ACCHANGE

Building economic models for understanding ATC performance

Sesar Innovation Days

25 November 2014

TRANSPORT & MOBILITY LEUVEN

האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

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Core-Invest n.v.

SESARWPE
LONG TERM AND INNOVATIVE RESEARCH

Introduction

- ACCHANGE project
  - Can change within ATM cannot come from within the sector
  - Today:
    - Very much top down regulated
    - Implementation different policies have not (yet) met expectations
- This paper (based on D4.1)
  - What about the regulatory framework for ANSPs?
    - How does the regulatory framework look like and what are key variables?
    - What incentives does this give to ANSPs for efficiency and quality of services?
  - Using a regulatory economics framework
    - Based on public utility model of Laffont & Tirole
    - Evaluate efficiency
    - Evaluate capacity

- Full report will be available on website

http://www.tmleuven.be/project/acchange/home.htm

Outline presentation

- Introduction
- Economic agents and their objectives
- Theoretical framework
  - Cost and information
  - Performance regulation
- Theoretical analysis
- Numerical illustrations
- Union bargaining model
- Conclusions

Economic agents and objectives

- Air navigation service providers
  - Attach value to the revenues of their customers: airports, airlines, passengers: γ_1^{ANSP}
    - Many ANSPs have representatives of airports and airlines in their boards
    - Many ANSPs are more or less controlled by their national governments
      - Governments put value on profits/employment at airports and national flag carriers
  - Attach value to their own revenues: γ_2^{ANSP}
    - They need to be able to recover their costs
    - Profits can be used to reinvest
    - Since performance regulation building up some reserves is not unrealistic
  - Attach value to national interests: γ_3^{ANSP}
    - Labour interest represented by unions
    - Other national interests such as sovereignty, manufacturers benefits, etc.

Economic agents and objectives

- Regulators
  - EC sets regulatory framework in collaboration with Eurocontrol
  - National supervisory authorities implement performance regulation
  - Not the focus of this presentation, more developed in paper

Theoretical framework: cost and information

- Cost per flight depends on ANS capacity
  - Inefficiency: Potential for efficiency improvement
  - Efficiency and effort to improve efficiency by ANSP management imperfectly observable

$$c = a + \theta - e$$

$$c(cap, e) = \frac{Cost(cap) + Other\ cost}{flightkm} + \theta - e$$

  - Efficiency effort is costly

$$\frac{Cost(e)}{flightkm} = \frac{\emptyset \cdot e^2}{2}$$

Theoretical framework: Performance regulation

- Goal is to provide efficiency incentives
  - Perfect information: $e^* = 1/\emptyset$
  - Rate of return regulation (cost+):

$$ansp_{cost+} = \frac{Tot\ Cost}{flightkm}$$

  - Price-cap regulation (based on determined costs principle):

$$ansp_{cap} = \frac{E(Tot\ Cost)}{E(flightkm)}$$

  - Adding financial incentive for outperforming performance targets
    - Reduce incentives to cut back on capacity (could increase delays)

$$-(del(cap) - del_0) \cdot BM \cdot \overline{\frac{flight}{flightkm}}$$

Theoretical framework: Performance regulation

- Current regulation
  - Mixed regulation

$$ansp_{charge} = (1 - B) \cdot ansp_{cap} + B \cdot ansp_{cost+} - (del(cap) - del_0) \cdot BM \cdot \frac{\overline{flight}}{flightkm}$$

Power of the price-cap B

Strength of financial incentive for reaching performance target BM

Strength of performance monitoring BM

Theoretical analysis

- Effect of performance regulation on ANSP efficiency incentives

$$e^{*}=\frac{\gamma_2^{ANSP}+B\cdot\left(\gamma_1^{ANSP}-\gamma_2^{ANSP}\right)}{\left(\gamma_2^{ANSP}+\gamma_3^{ANSP}\right)\cdot\emptyset}$$

- Pure price-cap (B=0):

$$e^{*}=\frac{\gamma_2^{ANSP}}{\left(\gamma_2^{ANSP}+\gamma_3^{ANSP}\right)\cdot\emptyset}$$

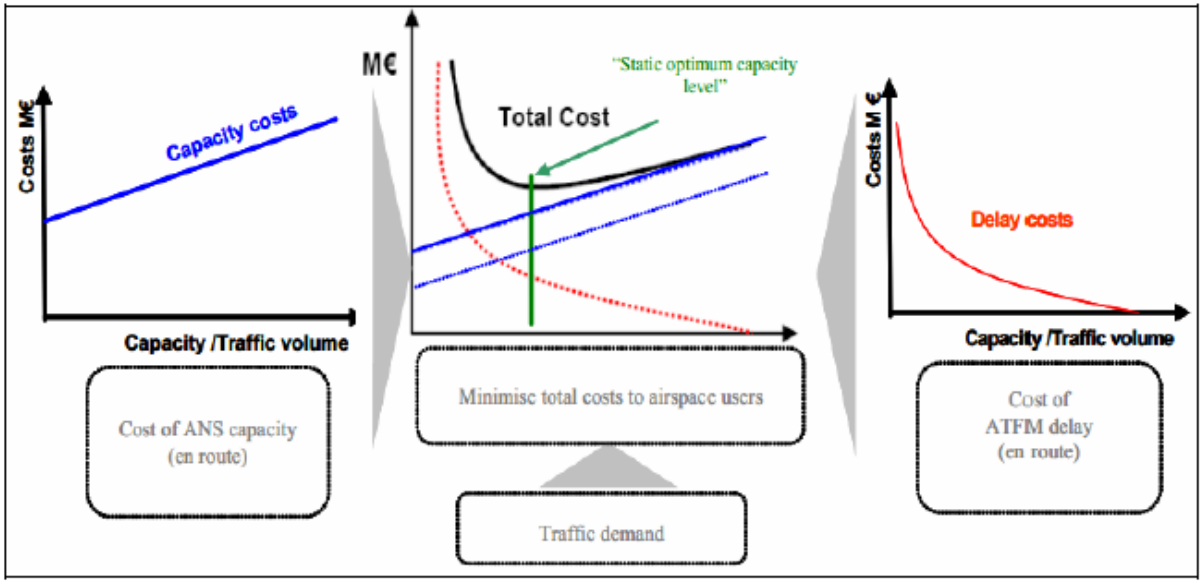
- Cost+ (B=):

$$e^{*}=\frac{\gamma_1^{ANSP}}{\left(\gamma_2^{ANSP}+\gamma_3^{ANSP}\right)\cdot\emptyset}$$

Theoretical analysis

- Effect of performance regulation on service quality
  - Focus on capacity and link with delays

$$del(cap) = \frac{Tot\ delay\ cost}{flights} = \frac{\delta}{cap}$$



$$pass(cap) = \frac{p_{max} - p_{user}(cap)}{coef}$$

Theoretical analysis

- Case with no performance monitoring and no financial incentives (BM=0)
  - Cost+ approach:

$$-\frac{\partial del}{\partial cap^*} = \frac{\partial a}{\partial cap^*} \cdot \overline{\frac{flightkm}{flight}}$$

  - Price-cap approach: incentives to reduce capacity

$$-\frac{\partial del}{\partial cap^*} \cdot \gamma_1^{ANSP} = \frac{\partial a}{\partial cap^*} \cdot \overline{\frac{flightkm}{flight}}$$

  - 'Traffic risk': lower capacity reduction incentives, but depends on strength of demand response

$$-\frac{\partial del}{\partial cap^*} \cdot \gamma_1^{ANSP} + \frac{pass'^{(cap)}}{pass(cap)} \cdot TR \cdot (profit\ \&\ CS) = \frac{\partial a}{\partial cap^*} \cdot \overline{\frac{flightkm}{flight}}$$

Theoretical analysis

- Introduction of performance incentives (BM>0)
  - Optimal capacity condition in price-cap approach:

$$-\frac{\partial del}{\partial cap^*} \cdot \left(\gamma_1^{ANSP} \cdot (1 - BM) + BM\right) = \frac{\partial a}{\partial cap^*} \cdot \frac{\overline{flightkm}}{flight}$$

  - Equivalent or better compared to cost+ approach if:

$$\left(\gamma_1^{ANSP} \cdot (1 - BM) + BM\right) > 1$$

  - Or if:

$$BM > 1$$

Numerical illustrations - efficiency

- Take $\gamma_1^{ANSP} = 0.5$ and $\gamma_2^{ANSP} = 1$
- Example for centralized services: theoretical potential of 2.5% reduction in ANS costs in EU

γ_3 B	1	0.8	0.6	0.4	0.2	0
0	1.25%	1.5%	1.75%	2%	2.25%	2.5%
0.1	1.14%	1.36%	1.59%	1.82%	2.04%	2.27%
0.2	1.04%	1.25%	1.46%	1.67%	1.87%	2.08%
0.3	0.96%	1.15%	1.35%	1.54%	1.73%	1.92%
0.4	0.89%	1.07%	1.25%	1.43%	1.6%	1.78%
0.5	0.83%	1%	1.17%	1.33%	1.5%	1.67%

Numerical illustrations - capacity

- Data for EU wide ANSP performance (ACE reports, average values 2004-2011)

Variable	Number	Source
Cost/minute delay	83 €/min	University of Westminster, delay cost
En-route ATFM delays	11.8M min	ATM cost-effectiveness benchmarking 2011
Delay cost	980 M€	Calculation
Flight hours	13.5 M	ATM cost-effectiveness benchmarking 2011
Average delay cost/flight	72 €/flight hour	Calculation
Estimated capacity level	1.15 flight hour/min	Calculation

Numerical illustrations - capacity

- More data from PRB & PRU reports

Variable	Number
Capacity cost elasticity	0.7
Average kilometers/hour	646
Average #passengers per flight	102
Current ANS capacity cost	0.156 €/flightkm
Passenger demand elasticity	-2.8%

Numerical illustrations - capacity

- Results with no monitoring of capacity performance target

Variable	Cost+ approach	Price-cap approach	Price-cap with traffic risk
Capacity (flighthours/min)	1.17	0.59	0.656
Delay cost per flight hour	71€	141€	127€
Delay per flight	1.25 min	2.49 min	2.24 min

Numerical illustrations - capacity

- Results with financial incentive for capacity performance target

BM	0	0.5	1	1.5	2
Capacity (flight hours/min)	0.59	0.88	1.17	1.47	1.76
Delay cost per flight hour	141 €	94 €	71 €	56 €	47 €
Delay per flight (min)	2.49	1.66	1.25	0.99	0.83

Union bargaining

- Introduce bargaining stage between ANSP (managers) and labour unions
- Possible explanation for variation in efficiency between ANSPs

$$(Goal\ ANSP)^{\delta} \cdot (W \cdot L - W^{0} \cdot L^{0})^{1-\delta}$$

Union bargaining

- Result: the labour interest are able to extract part of the ANSP benefit, depending on the relative bargaining powers δ & $1-\delta$

$$W \cdot L - W^0 \cdot L^0 =$$

$$\frac{1-\delta}{\delta} \cdot \left(\frac{\gamma_1^{ANSP}(CS) + \gamma_2^{ANSP}(Profit)}{\gamma_1^{ANSP} \cdot B + \gamma_2^{ANSP} \cdot (1-B)} \right)$$

Union bargaining

- Numerical illustration (for $\gamma_1^{ANSP} = 0.5$)

B δ	0.95	0.96	0.97	0.98	0.99	1
0	81 579	64 583	47 938	31 633	15 657	0
0.25	93 233	73 810	54 787	36 152	17 893	0
0.5	108 772	86 111	63 918	42 177	20 875	0
0.75	130 526	103 333	76 701	50 612	25 051	0
1	163 158	129 167	95 876	63 265	31 313	0

Conclusions

- Cost+ leads to excessive cost and over-investment in capital
  - Price-cap gives an incentive to improve efficiency of operations
  - May also give an incentive to cut back on capacity (quality of service)
    - 'Traffic risk' not very effective in incentivizing service quality
      - Low demand elasticity for air navigation services
    - Performance monitoring or financial incentives can improve incentive structure with respect to choice of capacity
  - Union bargaining provides alternative view on source of 'inefficiency' and also reduces the scope of price regulation in addressing them
    - Bargaining positions more important for efficiency improvement than performance regulation

Way forward

- Develop a simple network model to analyze interrelationships between various European ANSPs
- Analyze leverages for change in air navigation service provision
  - Collaboration (horizontal, vertical)
  - Technological implementation

Thank you!

Questions?

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