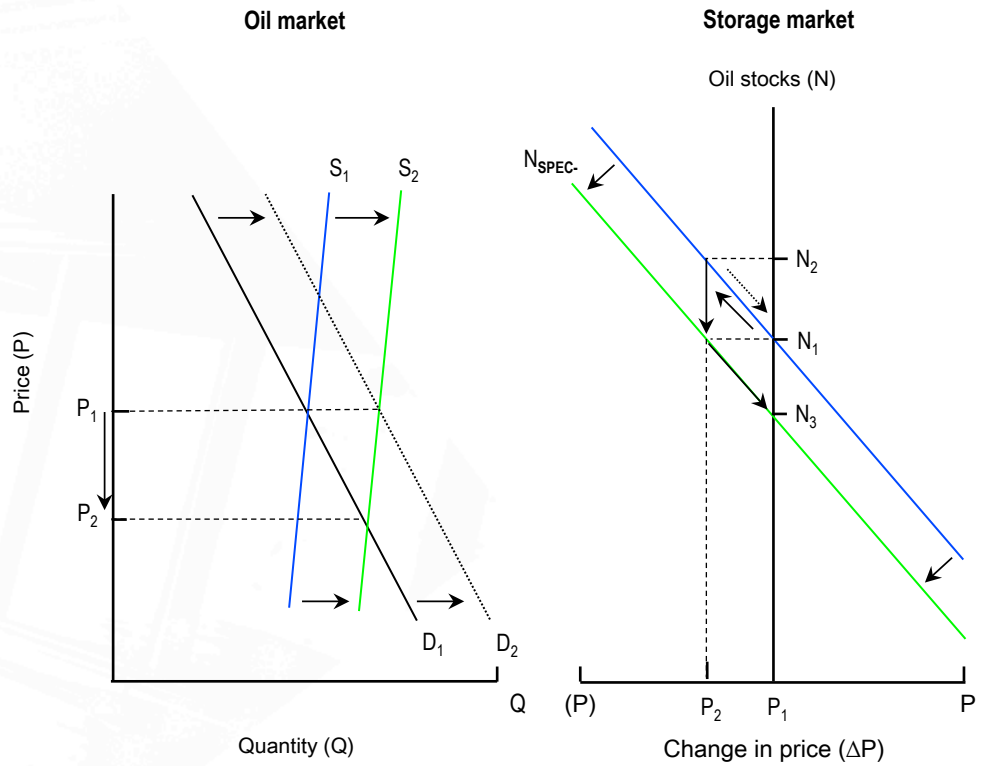
Consider in our example that the US experiences a positive supply shock represented by a shift to the right of the upward-sloping oil supply curve (S_2) along the downward-sloping oil demand curve (D_1):

Given that KSA is a price-maker and has the ability to adjust its oil production by holding spare capacity, the willingness of Saudi Arabia to shut-in operating capacity and cede its market share will effectively determine the impact on price and stocks. Indicatively,

- Unless the high-cost US production exits the market due to lower oil prices (return to S_1), the only way to resolve the market oversupply is for KSA to adjust its production by shutting-in operating capacity. Until then oil stocks will build-up (N_2) to smooth out excess supplies.
- However, the net impact on actual stock levels will be determined by the responsiveness of oil demand (D_2) to a lower price, insofar as stocks could return to initial levels (N_1).
- A negative shift in precautionary demand reflecting expectations of weakening future oil market conditions ($N_{SPEC.}$) in conjunction with growing oil demand (D_2) can result to oil supply balances and oil stocks moving to opposing directions (N_3). The former increasing while the latter decreasing.

Hence, a situation in which the market is over-supplied does not necessitate that oil inventories will increase unless the responsiveness of oil demand and non-OPEC supply to a lower price remains low, or the price is known to have fully adjusted to excess supplies and the latter are known to be only temporary. Conversely, excess supplies can be building up while oil stocks are declining as long as the market participants don't expect the rebalancing to last.

Simulating the market responses in an oversupplied case



Source: Constructed by the authors

Understanding the index of global oil supply balances (5/5)

Index of global oil supply balances

The true sample includes the actual and *counterfactual* production levels from a list of selected oil importing/exporting producing-countries constituting 80% of global oil production, namely:

- the United States (US);
- China (CHI);
- Total OPEC (by country);
- Russia (RUS);
- Canada (CAN);
- Mexico (MEX); and
- the North Sea (NS).

For the computation of *weights*, the index also takes into account the growth rates of oil consumption of the preceding list of countries, as well as Japan, India and Europe representing about 80% of total oil consumption.

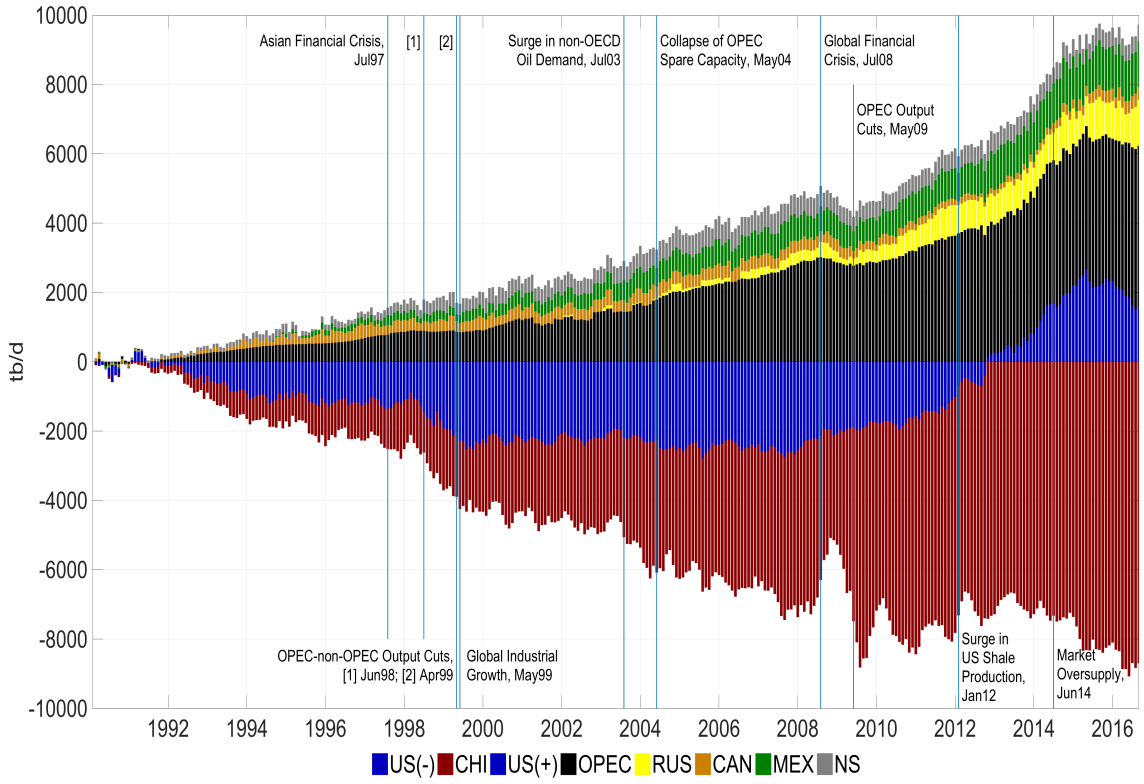
Finally, the index considers any amount of available spare capacity in total OPEC above the 2.0 mb/d buffer, as reported by the U.S. EIA.

The sample period extends from January 1990 to December 2017 and it is isolated from any exogenous geopolitical supply disruptions.

- For further details on the construction of the index see:

Economou, A. 2016. Oil Price Shocks: A Measure of the Exogenous and Endogenous Supply Shocks of Crude Oil. Oxford Institute for Energy Studies. WPM 68.

Cover/exposed levels in crude oil production from selected oil producers



Data: Authors' estimations