ONE TRAIN OPERATOR AND TWO INFRASTRUCTURE MANAGERS: A SIMPLE MODEL TO EXPLORE THE ISSUE OF INFRASTRUCTURE CHARGING

Dominique Bouf
LET, CNRS, University of Lyon 2

CONTEXT

- International link or « French concession »
- two infrastructure managers
- a certain degree of freedom to set infrastructure pricing.
- example here : Paris - Tour -Bordeaux. Tour-Bordeaux is operated in concession.
- Model during peak hours.

OPERATOR MODEL 1

- Linear demand :
- q=q0-b.p, q= passengers demand, p = price.
- K = capacity of a train;
- C1= marginal cost of a train, constant.
- operator regulated to cover marginal cost.
- p0 defined by p0.K=C1

OPERATOR MODEL 2

- q1=q0-b.p0
- ∃ m such as :
- m-1≤q1/K<m (if m=1, no train)
- the demand is rationed to fill exactly m-1 trains, thus the price increases from p0 to p, such as :
- q0-b.p=(m-1).K

$$p = \frac{q_0 - (m-1).K}{b}$$

- Revenue :
- (m-1)(p.k-C1)>(m-1)(p0k-C1)=0

OPERATOR MODEL 3

- The operator can choose to increase further the prices :
- q=(m1-1)K
- p=(q0-(m1-1)K)/b, there is a function* p(m)
- Bn= « benefit » from operating n trains
  = p.q-C= [(q0-n.K)/b] .n.K- n.C1
- the reciproque function of B(n) is n(B)

* a discrete function

OPERATOR MODEL 4/ EXISTENCE OF A MAXIMUM BENEFIT

- Bn-1 - Bn> 0 $\Leftrightarrow$
- (q0-(n-1).K).(n-1).K/b-(n-1)C1 - (q0-n.K).n.K/b-nC1 >0
- $\Leftrightarrow$
- n> ([q0.K-C1.b]/K2+1)/2≡ n0
- if n > n0, the benefit increases as the number of trains decreases.
- B(n0) ≡ Bmax, b(p) is the « benefit » at price p.

TWO INFRASTRUCTURE MANAGERS, IM1 AND IM2

Each one is the owner of a part of the track

IM1 Example : Paris Bordeaux
IM2 has a « concession »
BOT for 65 years on Tour Bordeaux

IM2 In this model, the IMs will increase their infrastructure charges and thus diminish the number of trains to achieve their objectives IM2

We will consider only the traffic between two cities

A) If IM1 and IM2 are charging marginal cost, constant:

- same calculation as before with C2=C1+cm1+cm2
- in comparison to previous case; q1 is smaller; m is smaller; p is larger

B) IM2 pricing is marginal cost IM1 pricing is full cost (including capital cost)

- Let us denote k1=K1.i,
  K1= capital spend to build infrastructure 1;
  i= interest rate.

- Model with C=C2=C1+cm1+cm2.

- If k1<Bmax, IM1 can recover its costs by iteration.
  IM1 sets the price to k1/(m-1), the number of train is m1
  IM1 sets the price to k1/m1, the number of train is m2 and so forth as k1<Bmax-cm1-cm2, there is one me such as
  B(me)>k1 and P(me)>k1/me.

- IM2 is subsidizing IM1
- If k1> Bmax, IM1 cannot fully recover its costs and IM1 needs subsidies.

C) Both IM want to recover their capital costs

- Not unlikely : IM1 wants to minimize the subsidies IM2 does not want to sudzidize IM1.

- There are two cases :
  1) k1+k2 < Bmax
  this case is similar to case B).
  2) k1+k2 > Bmax 11

C) 2) k1+k2 > Bmax

- IM2 chooses n(k2), thus p(n(k2)), IM2 don 't know what infrastructure charging will be chosen by IM1.
- Similarly IM1 chooses p(n(k1)).
- The outcome is a price superior to p(n(Bmax))
- (k1+k2)/m > Bmax/m $\forall$ m, number of trains running.
- It follows that they cannot reach a « benefit » of k1+k2
- but the number of trains is reduced and the « benefit » is reduced with respect to Bmax or anything between Bmax and b((k1+k2)/m)
- this situation is clearly sub optimal.

C) 2) k1+k2 > Bmax

How to exit this sub optimal situation ?

- This situation looks like a Bertrand curse : each one of the IM should benefit from a decrease in infrastructure charge but the one that decreases effectively its charge benefit less than the other.
- The solutions to exit this sub optimal situation could be :
  - long term contracts between the IM
  - regulation by a supervisory agency.13

CONCLUSIONS

- Possibilities of cross subsidies between IM
- Possibilities of sub optimal situation (the Bertrand curse)
- ==> necessity to co-ordinate and to regulate.