Divesting Power

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Motivation: market power mitigation in electricity

- Wholesale electricity markets prone to the exercise of market power for variety of reasons
- Market power mitigation a key policy consideration
  - Ex-ante regulation (including merger control)
  - Ex-post antitrust
- *Physical* or *virtual* plant divestments are often the main market power mitigation measures available to competition authorities/regulators
  - Merger control (several European examples since 2000)
  - Ex-ante regulation (e.g. UK, Italy, Spain)
  - Ex-post remedies for abuse of dominance (e.g. E.On, RWE, ENEL)

Common intuitions and some questions

- Distinction often made between *ability* and *incentives* assets
  - Ability assets have high marginal cost: lower opportunity cost of withholding
  - Incentive assets have low marginal cost: provide incentives for withholding ability assets
- Divestments of ability assets can reduce scope for withholding - but:
  - Which ability assets should be divested?
  - Should incentive assets also be divested to reduce incentives to withhold?
  - Can VPPs replicate the optimal divestment of ability and/or incentives plants?
- The existing literature primarily looks at effects of forward contracts (equivalent to a specific type of VPP), with generally limited attention to divestments

Aim of this paper

- Investigate the *optimal* market power mitigation policy, defined as the one leads to the greatest benefit to consumers (for a given size of intervention)
  - Different types of divestments
  - Divestments vs VPP
- Allow for rich set of divestment options within the generation portfolio (from baseload to mid-merit and price-setting plants)
- In order to do so we consider a simplified model of market power, i.e. the standard model of a dominant firm with a competitive fringe

Main results

- A unique optimal divestment can be identified in a model of a dominant firm with a competitive fringe, with the following features:
  - it includes price-setting generation plants, which would otherwise be withheld by the dominant firm
  - it does *not* include the cheapest generation assets withheld by the dominant firm (for sufficiently small divestment)
  - its the cost range spans the post-divestment price (for sufficiently large divestment)
  - it can be several-fold more effective than a baseload divestment
  - it is effective in reducing prices because it makes the residual demand faced by the dominant firm more elastic at the margin
- The effectiveness of VPPs is maximised when all of the call options included in the VPP are exercised
  - in this case the VPP reduces prices as much as a divestment of baseload generation of the same size
  - this implies that divestments are much more pro-competitive than VPPs (in a one-shot setting)

Model set-up

- Standard model of dominant firm with a competitive fringe
- Increasing and linear marginal cost function (symmetric): $c_i = \gamma q_i$ for $i = d, f$
- Demand is completely price-inelastic and constant: $q_d + q_f = \mu$
- The fringe bids all of its output at cost: $p = c_f = \gamma q_f$, where $q_f = \mu - q_d$
- Implies the following pre-divestment equilibrium:

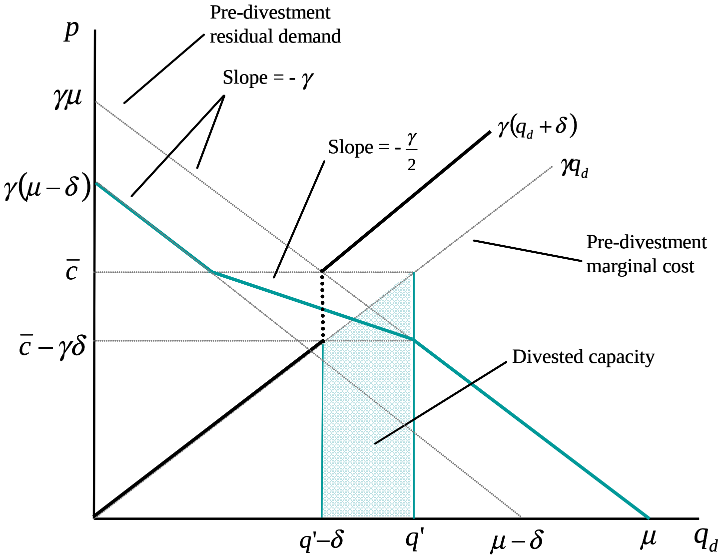
$$q_d^* = \frac{\mu}{3}; \text{ and } p^* = \frac{2}{3}\gamma\mu$$

- Prices are above the competitive level ($p^* > p^c = \frac{1}{2}\gamma\mu$).
- Withheld output equals $\frac{\mu}{6}$

Definition of divestment

- Transfer of contiguous segment of the marginal cost function of the dominant firm to the fringe (through a competitive auction that determines a lump-sum payment)
- Size of divestment defined as δ
- Position of divestment identified by highest (marginal) cost of the divested units, defined as $\overline{c}$ (implies lowest cost of the divested units is $\underline{c} = \overline{c} - \gamma\delta$)
- Divestment shifts both the marginal cost and residual demand schedules of the dominant firm:
  - *Cost-increasing* effect
  - *Demand-reducing* effect (coupled with a demand-slope effect)

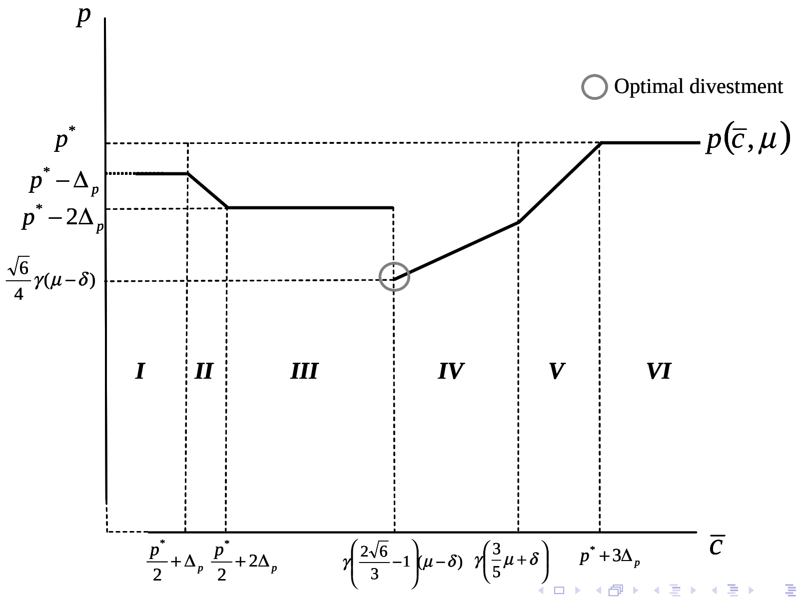
Description of divestment



Divestment size thresholds

- Three cases can be identified for the impact of a divestment on prices, depending on its size as a share of total demand ($\frac{\delta}{\mu}$)
  - *Small divestments*: $\frac{\delta}{\mu} < 1 - \frac{12}{5\sqrt{6}} \approx 0.02$
  - *Intermediate divestments*: $\frac{\delta}{\mu} \in \left[1 - \frac{12}{5\sqrt{6}}, 1 - \frac{2}{\sqrt{6}}\right]$
  - *Large divestments*: $\frac{\delta}{\mu} > 1 - \frac{2}{\sqrt{6}} \approx 0.18$
- We focus primarily on the intermediate case, which covers a broad range of outcomes (e.g. divestments of between 0.6 and 5.5GW in Spain at average demand)

Post-divestment price function



Post-divestment price function

- For intermediate divestments, the post-divestment price function is the following:

Segment	Price	Range of $\overline{c}$
I (baseload)	$p^* - \Delta_p$	$\gamma\delta \leq \overline{c} < \frac{p^*}{2} + \Delta_p$
II	$\gamma\mu - \overline{c}$	$\frac{p^*}{2} + \Delta_p \leq \overline{c} < \frac{p^*}{2} + 2\Delta_p$
III	$p^* - 2\Delta_p$	$\frac{p^*}{2} + 2\Delta_p \leq \overline{c} < \gamma\left(\frac{2\sqrt{6}}{3} - 1\right)(\mu - \delta)$
IV	$\frac{3}{8}(\gamma(\mu-\delta) + \overline{c})$	$\gamma\left(\frac{2\sqrt{6}}{3} - 1\right)(\mu - \delta) \leq \overline{c} < \gamma(\frac{3}{5}\mu + \delta)$
V	$\overline{c} - \gamma\delta$	$\gamma(\frac{3}{5}\mu + \delta) \leq \overline{c} < p^* + 3\Delta_p$
VI	p^*	$\overline{c} \geq p^* + 3\Delta_p$

where $\Delta_p \equiv \frac{\gamma\delta}{3}$.

Features of the optimal divestment

- The optimal divestment is given by setting:

$$\bar{c} = \hat{c} \equiv \gamma \left(\frac{2\sqrt{6}}{3} - 1 \right) (\mu - \delta) \approx 0.63\gamma (\mu - \delta)$$

- The divestment is price-setting in the post-divestment equilibrium:

$$p(\hat{c}) \in [\hat{c} - \gamma\delta, \hat{c})$$

- The divested capacity is marginal, but not ‘too’ expensive:

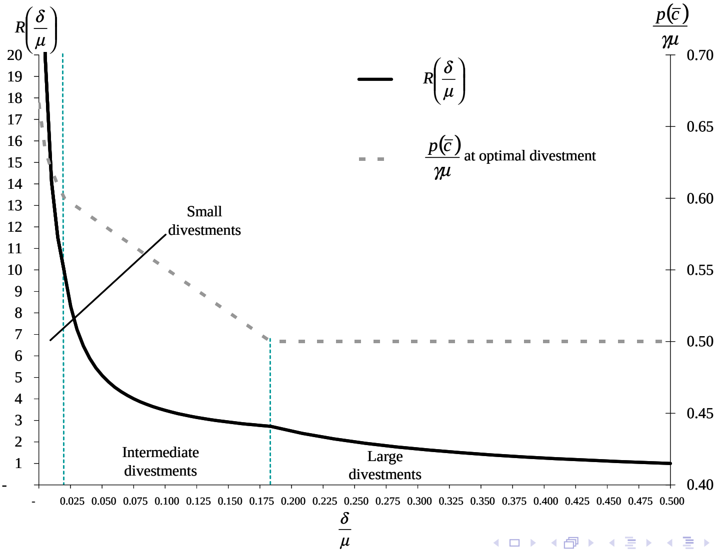
$$\hat{c} \in \left[\max \left(p^c, \gamma \left(\frac{\mu}{3} + \delta \right) \right), p^* \right)$$

- Achieves the competitive price p^c at the upper end of the range for $\frac{\delta}{\mu}$ (i.e. $\frac{\delta}{\mu} \approx 0.18$)

Small and large divestments

- *Small divestments* ($\frac{\delta}{\mu} < 1 - \frac{12}{5\sqrt{6}} \approx 0.02$)
  - optimal intervention is located at the bottom end of Segment V (i.e. the dominant firm to set a price equal to the lowest cost of the divested capacity)
  - the cost of divested plants remains between the competitive price and the pre-divestment price
  - the divested plants do not produce in equilibrium
- *Large divestments* ($\frac{\delta}{\mu} > 1 - \frac{2}{\sqrt{6}} \approx 0.18$)
  - it always optimal to divest the cheapest plants withheld by the dominant firm pre-divestment (i.e. setting $\overline{c} = \gamma \left(\frac{\mu}{3} + \delta \right)$)
  - the optimal divestment achieves the competitive price
  - the costs of divested capacity encompass the post-divestment price

Effectiveness of the optimal divestment compared to baseload



Welfare analysis

- A divestment affects total welfare (i.e. total costs) through 3 effects - e.g. at the optimal divestment:

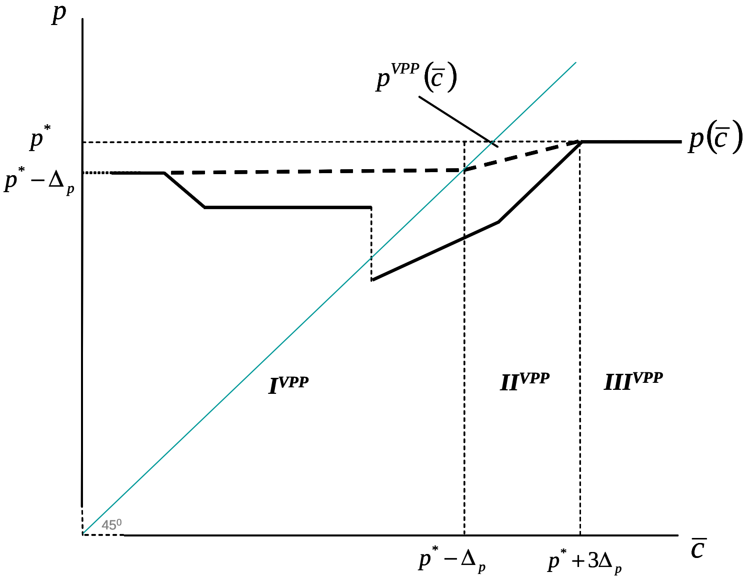
$$\Delta W(\hat{c}) = \underbrace{\int_{\frac{p(\hat{c})}{\gamma}}^{\frac{2}{3}\mu} \gamma x dx}_{\text{cost saving competitive fringe}} - \underbrace{\int_{\hat{q}-\delta}^{\frac{p(\hat{c})}{\gamma}} \gamma x dx}_{\text{additional cost divested units}} - \underbrace{\int_{\frac{\mu}{3}}^{\frac{\mu+\hat{q}-\delta}{4}} \gamma x dx}_{\text{change in cost dominant firm}} .$$

- Welfare increases as long as the output of the dominant firm (net of the divested output) does not decrease
  - This condition is satisfied at the optimal divestment
  - It is satisfied for other cost ranges except for range *III* (in which case welfare can fall if the divestment is sufficiently small and expensive)
- A baseload divestment increases welfare by less than the optimal one (due to the more limited re-allocation of output)

Definition of VPP

- We define a VPP as a group of call options that are imposed on the dominant producer
- The generator pays to option holders any positive difference between the spot price p and the strike price of each option p^s
- The maximum quantity which the option holders can exercise on aggregate is set equal to δ
- The options are sold through a one-off auction that determines a lump-sum payment to the generator
- A strike price function $f(q)$ can be defined to describe the (ordered) strike price(s) of the options contained in the VPP, for $q \leq \delta$
- Here we consider for simplicity an increasing and continuous linear strike price function that has slope γ
- This VPP therefore mimics a divestment of size δ and highest strike price $\overline{c}$

Impact of VPP (all sizes)



Baseload vs. non-baseload VPPs

- A VPP whose options are all exercised can be defined as a *baseload VPP*
- A baseload VPP achieves a price of $p^* - \Delta_p$, which in turn requires $\overline{c} < p^* - \Delta_p$
- A baseload VPP therefore yields the same price reduction as a baseload divestment of the same size:
  - it effectively "sterilises" an amount δ from the infra-marginal output of the dominant firm, inducing it to price lower
  - the effect is equivalent to simply not having some infra-marginal capacity and the associated demand (i.e. like in the case of a baseload divestment)
- With non-baseload VPPs (i.e. with $\overline{c} \geq p^* - \Delta_p$), a higher amount of the output of the dominant firm receives the spot price, inducing it to set higher prices

Divestments vs VPPs

- The comparison between the optimal and baseload divestment describes the relationship between the optimal divestment and the optimal VPP as well
- Why are VPPs are never more effective than divestments of the same size/position?
  - They affect the revenues obtained by the dominant firm but not the capacity available to its competitors
  - This implies that VPPs cannot be used to increase the output available to competitors without increasing the cost of the dominant firm (whilst divesting capacity that is marginal can achieve this)
  - Moreover, the dominant firm does not face incentives to drop its price to prevent some high-cost options in the VPP from being exercised (whilst this incentive is present at the optimal divestment)
- This comparison holds statically - it abstracts from the other possible (dis)advantages of VPPs

Conclusions

- We have identified the most pro-competitive divestment in a model of a dominant firm with a competitive fringe
  - the divested capacity needs to include price-setting generation plants, which would otherwise be withheld by the dominant firm
  - the optimal divestment is effective because it flattens the residual demand faced by the dominant firm, and can be several-fold more effective than a baseload divestment
  - the optimal divestment is welfare-increasing (and it can maximise welfare)
- The effectiveness of VPPs is maximised when it is exercised in its entirety
  - in this case the VPP reduces prices as much as a baseload divestment of the same size
  - this implies that divestments are much more pro-competitive than VPPs (in a one-shot setting)

Conclusions

- Policy implications: **remedies**
  - the choice of divested plants makes a significant difference to their effectiveness as a remedy
  - VPPs are significantly less effective than divestments as a remedy (in static setting)
  - Mimicking the optimal divestment through a VPP does not increase the effectiveness of the VPP
- Policy implications: **merger control & entry**
  - acquisition of price-setting capacity by a firm with market power can be significantly more anti-competitive than baseload acquisition (i.e. it relaxes a more significant competitive constraint)
  - on the other hand, a well-chosen marginal divestment can offset the effects of a larger baseload acquisition
  - entry of price-setting plants can constrain prices more than entry of baseload plants
- Possible extensions include cases with variable demand; and with oligopoly interaction