Frugals, Militants and the Oil Market

Games in Management Science (2019)

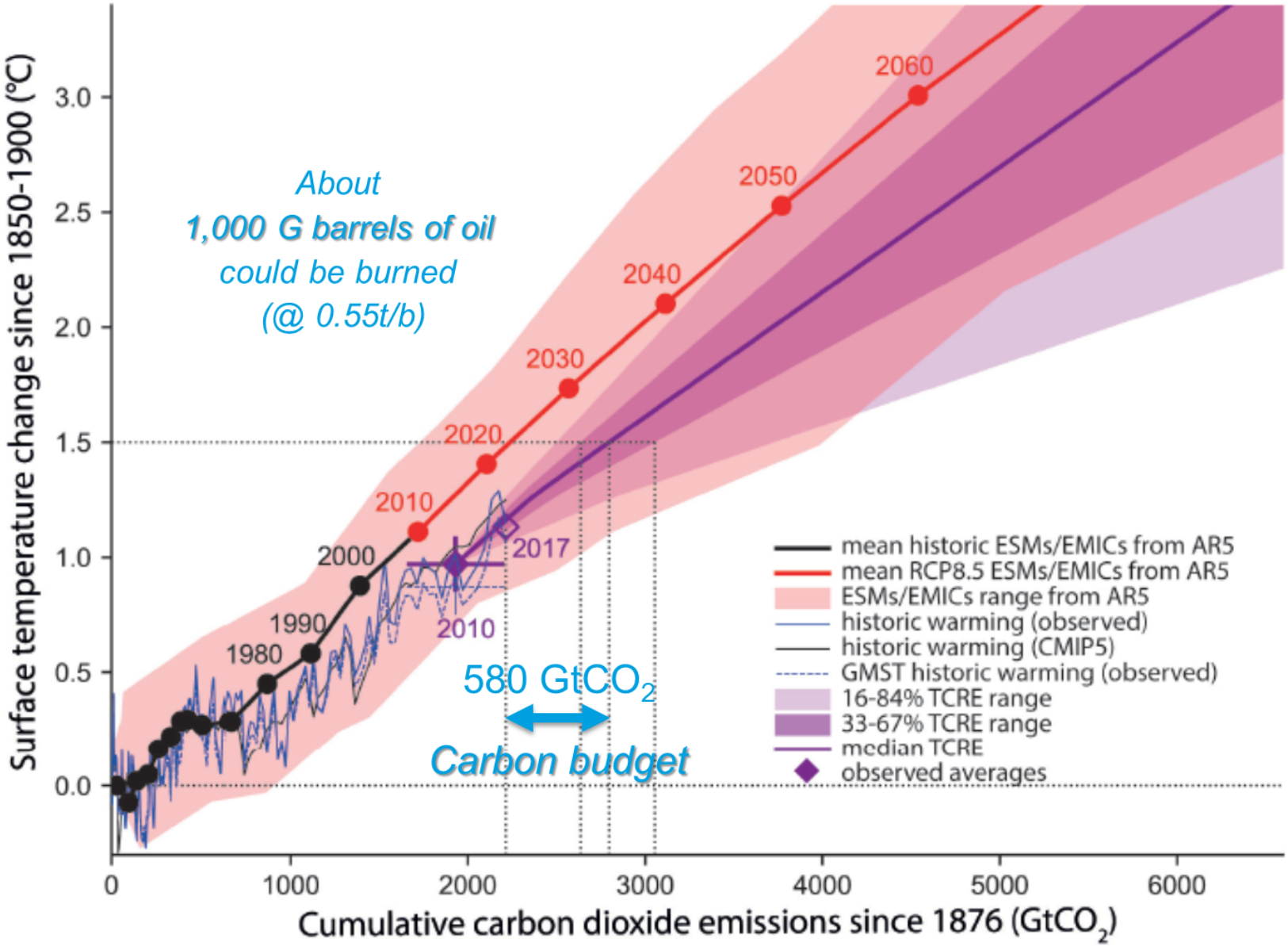
Etienne B. de Villemeur[1] Pierre-Olivier Pineau[2]

[1]Université de Lille (LEM), France

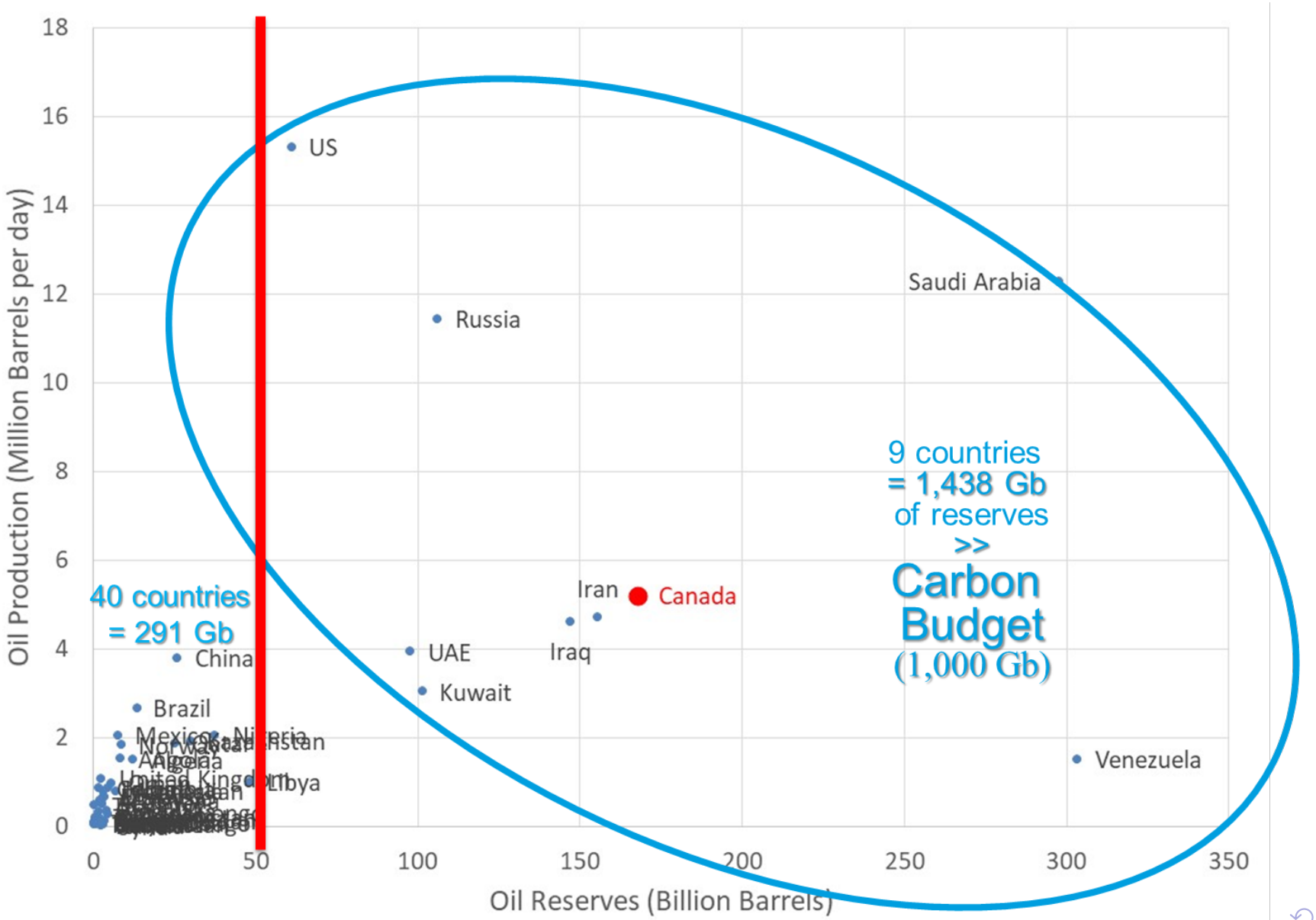
[2]HEC Montréal (Chaire de gestion du secteur de l'énergie), Canada

May 27th, 2020

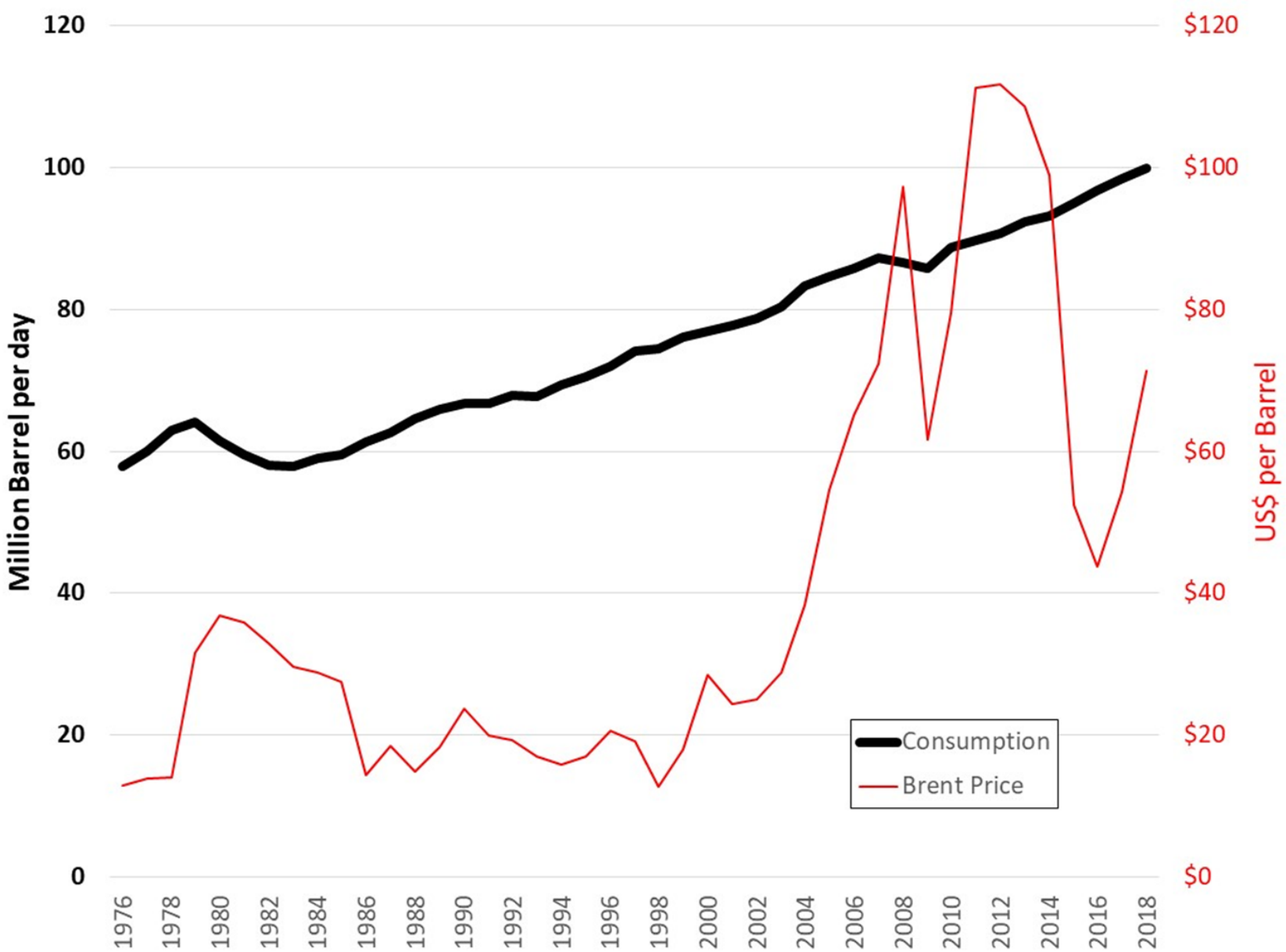
Carbon budget



World Oil Reserves (1,730 Gb)
and Daily Oil Production (Mb/d), 2018



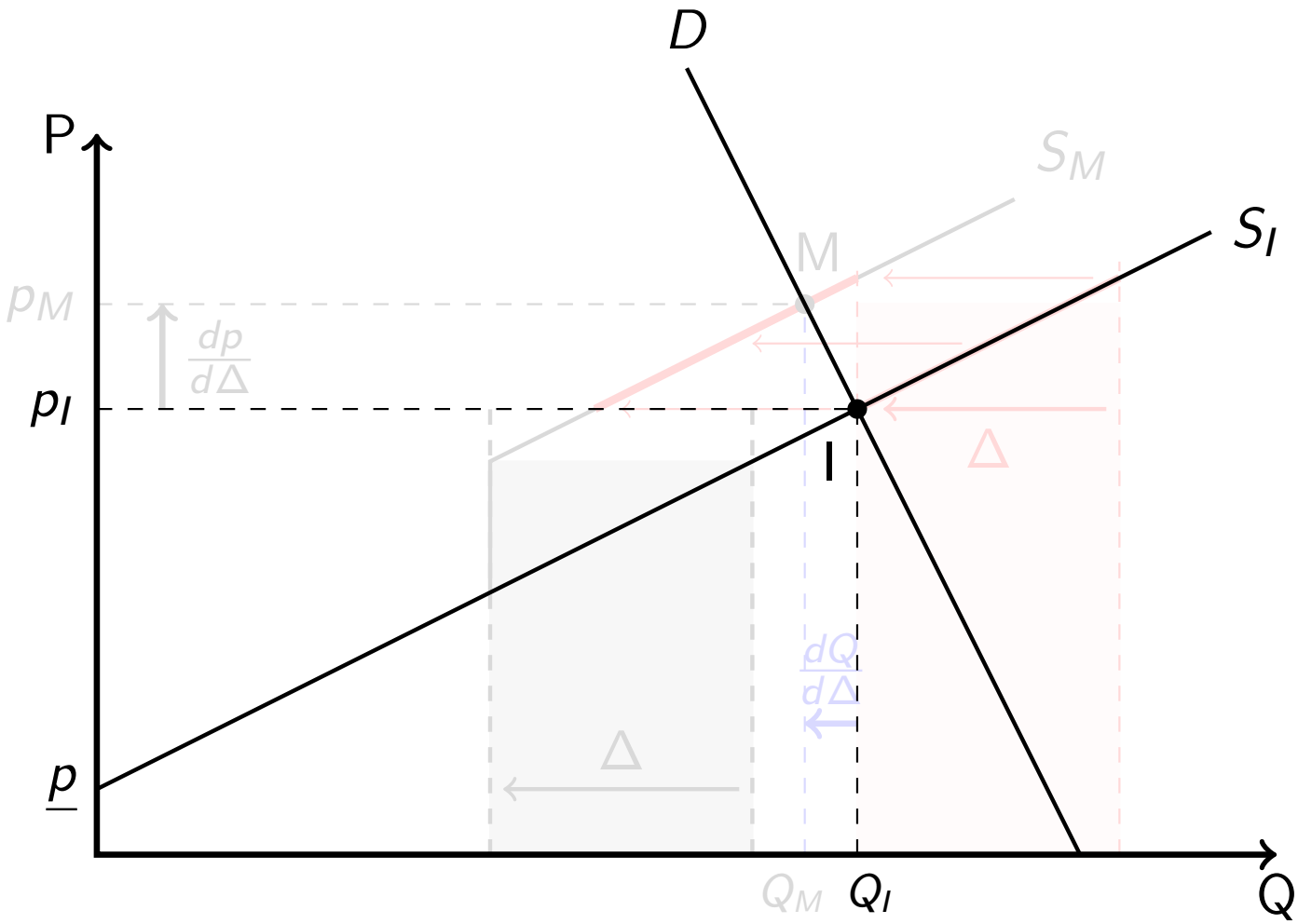
World Daily Oil Consumption (Mb/d) and Price (US$/b), 1976-2018.



Looking for a climate policy...

- **Reserves are huge:**
  - Limit pricing and the (in) effectiveness of the carbon tax. *Journal of Public Economics*, 2016, vol. 139, p. 28-39 by Saraly Andrade DE SÁ, and Julien DAUBANES.
- **The Carbon Tax is not necessarily a good way to tackle the issue**
  - Politiques climatiques: cessons de vouloir payer pour esquiver nos responsabilités!. Revue française d'économie, 2016, vol. 31, no 3, p. 159-175 by Étienne BILLETTE DE VILLEMEUR, and Justin LEROUX
  - Tradable climate liabilities: A thought experiment. Ecological Economics, 2019, vol. 164, p. 106355 by Étienne BILLETTE DE VILLEMEUR, and Justin LEROUX
  - The case for a supply-side climate treaty. Science, 2019, vol. 365, no 6451, p. 325-327 by Geir B. ASHEIM, Taran FÆHN, Karine NYBORG, et al.

Militant Action: a Cut on Supply



The initial equilibrium (I) is displaced by militant action upon supply (cut of the grey area). This results in part of the supply associated with the redish area to become competitive. The equilibrium with Militants (M) is associated to a slightly lower demand (a fraction of Δ) yet a substantially higher equilibrium price.

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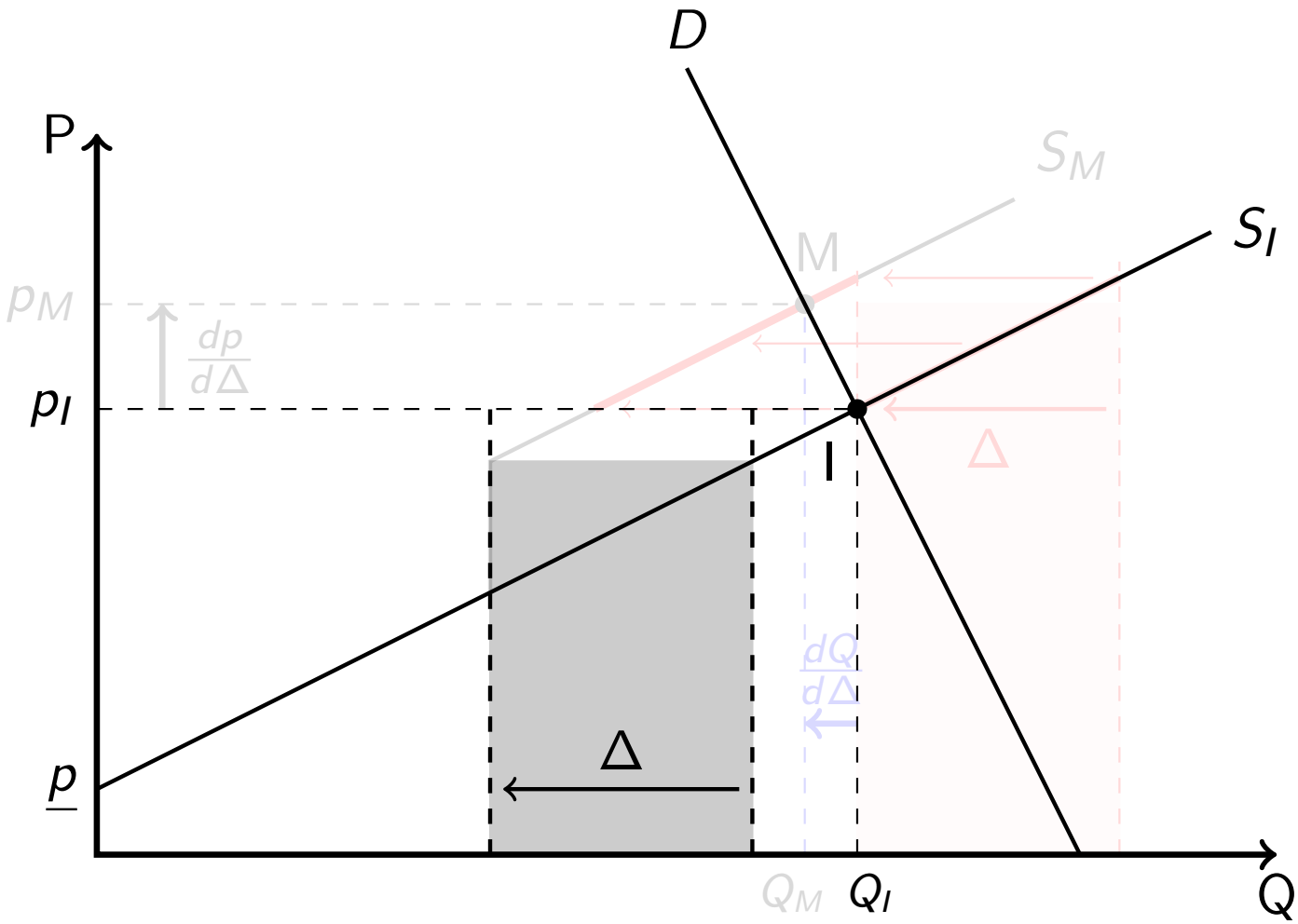

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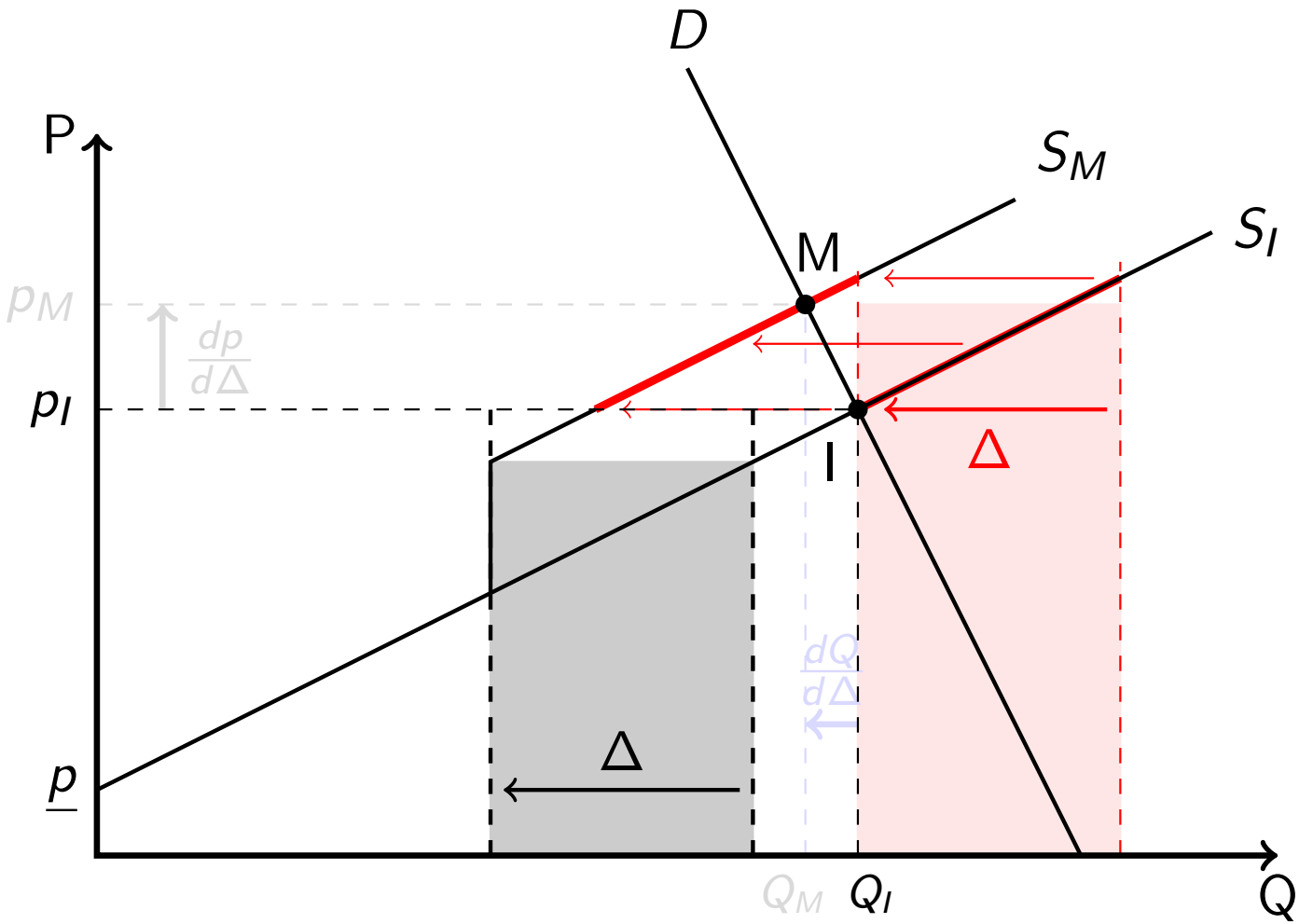

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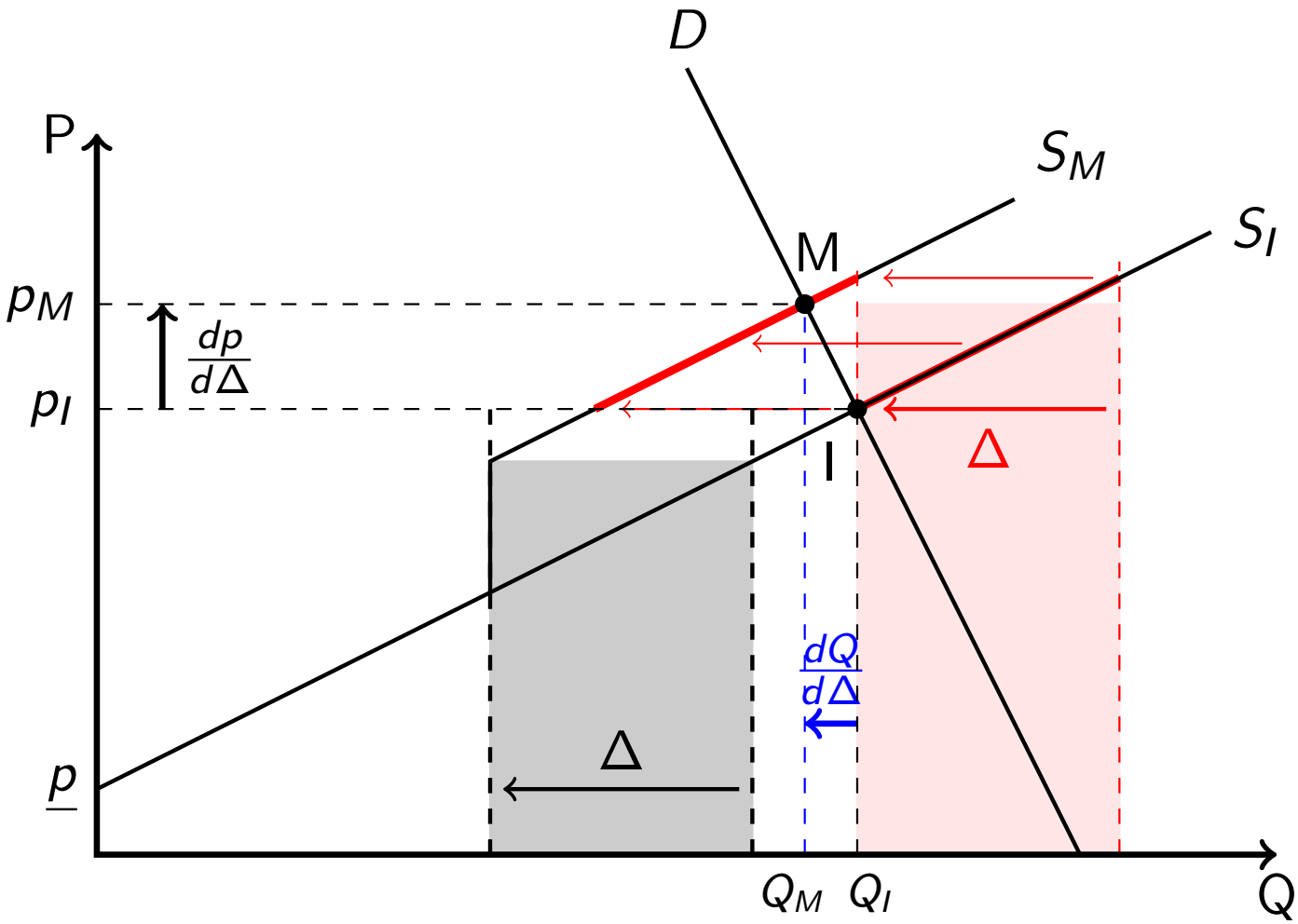

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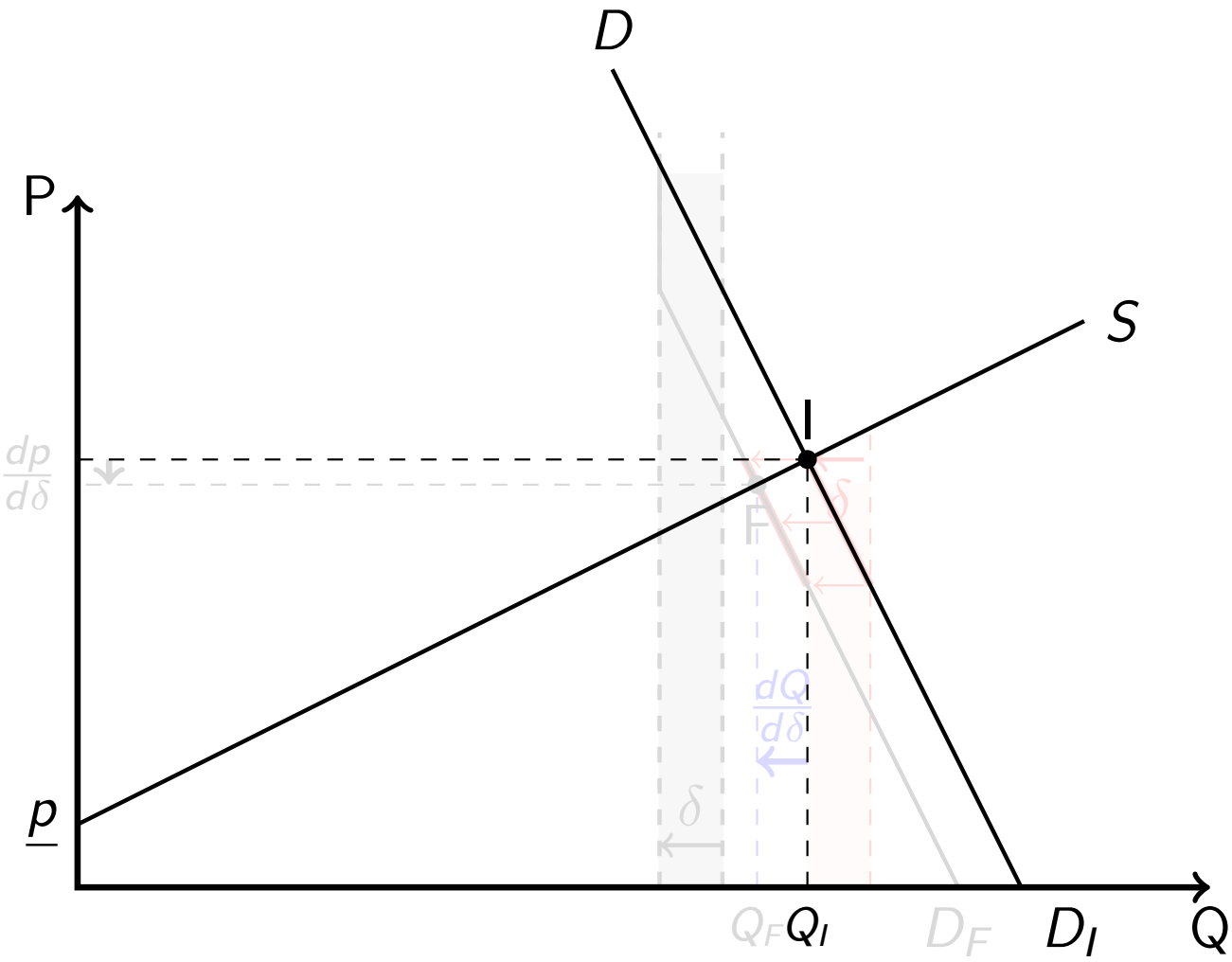
Impact of the Frugals: a Cut on Demand



The initial equilibrium (I) is displaced by frugal behaviour, i.e. a reduction on demand (cut of the grey area).
This results in part of the consummers associated with the redish area to get access to the energy markets.
The equilibrium with Frugals (F) is associated to a sizable reduction in consumption (as compared to δ) but also to a decreased equilibrium price.

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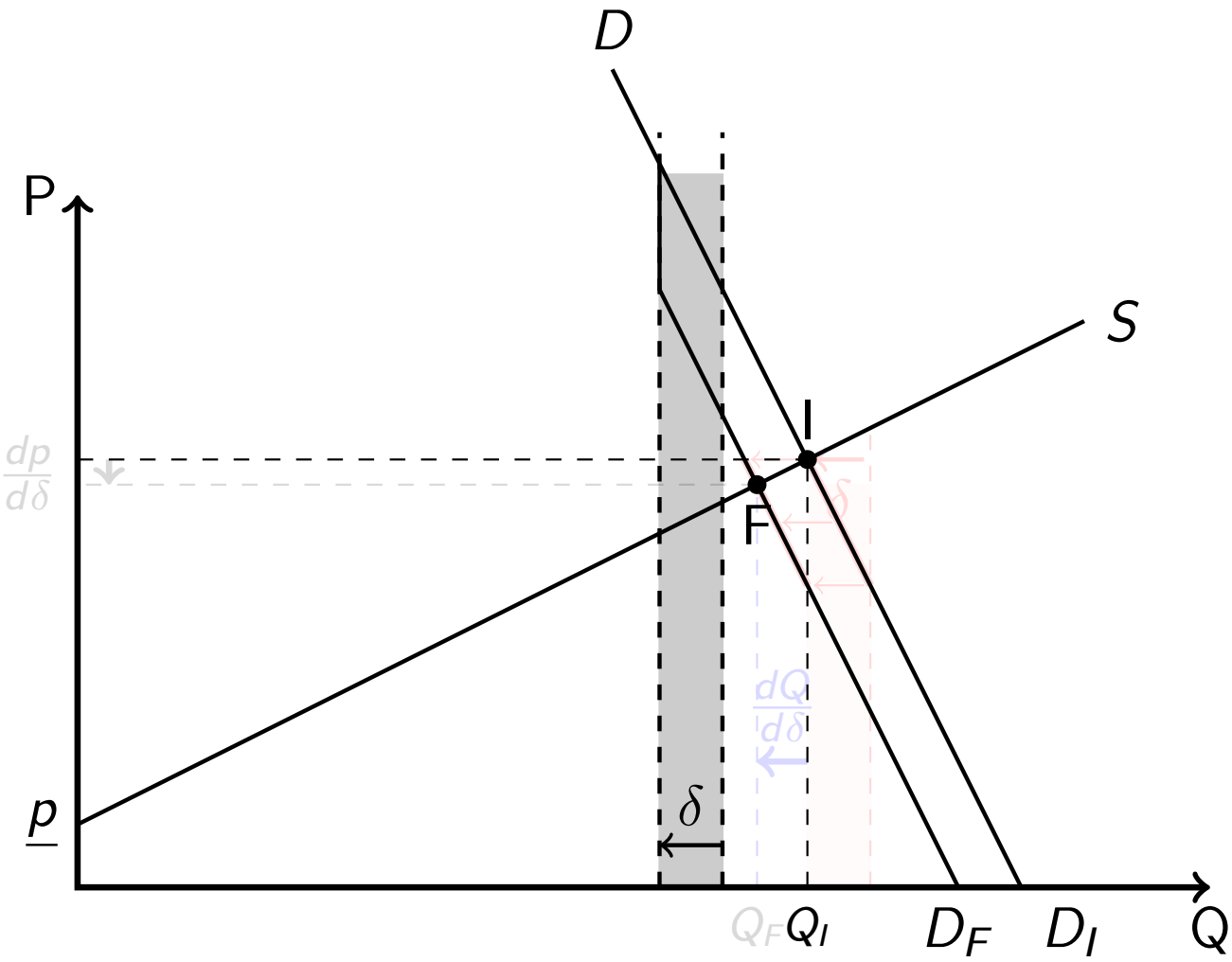

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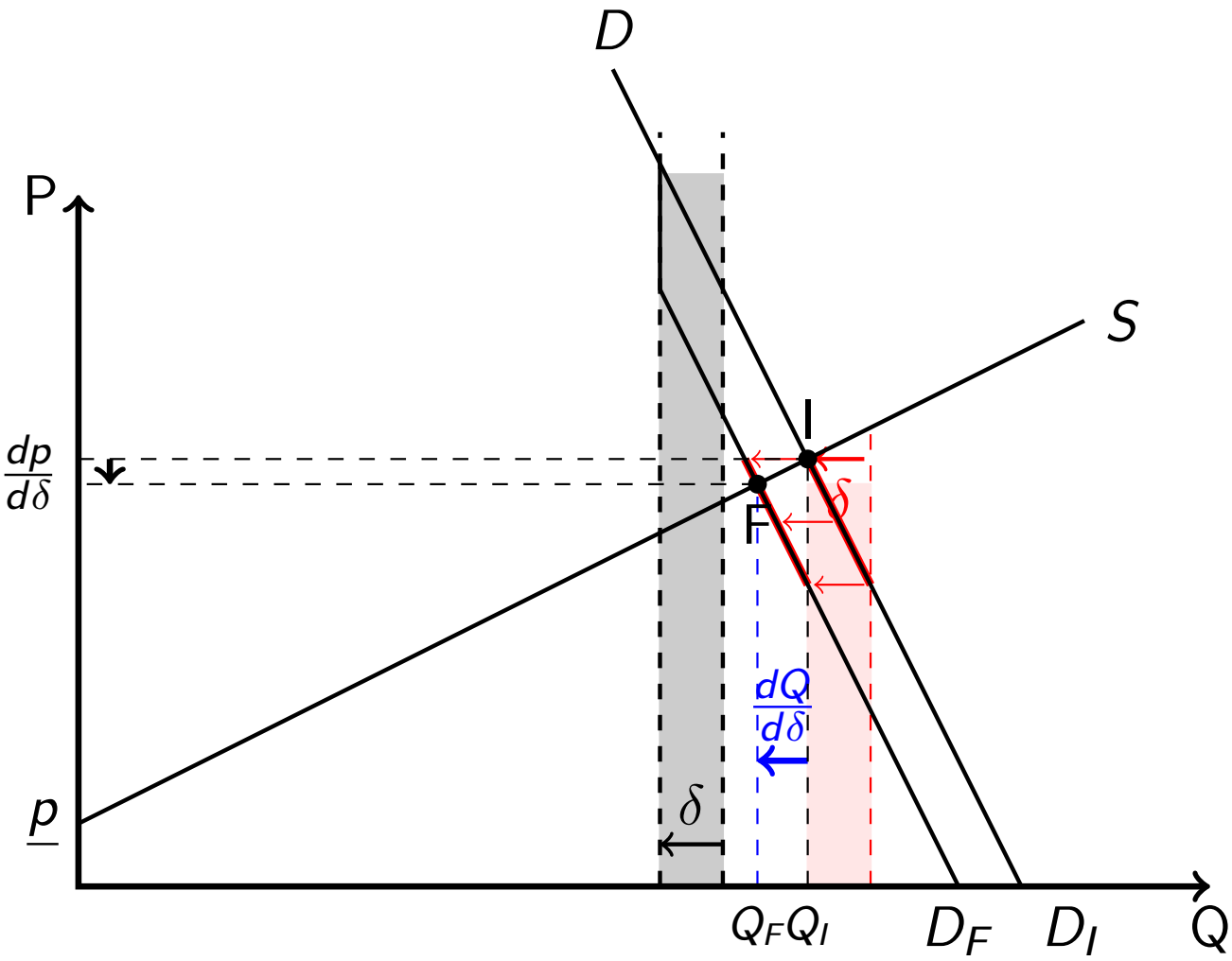

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The model

Set of agents: $N = \{1, ..., n\}$ with utilities

$$\mathscr{U}(q, s; p, Q) = v(p, q) + b(s) - e(Q),$$

where

- $v(p, q)$: Net utility from energy consumption of q units at price p,
- $b(s)$: Benefits from environmental stance $s \in \{m; \emptyset\}$
- $e(Q)$: Emissions and/or environmental damage resulting of total consumption Q

Assumption

In regard of their environmental impact, individuals find it individually too costly to adopt a frugal behaviour :

$$\mathscr{U}\left(f, s, Q\left(N_f; N_m\right)\right) < \mathscr{U}\left(a, s, Q\left(N_f - 1; N_m\right)\right),$$

for all $N_f \in [1; N]$ *and whatever the values of* $s \in \left\{m; \emptyset\right\}$ *and* $N_m \in [0; N]$

Assumption

Individuals find it individually profitable to adopt a stance of environmental militant:

$$\mathscr{U}\left(q, m, Q\left(N_f; N_m\right)\right) > \mathscr{U}\left(q, \emptyset, Q\left(N_f; N_m - 1\right)\right),$$

for all $N_m \in [1; N]$ *and whatever the values of* $q \in \left\{a; f\right\}$ *and* $N_f \in [0; N]$.

Assumption

It would be collectively rational to adopt a frugal behaviour:

$$\mathscr{U}\left(f, s, Q\left(N; N_m\right)\right) > \mathscr{U}\left(a, s, Q\left(0; N_m\right)\right),$$

whatever the values of $s \in \left\{m; \emptyset\right\}$ *and* $N_m \in [0; N]$.

Given these assumptions it is clear that:

Lemma

The dominant individual strategies are

$$\left(q^*; s^*\right) = (a, m).$$

A double Prisoner's Dilemma Game

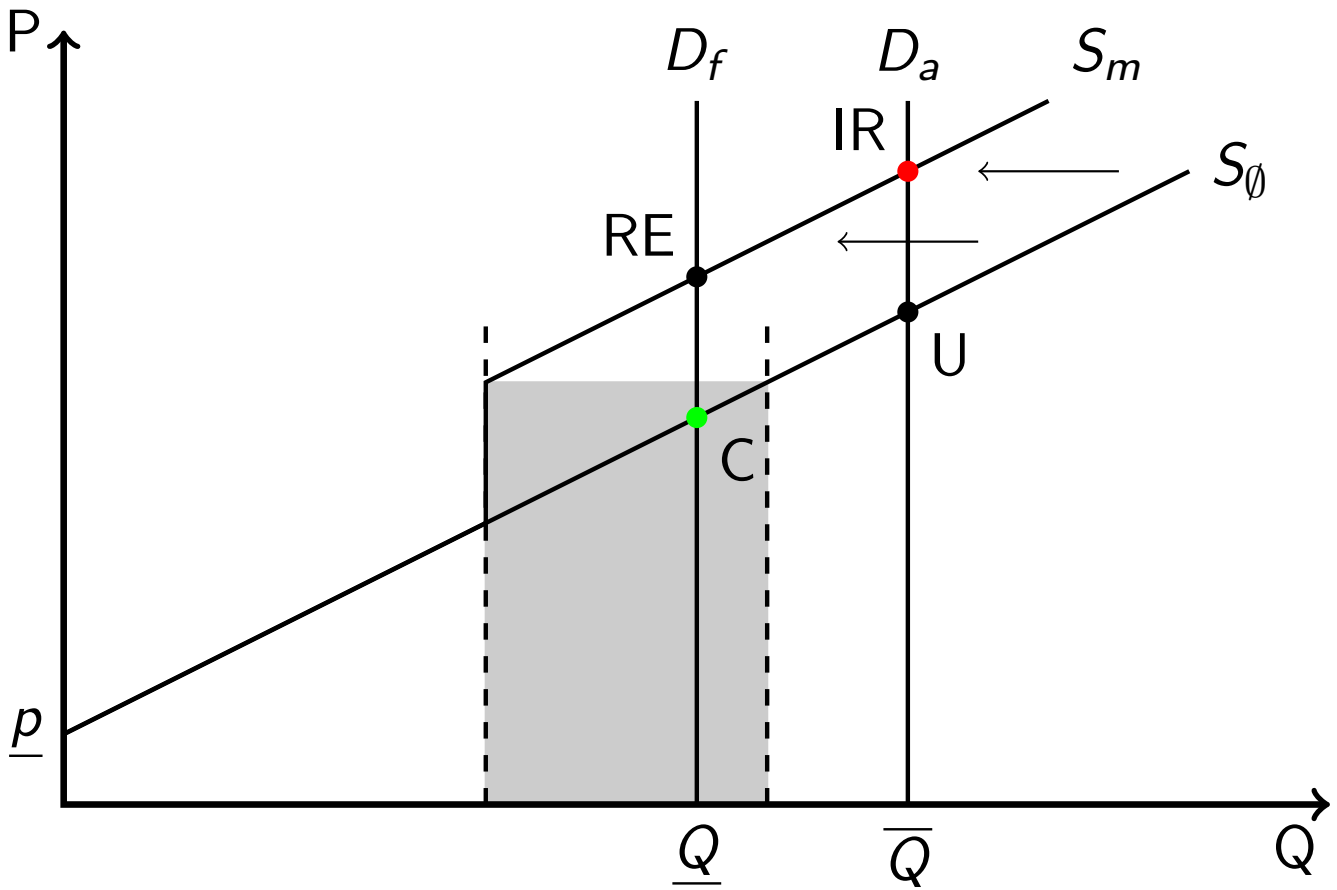
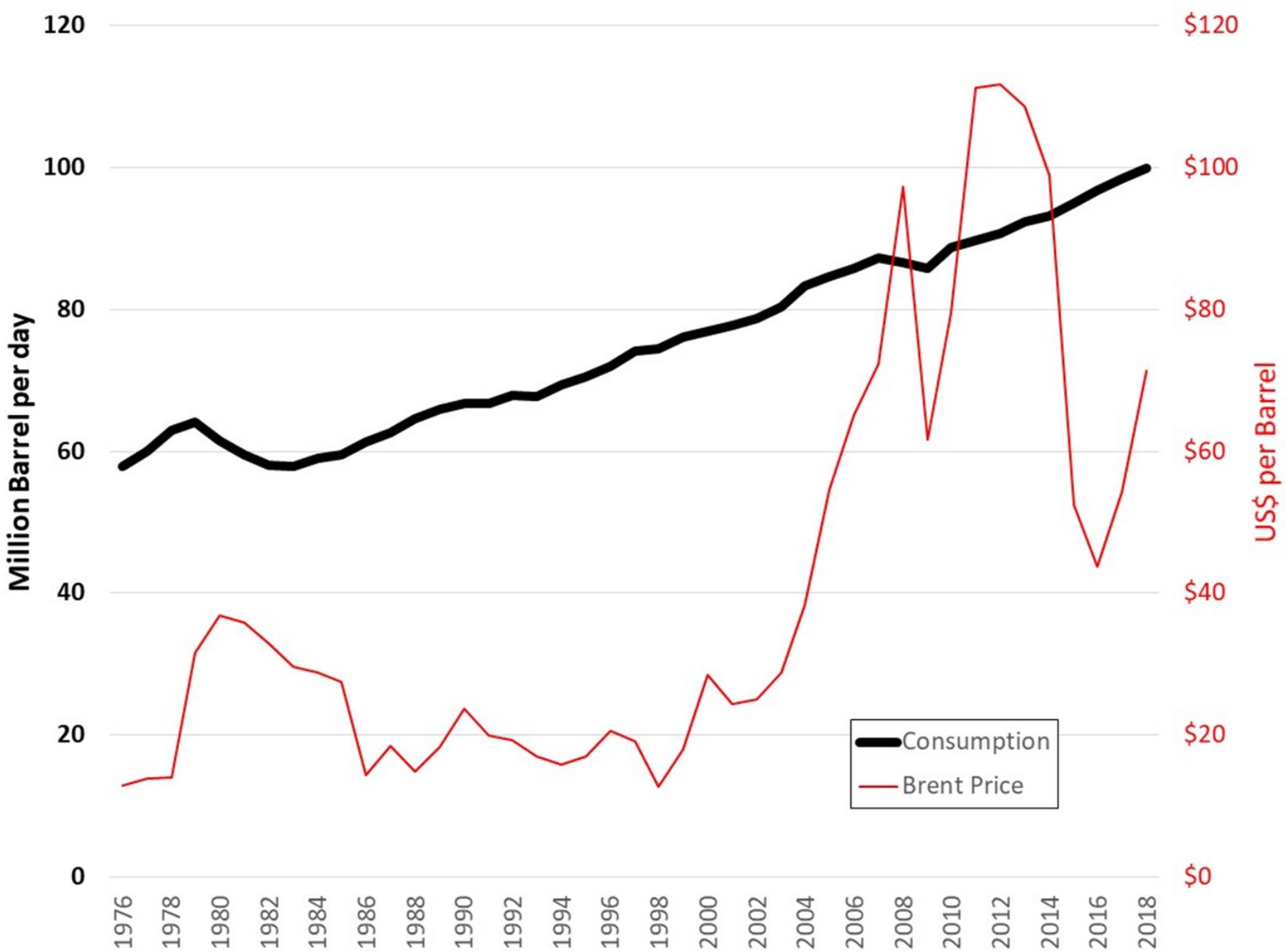


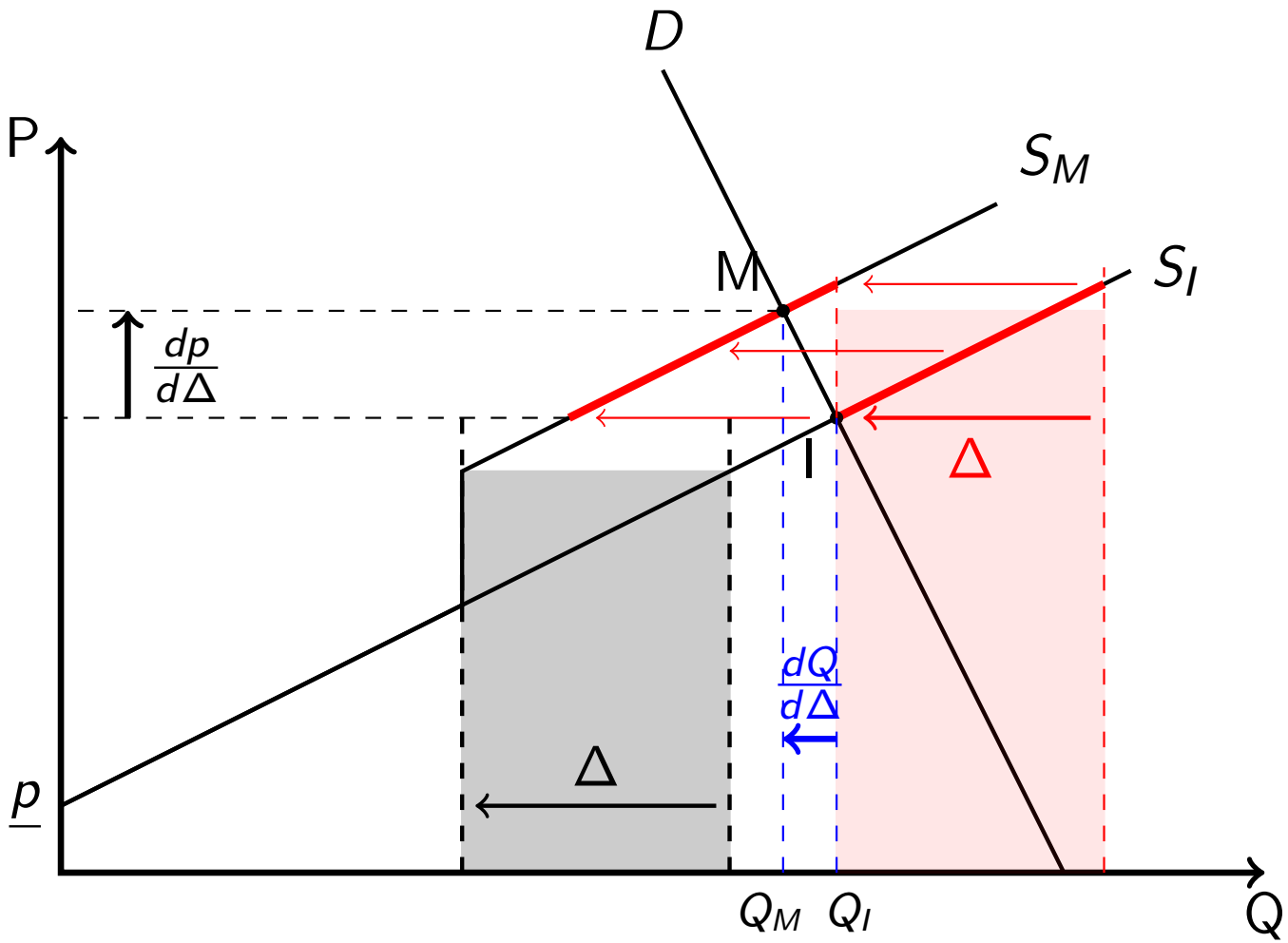
Figure: The four polar collective outcomes: Individually rational (IR), Unconcerned (U), Cooperative (C) and Radical environmentalist (RE). When militants manage for the projects associated to the grey area to be cancelled, the subsequent supply curve is shifted to the left.

Beyond Game Theory
Some Lessons to be drawn?

World Daily Oil Consumption (Mb/d) and Price (US$/b), 1976-2018.



Supply or Demand Policy?



Supply or Demand Policy?

- **Impact of a reduction Δ in the supply capacity:**
  Supply $=$ Demand : $D(Q) = C'(Q + \Delta)$ yields

$$\left(\frac{dQ^*}{d\Delta}\right) = \frac{-\epsilon}{\epsilon + (1 + \Delta/Q)\,\eta}.$$

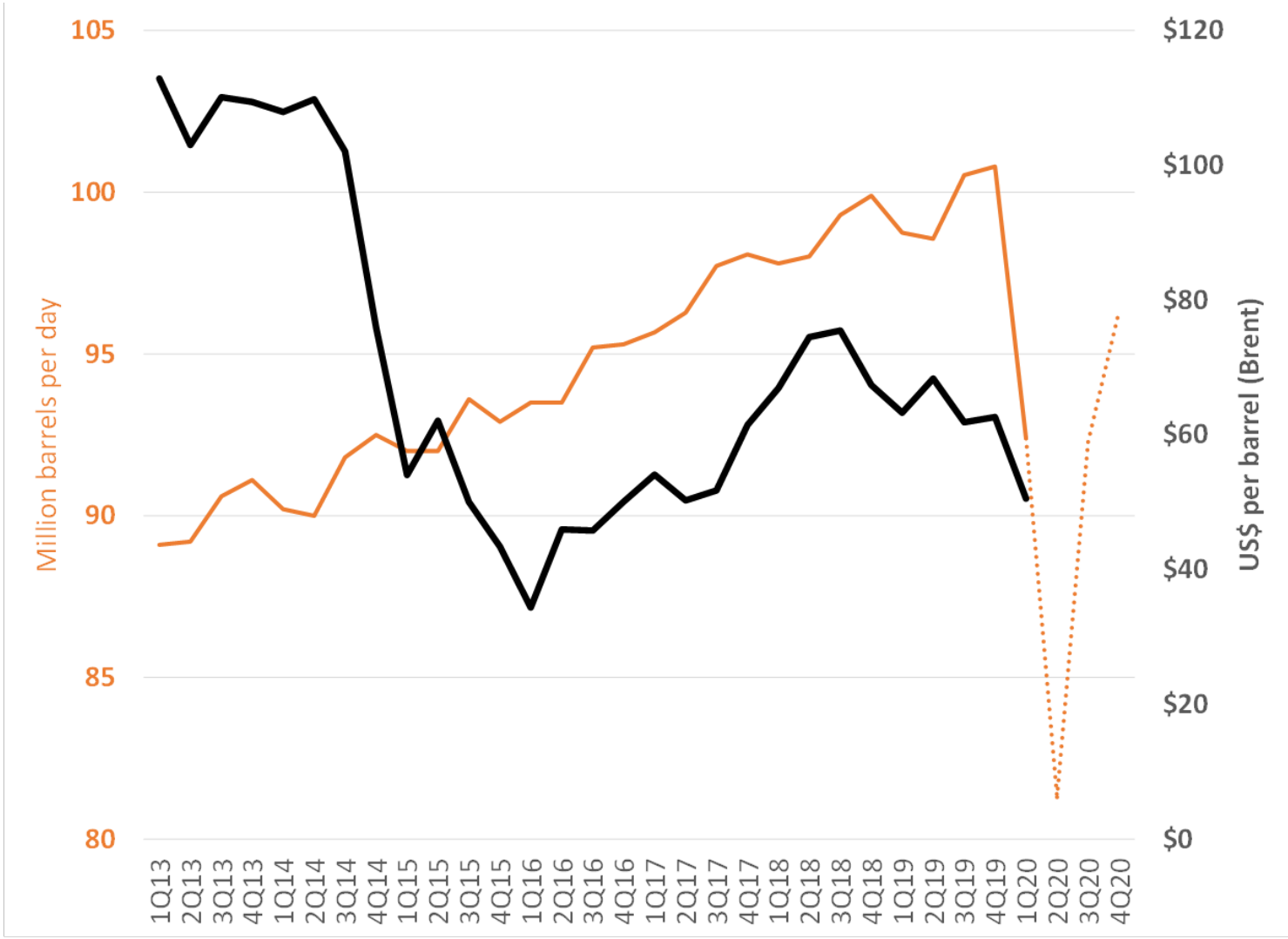
- **Impact of a reduction δ in structural demand:**
  Supply $=$ Demand : $D(Q + \delta) = C'(Q)$ yields

$$\left(\frac{dQ^*}{d\delta}\right) = \frac{-\eta}{\eta + (1 + \delta/Q)\,\epsilon}.$$

where $\epsilon(Q)$ and $\eta(Q)$ are respectively the (absolute values of) price elasticities of demand and supply

A zoom on the last years - up to "Covid-19"

World Oil Demand and Oil Price (Brent) Quarterly, 2013-2020



OPEC (2020) and Federal Reserve Bank St. Louis (2020)

Sketchy estimates

- Attributing the drop of prices of the last years to...
  - A change in supply only: $\epsilon = 0.16$
  - A change in supply
    + growth in demand (trend) $\epsilon = 0.10$

- **Covid-19:**
  - Structural shift of demand
  - No change in supply...
  - $\Rightarrow$ Equilibrium move along the supply curve:
    - Quantities drop by 30% (100 mb/d $\rightarrow$ 70)
    - Prices where divided by 3 (\$45 $\rightarrow$ \$15)
    - $\Rightarrow \eta \simeq 0.45$

- Supply or Demand policy?
  - Supply:
    $(dQ^*/d\Delta) = -\epsilon/\left[\epsilon + (1 + \Delta/Q)\,\eta\right] \simeq -\epsilon/\left(\epsilon + \eta\right) = 0.18$
  - Demand:
    $(dQ^*/d\delta) = -\eta/\left[\eta + (1 + \delta/Q)\,\epsilon\right] \simeq -\eta/\left(\eta + \epsilon\right) = 0.82$

Conclusion

- **Militant Action to cut supply:**
  - *Higher prices and profits to the industry (but that directly hurt by the action)*
  - Low environmental gains
- **Frugality and reduction in demand:**
  - *Lower prices hence more accessibility*
  - Relatively large environmental gains

Don't attempt to curve markets:
Aim at structural (demand) changes !