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Slot allocation under uncertainty

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Agenda

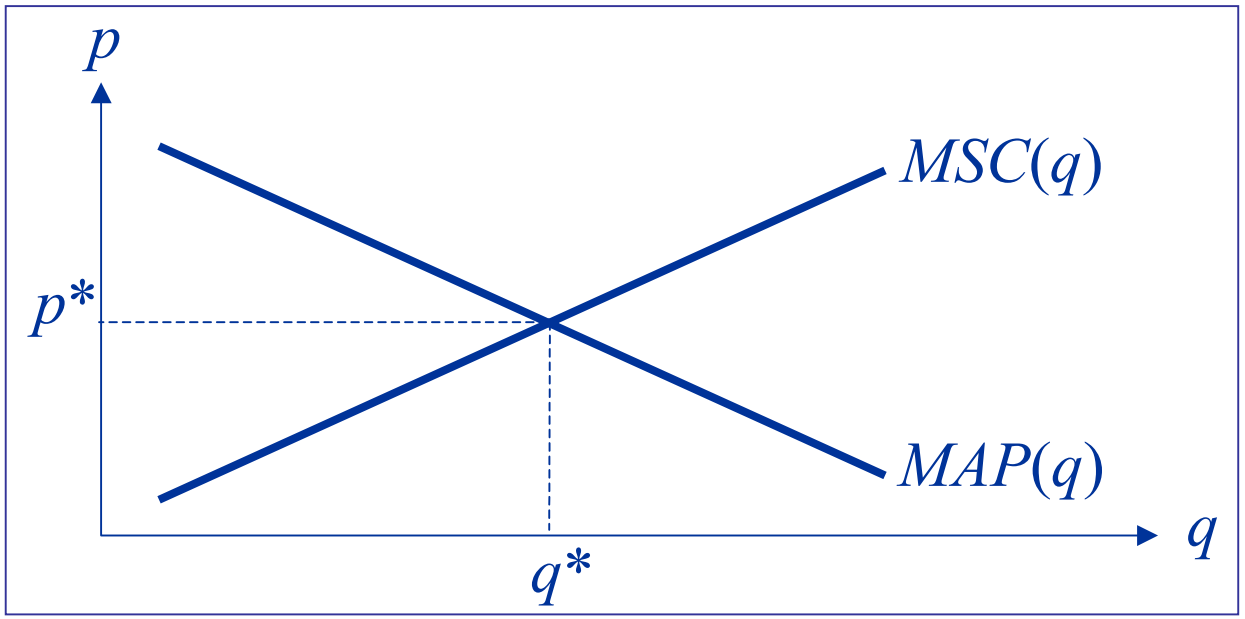
- Aim of the presentation
- Slot allocation under perfect information
- Uncertainty in the air transport industry
- Price based mechanisms versus quantity based mechanisms
- Price and quantity based mechanisms
- Conclusions
- Literature

Aim of the presentation

- A slot is, roughly spoken, the permission of an airline to take-off or to land at an airport at a specified time
- Slot prices and quantities can be varied by a regulation authority or the airport
- The aim of the presentation is to show that uncertainty has an important effect on the (expected) welfare generated by different market mechanisms for determining prices and quantities

Slot allocation under perfect information

- Welfare(q) = Airline profits(q) – Social cost(q) with $q \geq 0$ being the number of homogeneous slots
- Welfare maximization: ***M***arginal ***A***irline ***P***rofit(q) = ***M***arginal ***S***ocial ***C***ost(q)
  (Given that only one such point exists and the second order condition for a maximum is also fulfilled)
- Airlines have to pay a price $p \geq 0$ per slot



➢ ***Under perfect information, the implementation of a slot charge p* or an (efficient) auction with quantity q* leads to welfare maximization!***

Uncertainty in the air transport industry

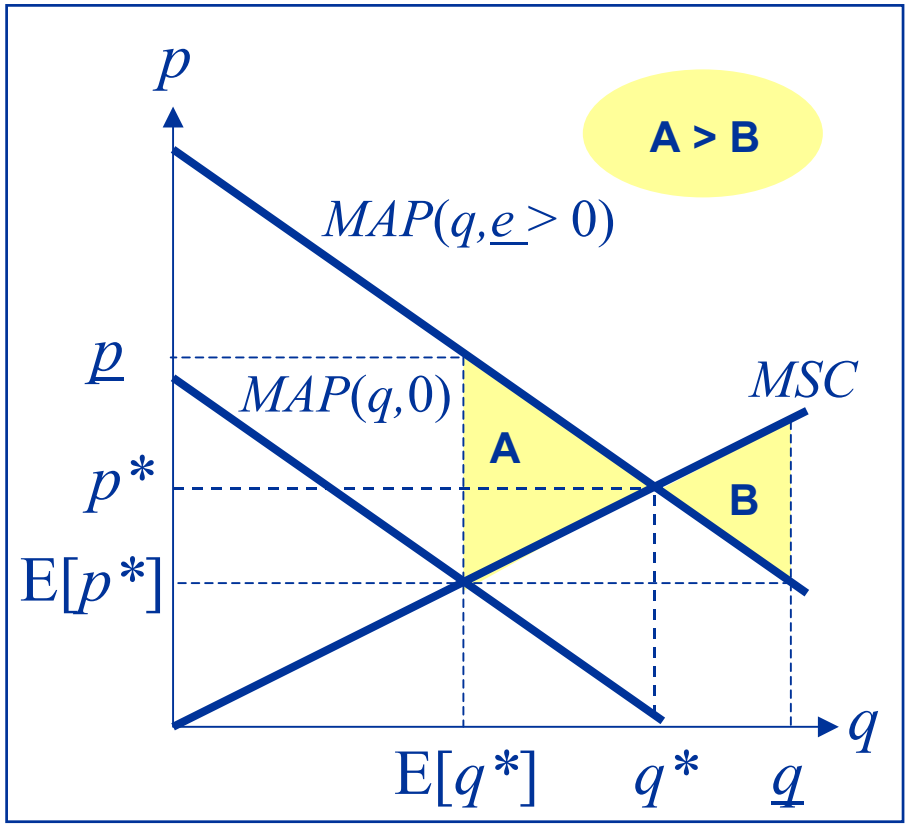
- Airline profitability
  - Profitability, hence, slot demand is private information
  - Airlines face uncertain passenger and shipper demand
- Social costs
  - Delay or environmental costs are difficult to estimate
  - Delay depends on the pattern of aircrafts used by airlines which is uncertain

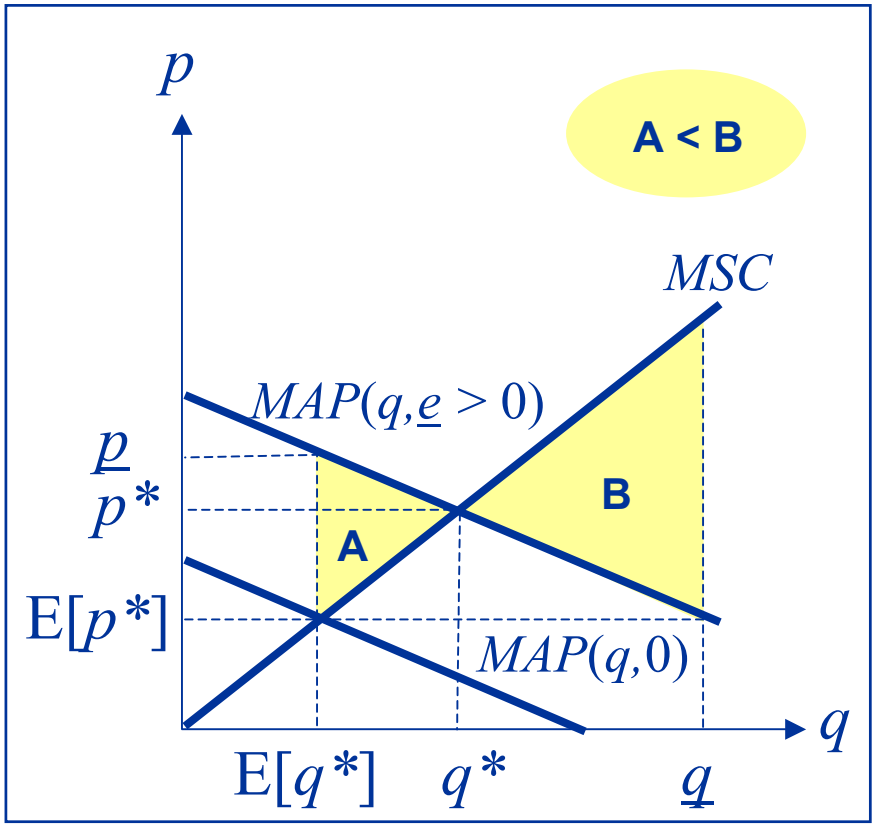
➢ ***The following analysis focusses on an uncertain airline profitability or rather an uncertain slot demand***

Price versus quantity

$MAP(q,e) = a - bq + e$ with $a,b > 0$ and $e \sim (0,\sigma^2)$

$MSC(q) = vq$ with $v > 0$





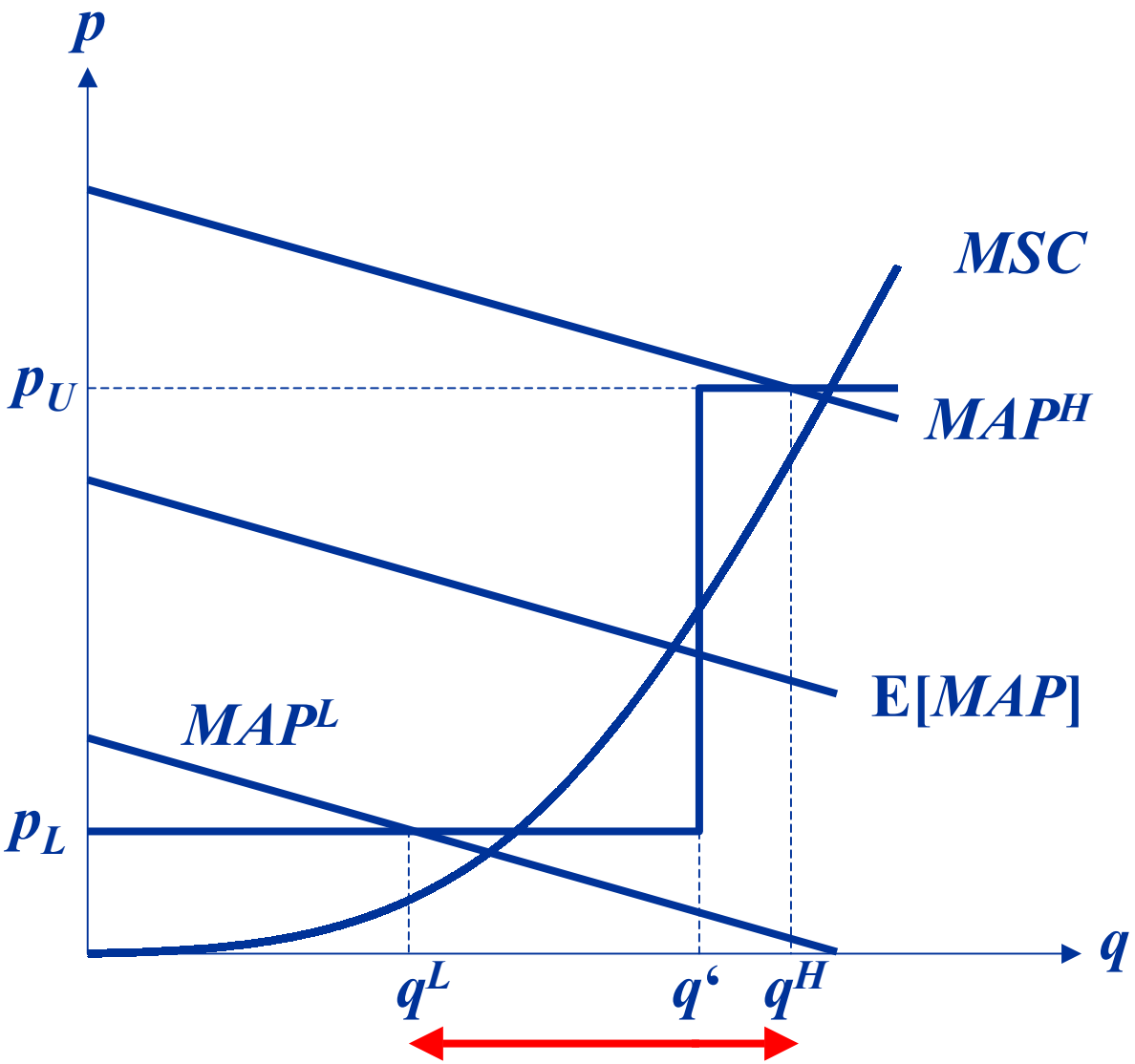
➢ ***Superiority of fixing E[p*] instead of E[q*] depends on the slopes of the functions MAP and MSC: E[p*] better than E[q*] iff*** $\sigma^2(b - v)/2b^2 > 0$.

Price and quantity

- In general, the superiority of price based or quantity based mechanisms only holds if the relevant functions are „nearly“ linear (Weitzman 1974)
- A price and quantity based mechanism increases expected welfare even more
- Such a mechanism could consist of three elements (Roberts and Spence 1976):

  1. an upper price-limit $p_U \geq 0$
  2. a lower price-limit $p_L \geq 0$ with $p_U \geq p_L$
  3. and a certain default quantity $q' \geq 0$

Prices and quantities



Conclusions

- Uncertainty strongly affects the preferability of different market mechanisms
- Price and quantity based mechanisms increase expected social welfare

Thank you very much for your attention!

Literature

Adar, Z. & J. M. Griffin, 1976, Uncertainty and the Choice of Pollution Control Instruments, *Journal of Environmental Economics and Management* **3**, 178-188.

Baumol, W. J., W. E. Oates, 1988, The Theory of Environmental Policy (Cambridge).

Collinge, R. A. & W. E. Oates, 1982, Efficiency in Pollution Control in the Short and Long Runs: A System of Rental Emission Permits, *Canadian Journal of Economics* **15**, 178-188.

Cropper, M. L. & W. E. Oates, 1992, Environmental Economics: A Survey, *Journal of Economic Literature* **30**, 675-740.

Kaplow, L. & S. Shavell, 1997, On the Superiority of Corrective Taxes to Quantity Regulation, NEBR Working Paper 6251.

Roberts, M. J. & M. Spence, 1976, Effluent Charges and Licenses under Uncertainty, *Journal of Public Economics* **5**, 193- 208.

Shrestha, R.K., 2001, The Choice of Environmental Policy Instruments Under Correlated Uncertainty, *Resource and Energy Economics* **23**, 175-185.

Stavins, R.N., 1996, Correlated Uncertainty and Policy Instrument Choice, *Journal of Environmental Economics and Management* **30**, 218-232.

Weitzman, M. L., 1974, Prices vs. Quantities, *Review of Economic Studies* **41**, S. 50-65.