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ITPU International Seminar on Transport Congestion Policy
Slot allocation, pricing, and regulation in congested airports

Congestion and Transport Policy

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Outline

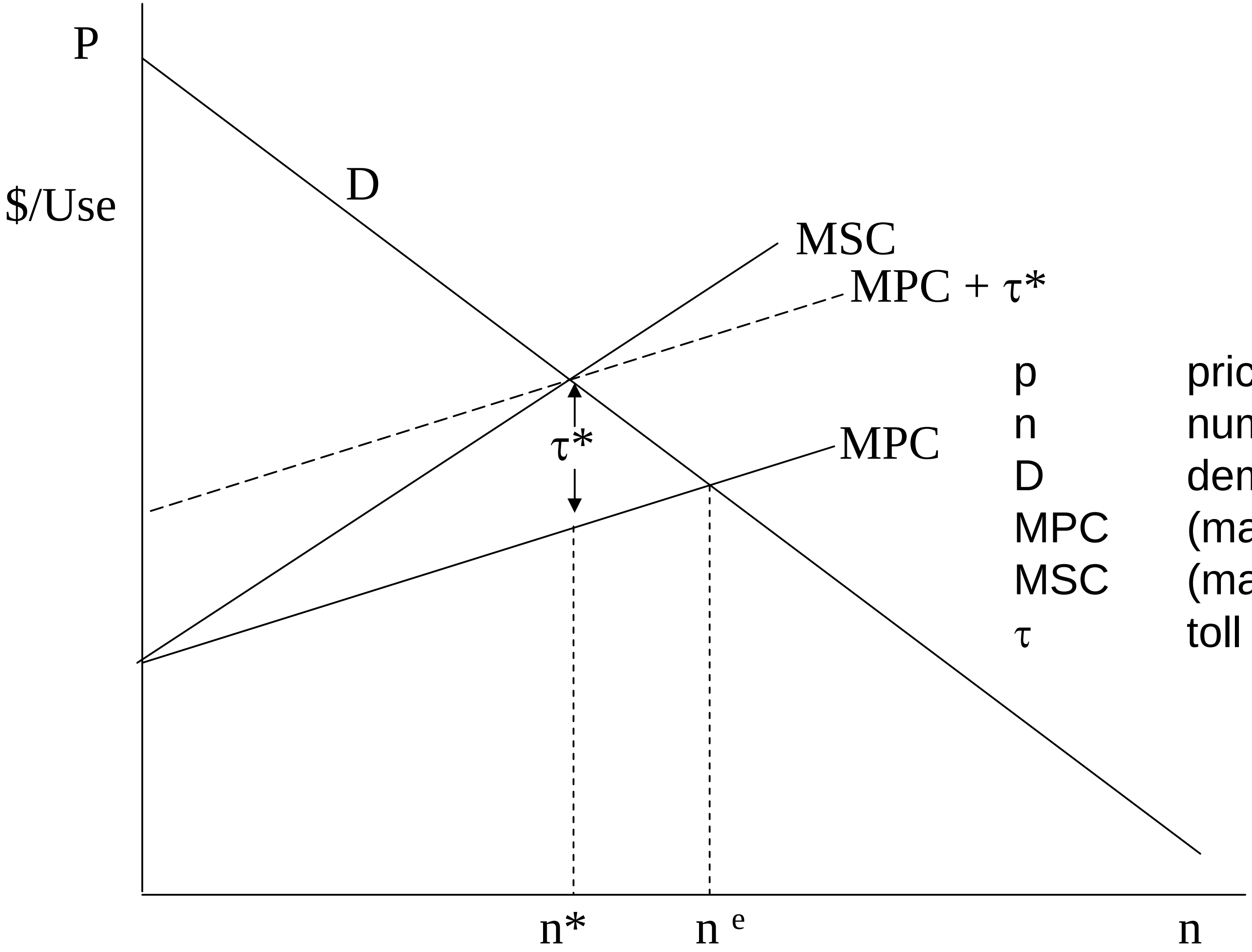
- 1. Congestion: general principles
- 2. Congestion: simple geometric analysis -- short run
- 3. Congestion: simple geometric analysis -- long run
- 4. Complications -- networks, multiple congestible elements, stock vs flow congestion, heterogeneous users, second best
- 5. Particular features of airport congestion

- 1. General Principles
- A general rule of economic allocation is that a rational, self-interested economic agent will make efficient decisions if he faces the full social cost of his actions and receives the full social benefits from them.

- Let's apply this principle in the context of congestion. An individual who uses a congestible facility increases the cost of those who are already using the facility (or diminishes their benefit from its use) without compensating them. In economic terminology, there is an "uninternalized negative externality". Since the private cost to the individual of using the facility is less than the social cost, he will tend to overuse the facility from a social point of view, generating inefficiency.

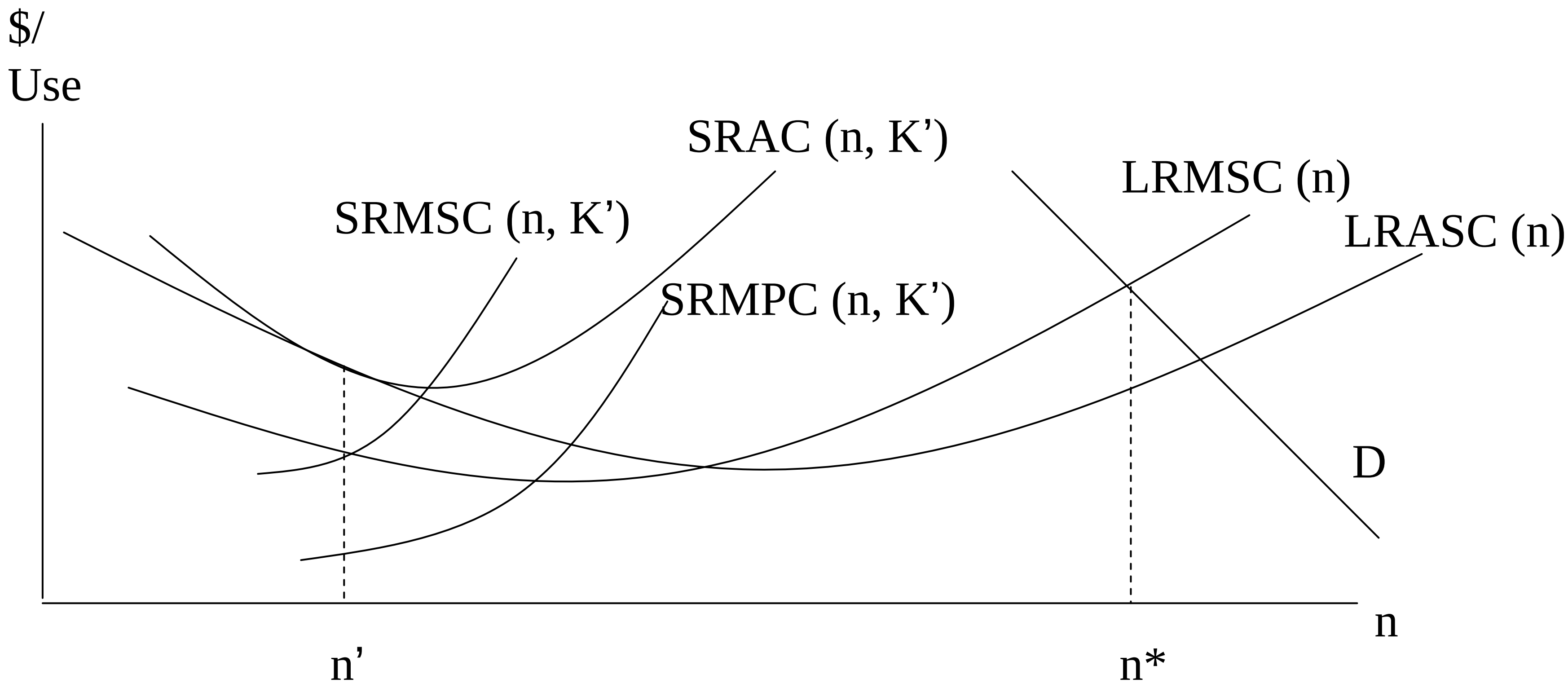
- One way to correct this inefficiency is to charge each user a congestion toll equal to the difference between the social cost and the private cost of using the facility. When the toll is applied, the individual faces the social cost of facility usage, and therefore makes efficient decisions with respect to usage.
- This principle applies not only to congestible transport facilities but to swimming pools and even to cities.

- 2. Simple Geometric Analysis: Short-run
- This line of argument is illustrated by the following diagram.



p	price
n	number of uses
D	demand curve
MPC	(marginal) private cost
MSC	(marginal) social cost
τ	toll

- 3. Simple Geometric Analysis: Long-run



K'	level of capacity
SRAC	short-run (capacity fixed) average cost
SRMPC	short-run marginal private cost
SRMSC	short-run marginal social cost
LRASC	long-run (capacity variable) average social cost
LRMSC	long-run marginal social cost

- Long-run average cost curve is the lower envelope of the short-run average cost curves.
- Let K*(n) denote the cost-minimizing level of capacity as a function of n. At that n for which K'= K*(n), n', SRMSC(K',n') = LRMSC(n')
- Optimal long-run usage occurs at that n for which the demand curve intersects the long-run marginal social cost curve, n*.
- Optimal capacity is the efficient level of capacity for n*, K*.
- τ^* = SRMSC(K*,n*) - SRMPC(K*,n*)

- 4. Complications
- A. Networks/multiple congestible elements of capacity
- The simple presentation above deals with a single congestible element of capacity. Most congestible facilities contain a network of congestible elements of capacity. This is obviously the case for transportation systems. Air traffic takes place on a network, with each airport a congestion node. But also, each airport contains a network of congestible facilities: road access, parking, check-in, security, concessions, gate seating, gates, runways, airspace.
- The above principles apply to each congestible element of capacity

- B. Stock vs. flow congestion, link vs. nodal congestion
- There are different types of congestion. One distinction is between stock and flow congestion. Stock congestion occurs when the delay (or degradation of service) is a function of the stock of users; an example is the number of swimmers in a pool. Flow congestion occurs when the delay is a function of number of users per unit time; freeway congestion is usually modeled as flow congestion. Another distinction is between link and nodal congestion. Link congestion occurs on network links; e.g. freeway flow congestion. Nodal congestion occurs at network nodes; e.g.,switching circuits for telephone traffic. At the level of the network, most air travel congestion is nodal.

- C. Heterogeneous users
- The simple analysis above assumed that all users are the same. But user groups may differ in not only their demand characteristics but also in how they contribute to congestion. An example of the latter is planes of different sizes and performance characteristics. With heterogeneous users, the issue arises as to whether it is efficient to have separate facilities for different user types. Prices may also be differentiated across users. Policies will differ according to the observability of user characteristics. Different policies can be applied to cars and trucks but not to users who differ according to the value of time.

- D. Second best
- The simple analysis above assumed that the full optimum, the first best, is attainable. If there are political, institutional, or informational restrictions which preclude attainment of the first best, the analysis of policy becomes an exercise in the theory of the second best and is more difficult.
- E. Reliability
- The simple analysis above assumed that demand and travel times are deterministic. But neither is completely predictable. In the context of air travel, weather at a particular airport affects arrival and departure capacity, and weather at other airports leads to unpredicability of the arrival rate.

- 5. Particular Features of Airport Congestion

- Different congestible facilities have different characteristics. Some of the particular characteristics of airport congestion are the following.

- A. Three-stage game
- Passengers decide on what airline to patronize, when to fly, and how often to fly, taking prices, schedules, and congestion as given. Airlines decide on prices, schedules, and carrying capacity, in strategic competition with one another, taking into account how passenger traffic and congestion will respond to their policies, and normally taking airspace, runway, traffic control capacity, and other airport authority decisions as given. Airport authorities make their decisions, taking airline and passenger responses into account, and subject to the regulatory constraints they face.

- B. Schedule delay
- Passengers will decide when to travel, taking into account not only fares and congestion but also schedule convenience and connection delays.

- C. Connection delays
- Efficient scheduling at hub airports involves arrival and departure banks, which reduces connection delays.

- D. Regulation of airport authorities
- Most airport authorities are regulated. These regulations may restrict an airport authority's ability to implement efficient policy. Suppose, for example, that the airport authority is required to break even and that airlines resist congestion pricing for runway use. The airline authority may choose to charge monopoly rents for concessions -- food, parking, etc.

- E. Air traffic noise and access congestion
- The siting and capacity of airports may be heavily constrained by local opposition to the noise and access congestion caused by airports.

- F. Reliability
- Reliability of travel times is an important element of air travel.