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OPEC at 60: The World With and Without OPEC

Bassam Fattouh and Andreas Economou
Oxford Institute for Energy Studies

Technical Workshop on OPEC at 60: Contributions to the Global Economy and Energy Markets
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An historical perspective

We explore the historical contribution of OPEC for global oil market stability since 1990

- Analysis builds on a methodology simulating counterfactual outcomes in the rich context of state-of-the-art structural VAR models of the world oil market and concludes by employing a CGE model to determine the global welfare implications of OPEC's spare capacity.
- Imagine a world with (**actual**) and without (**counterfactual**) OPEC, in which counterfactual scenario OPEC is producing at maximum capacity and hence, has held no spare capacity and no balancing role since 1990.
- We assess the importance of OPEC during its modern history and quantify its impact on the functioning of the global oil market in terms of the historical evolution of oil production, prices, volatility, supply-demand elasticities and global stocks, as well as on global welfare.
- Analysis concludes with the importance of the more recent historic Declaration of Cooperation between OPEC and non-OPEC producers for the rebalancing of the global oil market after the 2014/16 oil price collapse.

Methodology

The workhorse model of the World Oil Market

4-variable structural VAR

Counterfactual analysis builds on a four-variable structural VAR model in the tradition of Kilian and Murphy (2014)[1] that decomposes the oil price to its components driven by flow supply, flow demand and speculative demand.

Flow supply shock: shocks to crude oil supply that arise from geopolitical episodes, the output decisions of oil producers and other supply shocks.

Flow demand shocks: shocks to the demand for immediate consumption associated with fluctuations in the global business cycle.

Speculative demand shocks: shocks to stock demand reflecting the forward looking behaviour of the market participants.

Other demand shocks: Other idiosyncratic shocks not captured by the preceding structural shocks.

In constructing the **counterfactual** we replace the estimates of the flow supply shock ε_t^1 from 1992 to 2018 by counterfactual values reflecting the path of global oil production in the absence of OPEC spare capacity and follow Kilian (2016)[2] in providing explicit estimates of the impact on monthly Brent price.

Model representation

$$y_t = (\Delta prod_t, rea_t, \Delta rpo_t, \Delta stocks_t)'$$

Percent-changes in global oil production

Level-changes in global oil stocks

Real economic activity index

Real price of oil

Identification procedure

$$B_0 y_t = \alpha + \sum_{i=1}^{24} B_i y_{p-i} + \varepsilon_t, \text{where } e_t = A_0^{-1}\varepsilon_t$$

	Flow supply	Flow demand	Speculative demand
Oil production	–	+	+
Real activity	–	+	–
Oil price	+	+	+
Inventories	.	.	+
Supply elasticity bound		≤ 0.025	
Demand elasticity bounds		$-0.8 \leq elas \leq 0$	

[1] L. Kilian and D.P. Murphy (2014), The Role of Inventories and Speculative Trading in the Global Oil Market for Crude Oil, *Journal of Applied Econometrics, 29, 454-478.*

[2] L. Kilian (2016), The Impact of the Fracking Boom on Arab Oil Producers, *Energy Journal,* 38(6), 2017, 137-160.

Not all oil supply shocks are alike

5-variable structural VAR

Recently, Economou et al. (2017)[3] refined the SVAR oil market model due to Kilian and Murphy (2014) to further decompose the supply components of the oil price to supply shocks that are explicitly associated with geopolitical disruptions (**exogenous supply shocks**) and those that arise from within the oil market by the output decisions of oil producers (**endogenous supply shocks**), along its demand-driven components.

This distinction is important because the impact of each distinct type of supply shock on oil prices differs greatly, both in terms of magnitude and duration.

Model representation

$$y_t = (prod_t, cap_t, rea_t, \Delta rpo_t, \Delta stocks_t)'$$

- $prod_t$: Measure of OPEC supply disruptions
- cap_t: Measure of global crude production balances
- rea_t: Real economic activity index
- Δrpo_t: Real price of oil
- $\Delta stocks_t$: Level-changes in global oil stocks

Identification procedure

	Exogenous supply	Endogenous supply	Flow demand	Speculative demand
OPEC disruptions	–	.	.	.
Global crude balance	+	–	+	+
Real activity	–	+	+	–
Oil price	+	+	+	+
Inventories	.	–	.	+
Supply elasticity bound		≤ 0.025		
Demand elasticity bounds		$-0.8 \leq elas \leq 0$		

[3] A. Economou, P. Agnolucci, B. Fattouh, V. De Lipsis (2017), A Structural Model of the World Oil Market: The Role of Investment Dynamics and Capacity Constraints in Explaining the Evolution of the Real Price of Oil, Oxford Energy Insight: 23.

Historical evolution of oil supply and demand elasticities

Time-varying parameter VAR

Model representation

Having estimated the historical evolution of the oil price in the absence of OPEC's spare capacity based on the counterfactual production path, we employ a Bayesian structural VAR oil market model with time-varying parameters (TVP-VAR) and stochastic volatility in the innovation process in the spirit of Baumeister & Peersman (2013)[4].

This framework enables the assessment of the joint evolution of the short-run price elasticities of oil supply and demand at each point in time.

$$y_t = (\Delta prod_t, rea_t, \Delta rpo_t)'$$

Percent-changes in global oil production

Real economic activity index

Real price of oil

Identification procedure

	Flow supply	Flow demand	Other demand
Oil production	–	+	+
Real activity	–	+	–
Oil price	+	+	+
Supply elasticity bound	n/a	We remain relatively agnostic to the bounds of the oil supply and demand elasticities in the TVP-VAR, as the objective is to assess the extent to which the slope of the oil supply and demand curves have varied over time.	
Demand elasticity bounds	n/a		

[4] C. Baumeister and G. Peersman (2013), The Role of Time-Varying Price Elasticities in Accounting for Volatility Changes in the Crude Oil Market, *Journal of Applied Econometrics*, 28, 1087-1109.

Welfare impacts calculations

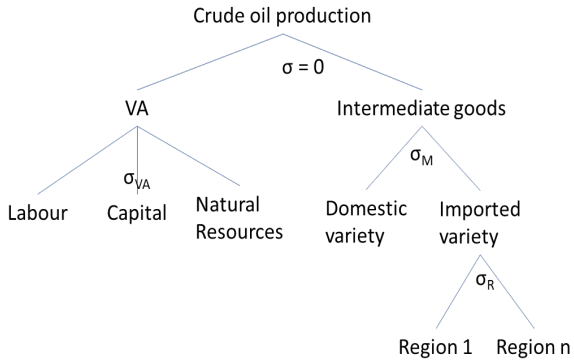
Global CGE model

The GDP impacts are determined for two types of supply shocks in the CGE framework:

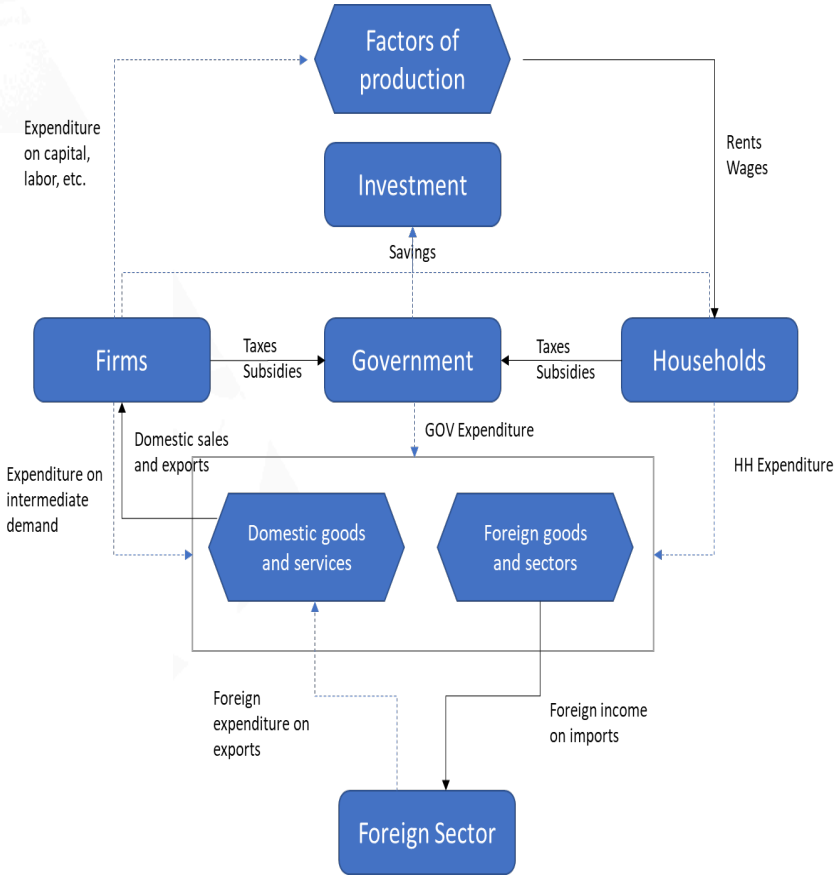
- OPEC produces at maximum capacity in the absence of exogenous supply shocks.
- Exogenous production shortfalls elsewhere under full capacity utilisation in OPEC countries.

The welfare impacts are obtained by combining the actual and counterfactual oil prices obtained by the SVAR, as well as the actual and counterfactual production paths, with the annual GDP response curves obtained by the results of the CGE sensitivity analyses.[5]

Crude oil production technology



Circular flow of income in CGE model

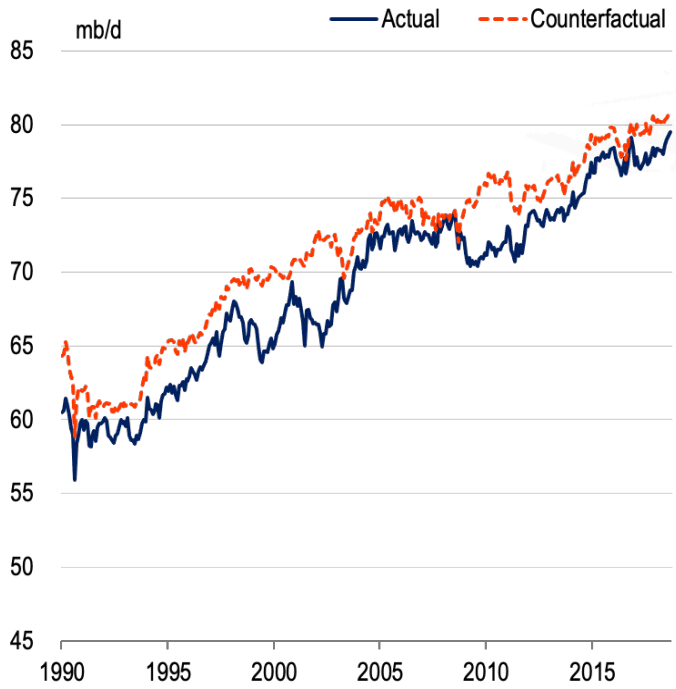


[5] With contribution of Victor Nechifor, Research Associate, UCL Institute for Sustainable Resources.

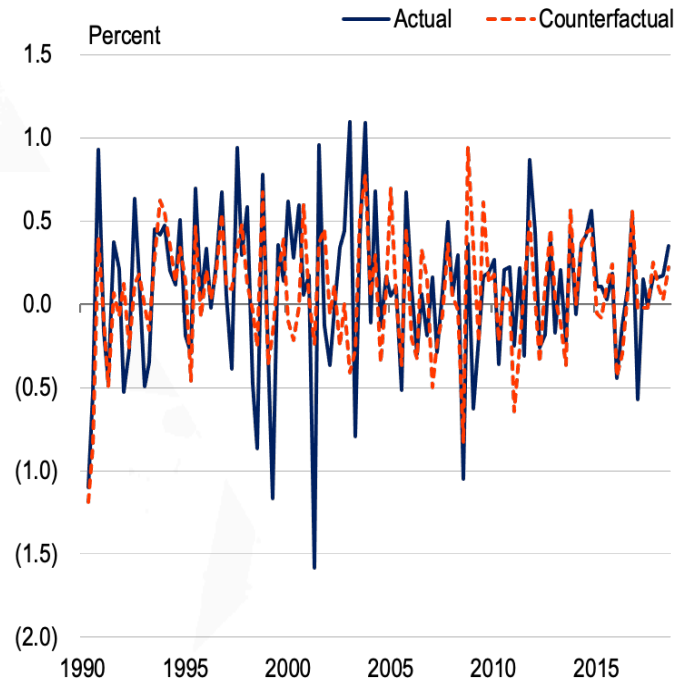
The world with and without OPEC: An historical perspective

Evolution of global oil production w/out OPEC

Global oil production



Global oil production volatility



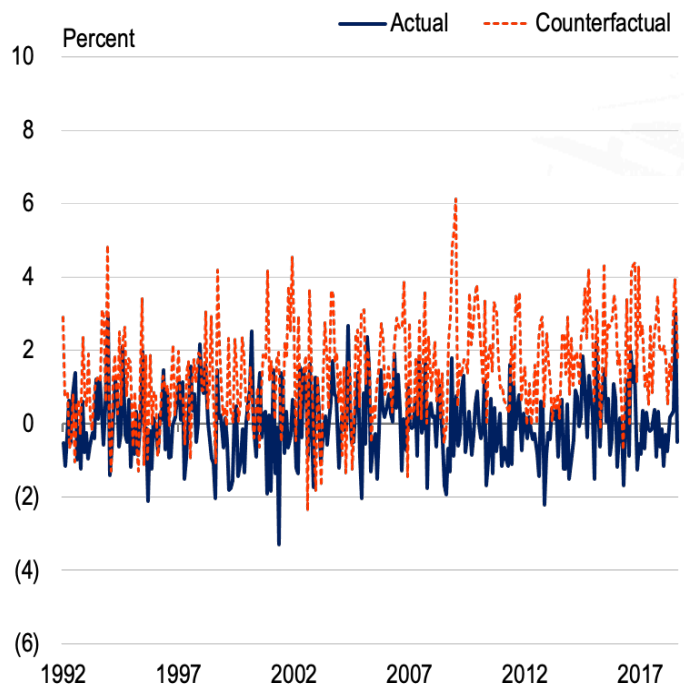
- In a world w/out OPEC, crude oil production would have averaged higher by 2.5 mb/d, with most of the difference attributed to KSA. The growth of global production however would have been slower by 1.5 mb/d (1990-2018).

- The volatility of global oil production would have averaged less than 0.8%, compared to the actual 1%, due to the absence of OPEC's output adjustments in response to oil supply and demand shocks hitting the market.

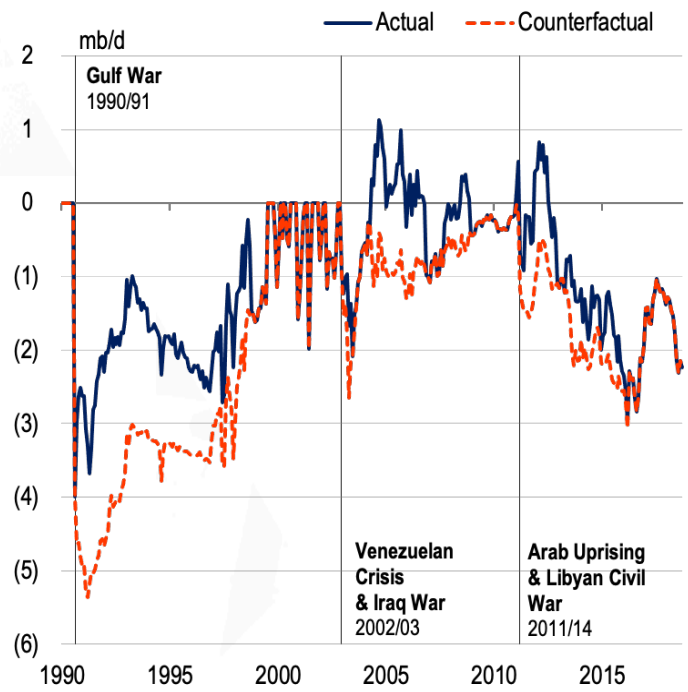
Source: OIES

Oil supply shocks in the absence of spare capacity

Sequence of oil supply shocks



OPEC geopolitical supply disruptions

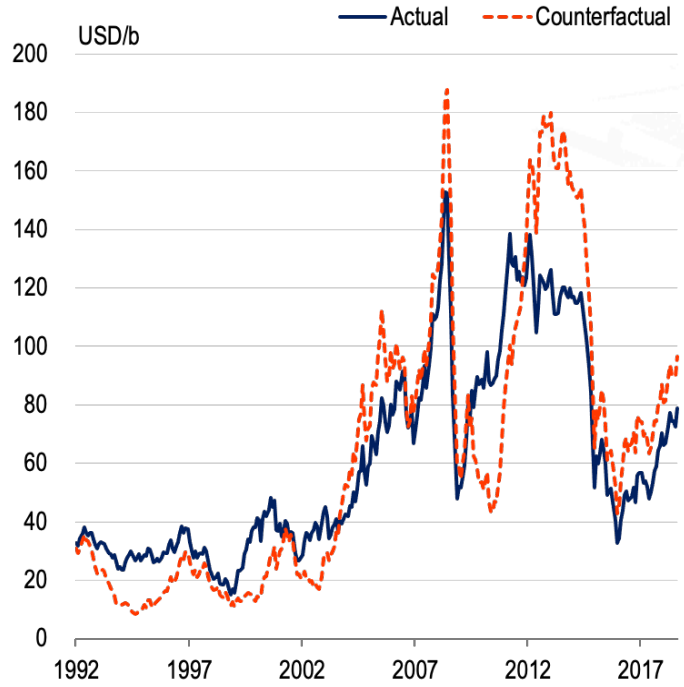


- Despite the decline in global oil production volatility, oil supply shocks would have been significantly larger and more persistent, as w/out spare capacity there would be no buffer against abrupt supply disruptions.
- Overall, geopolitical supply disruptions would have averaged 0.8 mb/d higher and during key episodes they would have been twice as large as the actual observed (e.g. 1990, 2002/03, 2011-onwards).

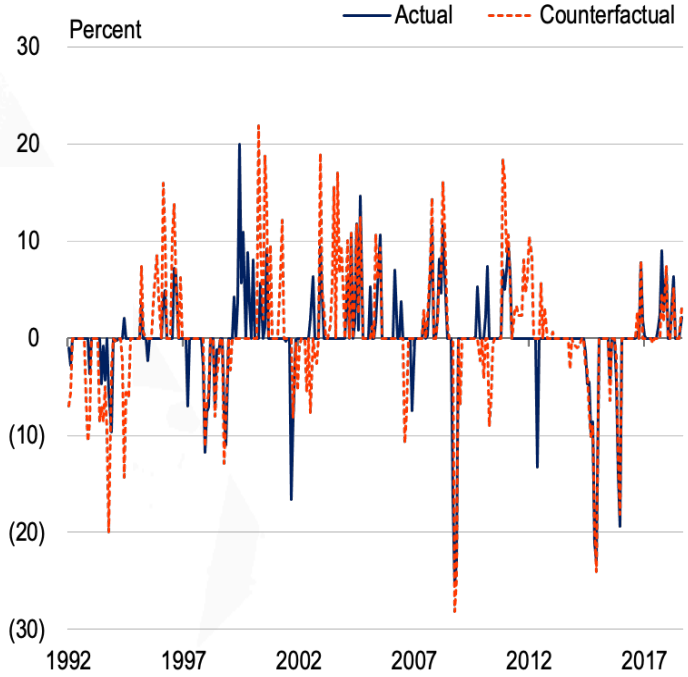
Source: OIES

Implications for the historical evolution of the Brent price

Historical evolution of the Brent price



Historical evolution of oil price shocks



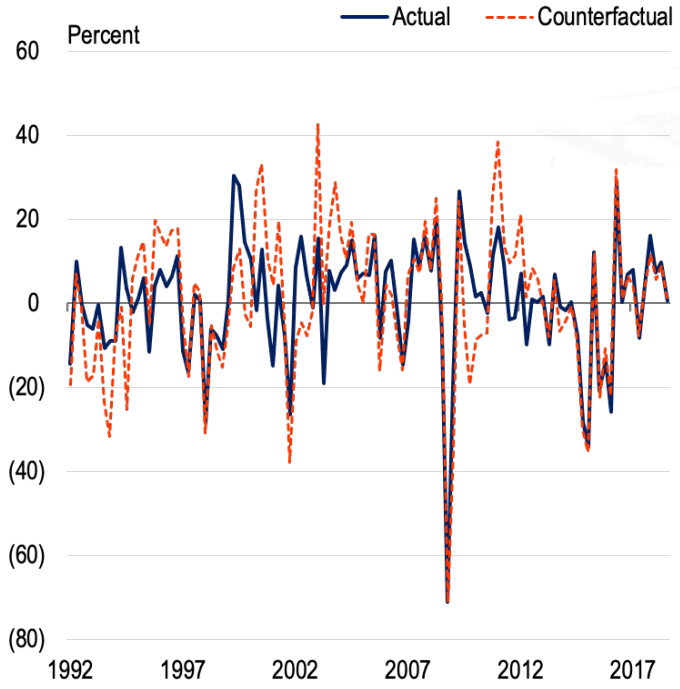
- During episodes of tight markets, the Brent price would have spiked higher in the absence of OPEC's spare capacity (e.g. 2005/07); while during episodes of weak markets, prices would have persisted lower for longer (e.g. 2009/10).

- The presence of spare capacity has had a smoothing effect on global oil price movements, with prices in the absence of the spare capacity cushion exhibiting much sharper price cycles and resulting in more frequent oil shocks.

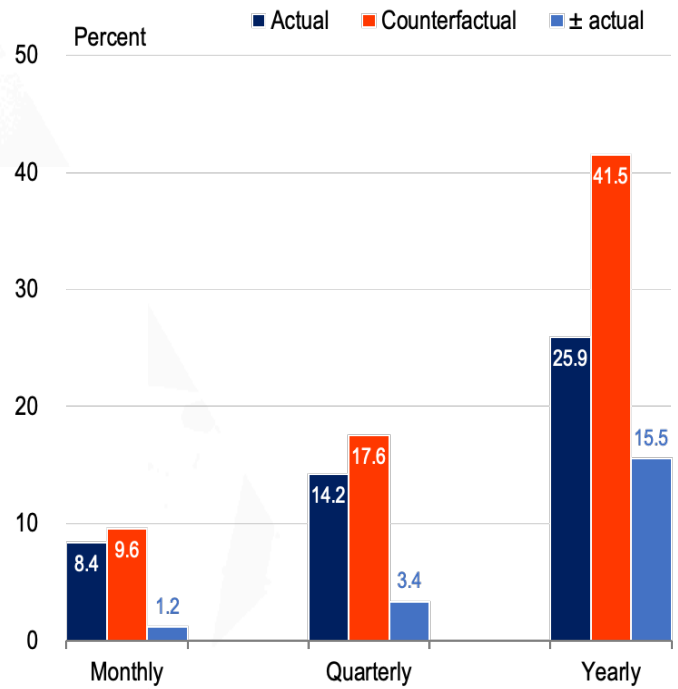
Source: OIES

Implications for oil price volatility

Brent price volatility



Average Brent price volatilities

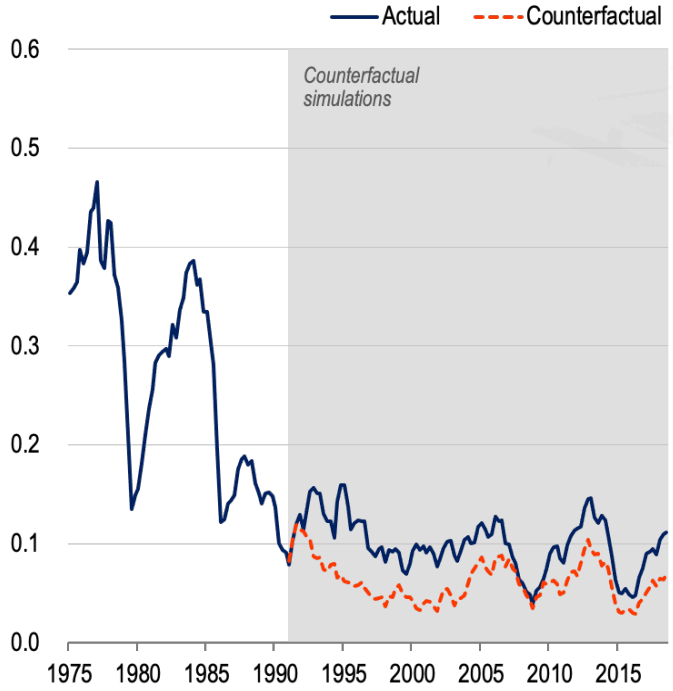


- Oil prices in a world w/out OPEC spare capacity would have been more volatile, as the price adjustments and readjustments to the prevailing market conditions would have been larger and more frequent.
- On annual terms, the price volatility would have been almost twice as large as the actual, affecting adversely the economic interests of producers (e.g. investment inefficiencies) and consumers (e.g. dampening growth prospects).

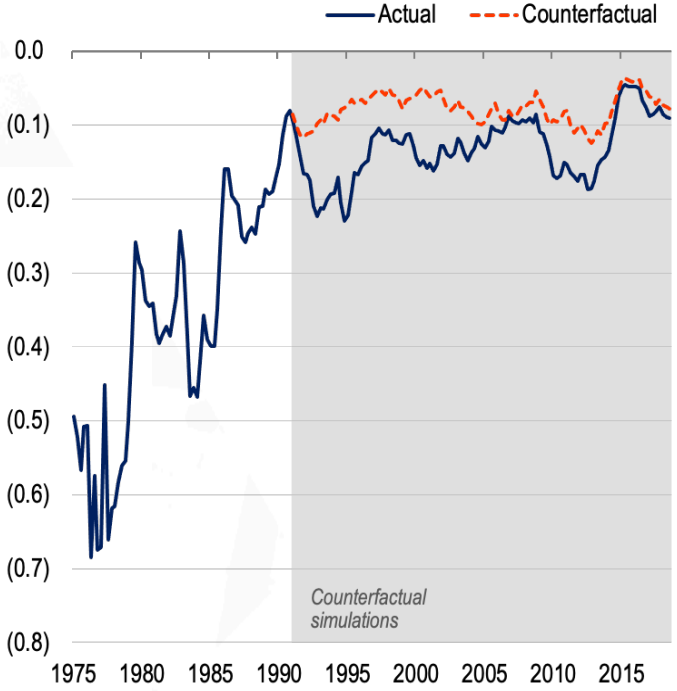
Source: OIES

Implications for the joint evolution of oil supply and demand elasticities

Short-run oil supply elasticity



Short-run oil demand elasticity

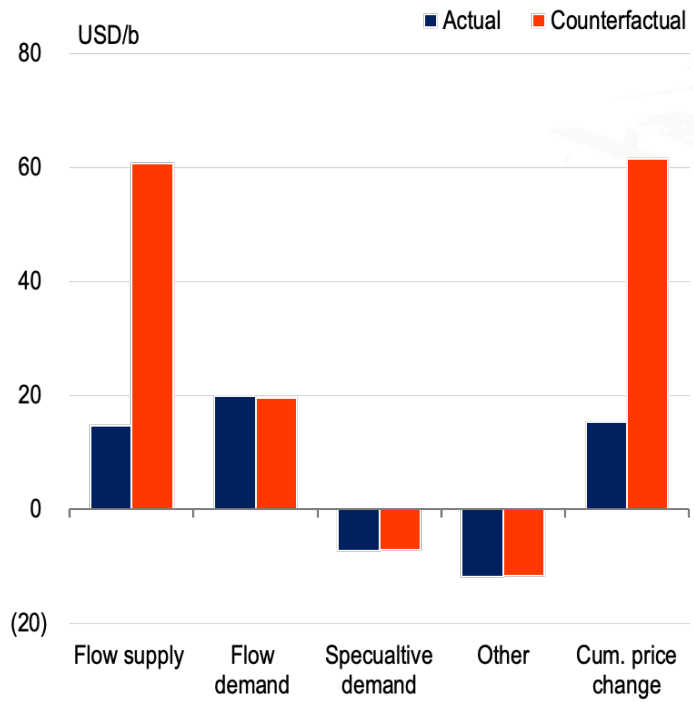


- With OPEC producing at maximum capacity, the supply and demand elasticities would have been markedly lower and only half the actual observed. On average, the short-run elasticity of supply would have declined to 0.06 from 0.1.
- Oil demand would have become less elastic averaging at -0.8, as opposed to the actual -1.3, because the share of precautionary demand for oil on total demand would have been higher leading to a steeper oil demand curve.

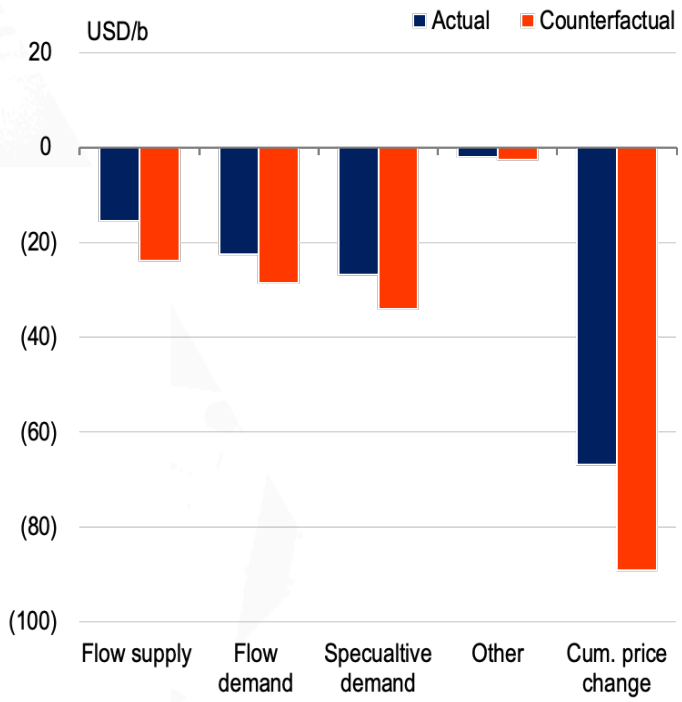
Source: OIES

Historical price episodes w/ and w/out spare capacity

Oil price drivers in 2011



Oil price drivers in H2 2014



- In the absence of spare capacity in 2011, the Brent price would have been higher by $46/b, with the entire difference attributed to the larger impact of oil supply shocks, pushing prices to uncharted territory in 2012/13, close to $165/b.
- In the H2 2014, the Brent price would have plunged even further by $22/b, as all three supply-demand shocks would have generated a larger negative price response. That is despite OPEC choosing to defend its market share.

Source: OIES

Price responsiveness to oil supply shocks

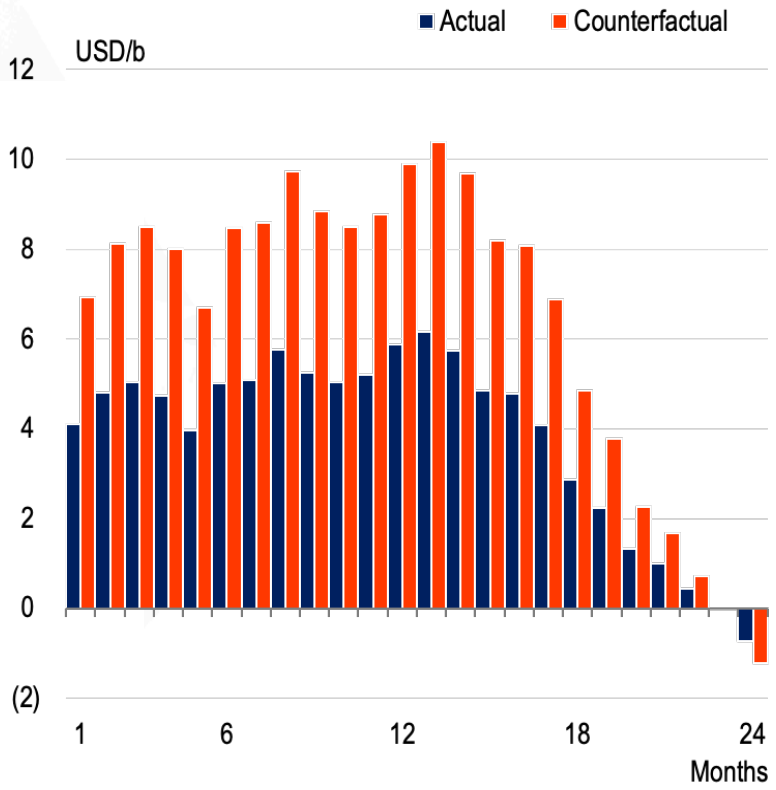
No spare capacity, no buffers

In the event of a hypothetical geopolitical supply disruption in oil supplies of 1 mb/d, the price response in the absence of spare capacity will be twice as large (*actual case* peaks at $6/b vs *counterfactual case* that peaks at $10.4/b).

But not only is the price increase expected to be larger, but also the price episode is expected to be longer in duration. That is because in the absence of spare capacity, the production shortfalls associated with some geopolitical episodes cannot be replaced by other producers, nor can stocks mitigate the impact of the supply shock on price until the latter have fully adjusted to the episode in question.

Essentially, in the absence of OPEC spare capacity the market has no mechanism to act as a buffer against abrupt oil disruptions, leaving it to prices to clear the market via large unexpected adjustments.

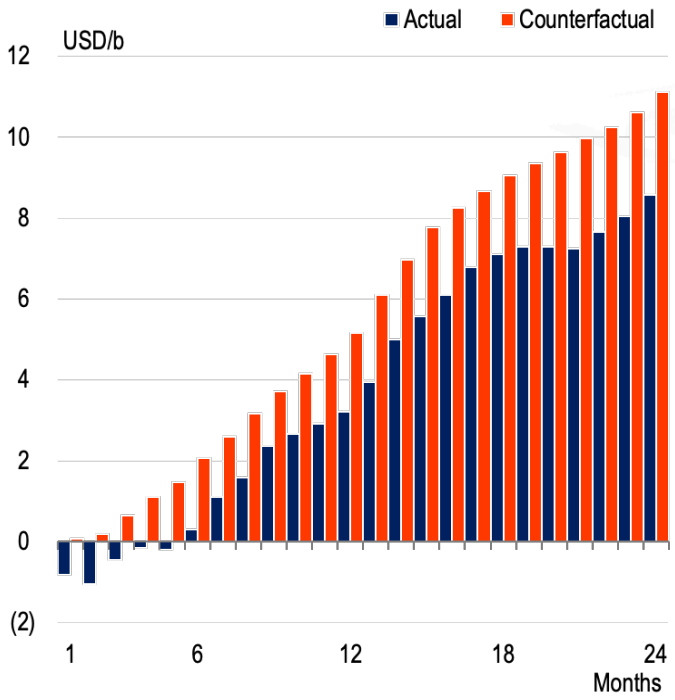
Price response to a supply disruption



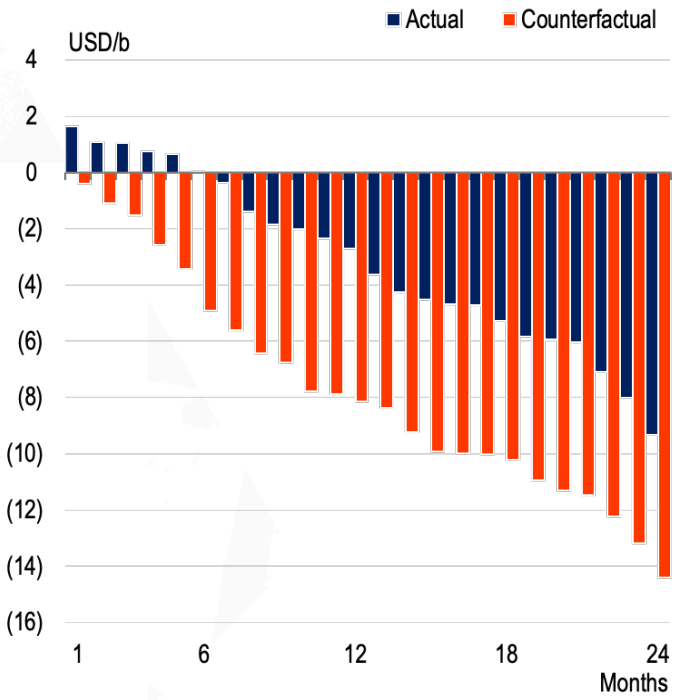
Source: OIES

Price responsiveness to oil demand shocks

Price response to demand expansion



Price response to demand contraction

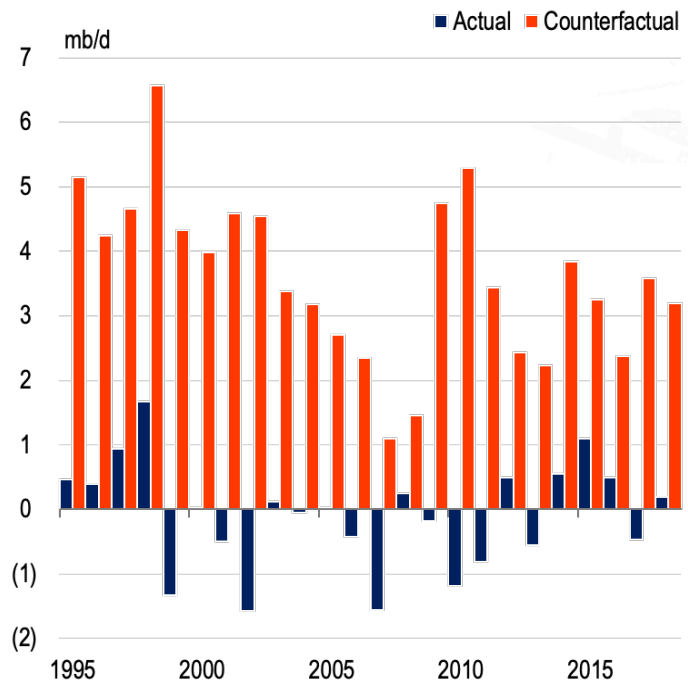


- By suppressing prices lower, spare capacity has the effect of maintaining the momentum in growth. In contrast, in the absence of spare capacity, the higher oil price acts to dampen the prospects of global growth.
- If OPEC abandons its balancing role in a falling market characterised by a slowdown in global oil demand amid increasing oil supplies, the price response is expected to be sharper, more persistent and steeper.

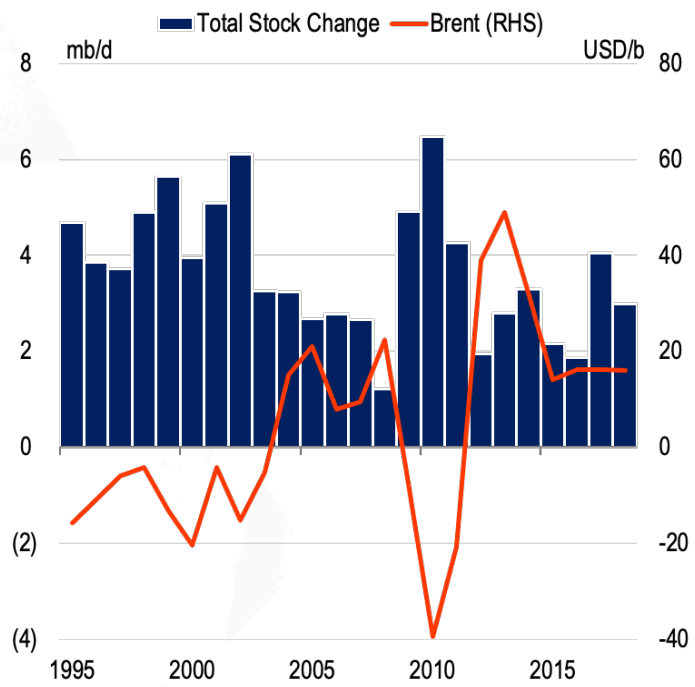
Source: OIES

Implications for global oil stocks

Total stock changes



Changes from actual world

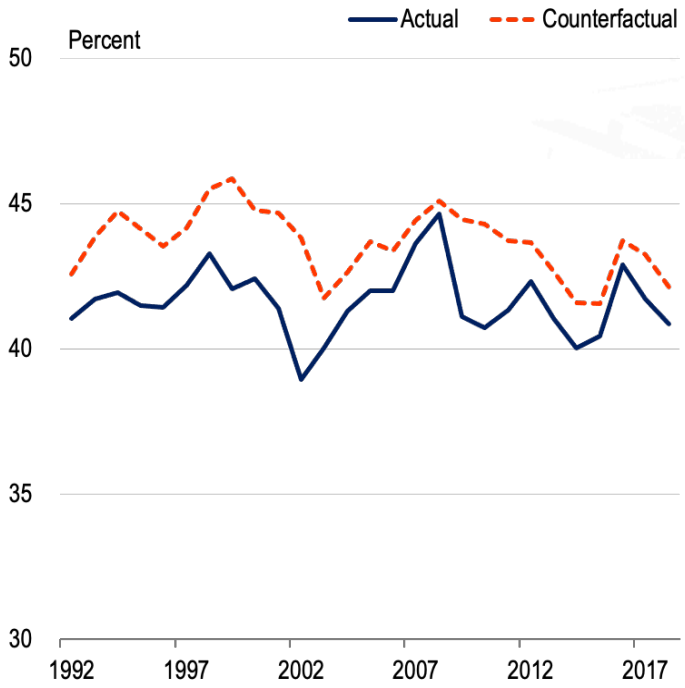


- In the absence of OPEC's *below-ground* inventories, global stocks (i.e. *above-ground*) would have averaged 3.7 mb/d higher, as the stock-out avoidance (or precautionary demand) motive becomes more prominent.
- Two important issues arise. First is the issue of the cost of holding more stocks above-ground and who bears that cost. Second, higher stocks would have had few stabilising effects, because stock withdraws would have been very rigid.

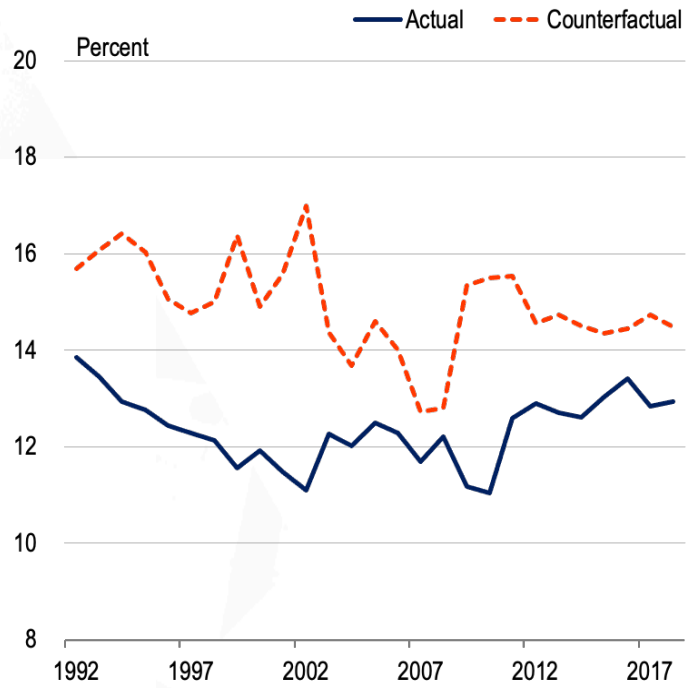
Source: OIES

Impact on OPEC and Saudi Arabia's market share

OPEC market share



Saudi Arabia market share

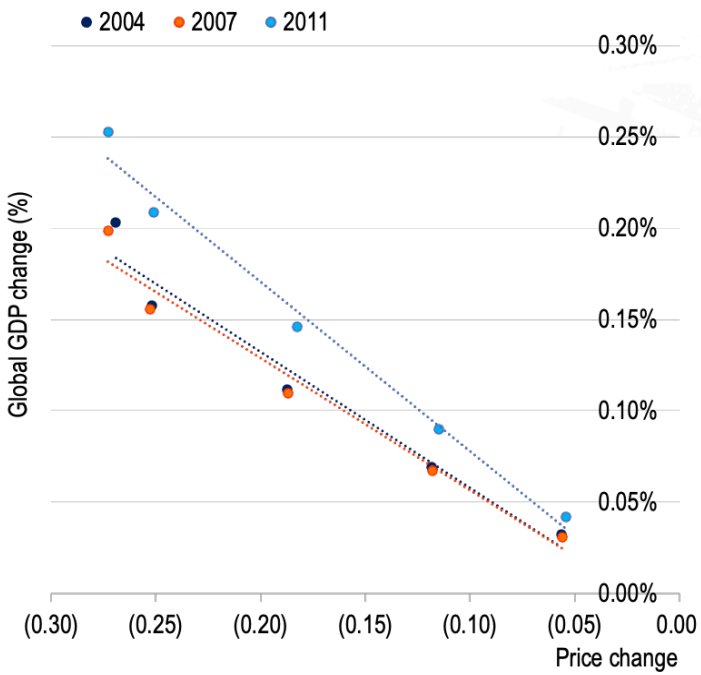


- Overall, OPEC market share would have been higher over the entire period by 2.1%, relative to the actual observed, averaging 43.7% of the total compared to 41.6%.
- KSA would have experienced a slightly higher gain in market share relative to other OPEC oil producers by 2.6%, averaging 15% throughout, mainly due to its large low-cost oil reserve base.

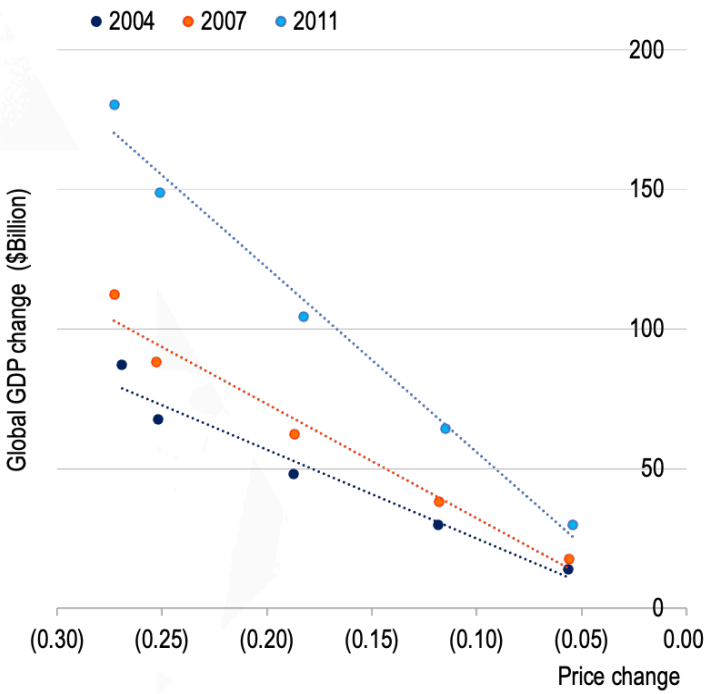
Source: OIES

Impact on World GDP

World GDP gains w/out spare capacity
(% chg.)



World GDP gains w/out spare capacity
($billion)



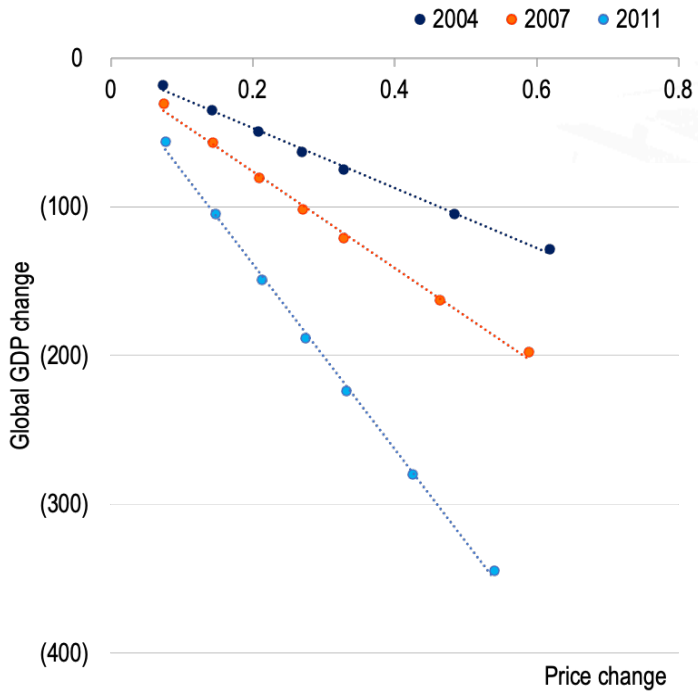
- Shifts in OPEC output policy and abandoning its balancing role have global welfare implications that are channeled through the price outcomes. The impact however is different across regions and varies across time.

- A production increase leading to a 25% price decline would have boosted GDP by 0.15% in 2004/07 and 0.20% in 2011. The differences over time are higher when factoring in the global GDP expansion between 2004/11, leading to gains of $50B, $75B and $150B.

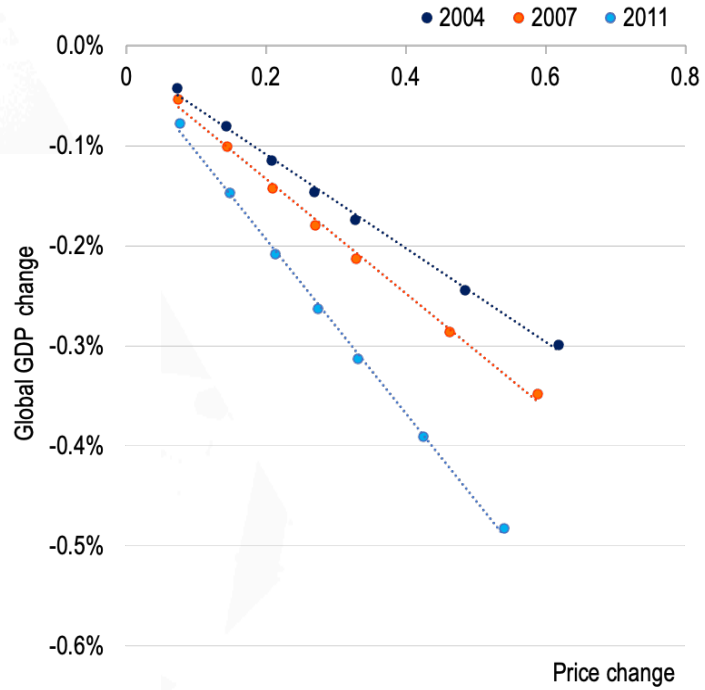
Source: OIES

Cost of oil supply shortfalls

Cost of oil supply shortfalls
(% chg.)



Cost of oil supply shortfalls
($billion)



- In the face of supply disruptions however, the net negative impact on global GDP is much higher and more-than-offsets the expected gains. Again the impact increases over time as a marker of a decreasing oil demand elasticity.

- In absolute terms, for a 27% price increase induced by a negative supply shock in the absence of spare capacity, the cost of the supply shortfalls on global GDP rises from $60B in 2004, to $80B in 2007 and $185B in 2011.

Source: OIES

Global welfare implications

The cost of lack of spare capacity

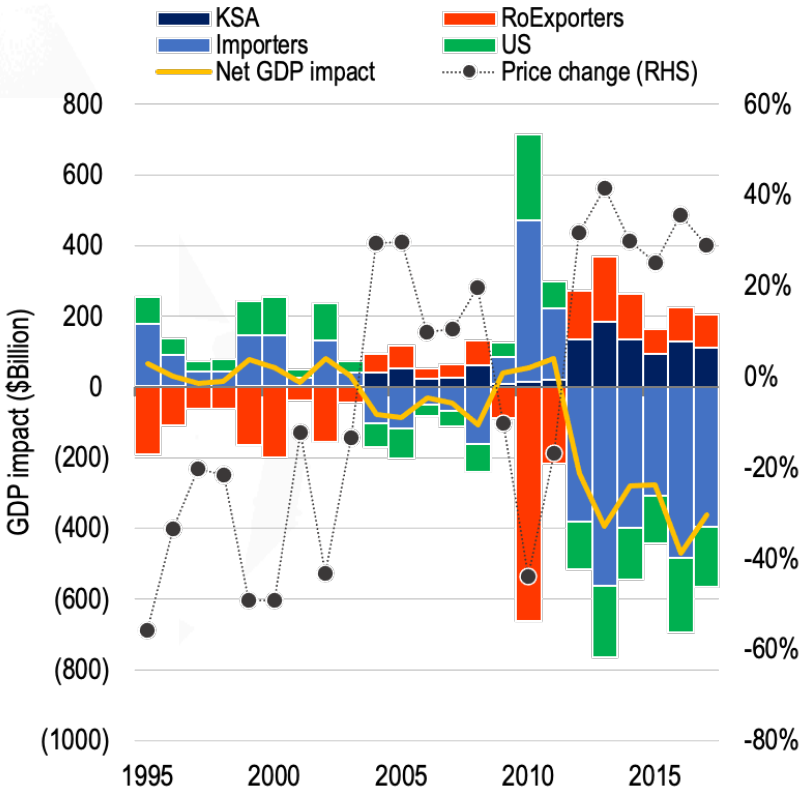
An oil price decrease driven by OPEC producers maximising their output, ceteris paribus, leads to a net GDP increase for the oil-importing countries. At the same time, lower prices determine a loss in oil revenues for oil exporters and as such have a negative impact on their respective GDP.

In tighter supply conditions, the impact on GDP in the absence of spare capacity is much higher. While oil exporters benefit from higher oil prices, the welfare impacts on oil importing countries is much larger.

The cost of lack of spare capacity grows significantly after 2012 with the net global welfare loss values in the order of $250-450 billion and by 2017 it is estimated at ***$360 billion.***

These results underscore the growing welfare importance of spare capacity and OPEC in the oil market over time to smooth out unexpected and abrupt oil shocks.

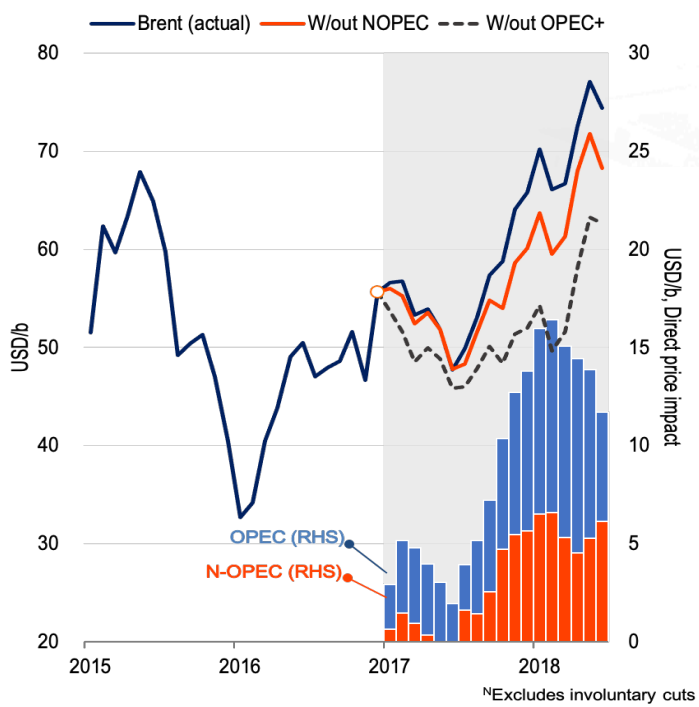
Welfare impacts w/out spare capacity



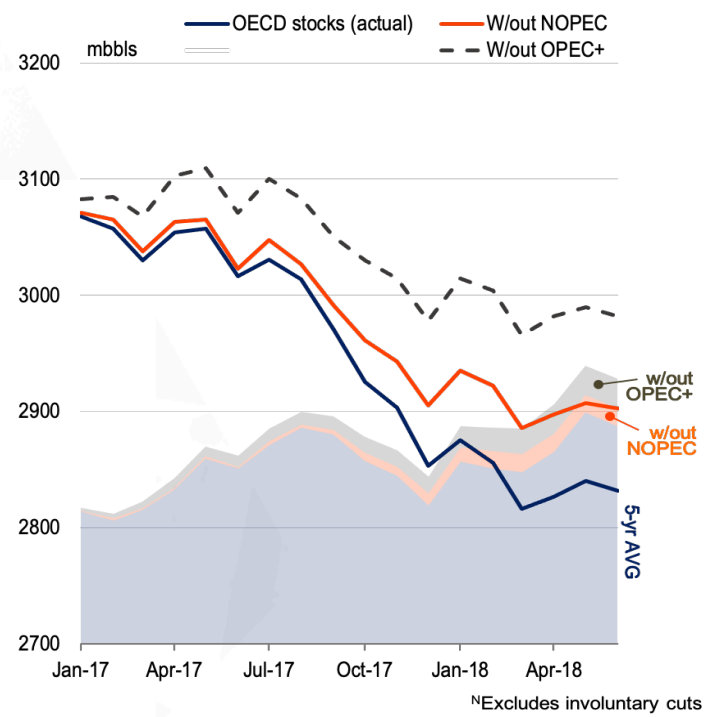
Source: OIES

OPEC evolves in a dynamic context

Net impact of the DOC on Brent



Net impact of the DOC on OECD stocks



- In December 2016, OPEC and non-OPEC producers formed the historic Declaration of Cooperation that helped accelerate the price recovery in 2017/18. The OPEC+ output cut deal, added up to $15/b to the price rebound.

- OPEC+ also made a materially important contribution to the market rebalancing by accelerating stocks clearing by at least half a year and showed that it can overcome the many challenges facing producer-producer relations in a cooperative framework.

Source: OIES

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Bassam Fattouh, Director ,OIES

Andreas Economou, Senior Research Fellow ,OIES

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