The Analysis of Impact of Aircraft Technological Innovation on Frequency

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Introduction

Challenges for airline industry:

- Current global appeal for sustainable development
- Vigorous competition within the industry
- Volatile fuel prices
- Increasing demand

Airbus: ”A380 is a the biggest double-deck aircraft that is designed to meet the future demand for more-efficient, cleaner, quieter and smarter aircraft.”
Aircraft suits long-haul and high-density markets, allowing to absorb high-frequency operations (King, 2007)

Objectives of the research

- Given the introduction of A-380 do other companies have incentives to follow this innovation?
- After the introduction of A-380 do competitors have incentive to change their frequency?

What have already been done

Econometric model - Conditional fixed effect logistic model on the route FRA-JFK

$$P(\text{use A380}_{it} = 1 \mid x_{it}, y_{it-1}) = \Lambda(\beta_0 + \beta_1 A380Ratio_{jt} + \beta_2 A380Ratio_{it-1} + \beta_3 MarketShare_{jt} + \beta_4 FuelPrice_t + \beta_5 DepartmentGDP_t + \delta_t t_t + \gamma_n i_n + u_{it})$$

Results:

- the higher is intensity of use A380 by competitor, the higher is probability to use A380
- the higher is market power of competitor, the lower is incentive to innovate
- the higher is fuel price, the higher is probability to use A380
- the higher is GDP (traffic), the higher is probability to use A380

Literature review

There are three perspectives captured in our two research questions:

1. Strategic theoretical approach to innovation and competition
   a) What does classical industrial organization theory can suggest about the incentives to follow innovation in airline market?
   b) How do we measure and classify competition among the airline companies?

2. The empirical examples of green innovations in airline industry

a) The influence of aircraft type and size on fuel consumption and CO_2 emission
b) Current fuel and operational efficiency of airline companies
c) Airline fuel efficiency given the environmental tax (carbon fee for level of CO_2 emission or cap for max emission level allowed)

3. Market share and frequency share modeling for airline market

Innovation in industrial Organization Theory

- A380 - Non-drastic innovation $p(\underline{c}) > \bar{c}$
- A380 - Technology acquiring innovation (developer - firm not active on the market, Airbus)
- Incentive to innovate - profit (pure incentive)
- Aghion (2005):
  - Firms evaluate innovation in terms of present value of future profits
  - Neck-and-neck industries have highest incentives to introduce innovation

$$\Downarrow$$

Probability to follow A380 should be higher for routes with neck-and-neck competition

Empirical analysis of innovation and CO_2 emission

- Larger aircraft provides improvement in efficiency $\Rightarrow$ larger aircraft tends to be used more often for short and medium haul flights
- Environmental innovations positively influence firm's revenues (in some cases profit)
- Carbon fees may be effective tool to manage the rapidly growing demand for air traffic (depending on elasticity of demand and carbon price level)

Market share and flight frequency modelling

Airline companies by increasing market share have higher probability of profit maximization (Babic et al, 2014). Two common strategies to increase market share:

- Increase frequency
- Increase seating capacity with larger airplanes

Factors that affect frequency:

- Alliance membership/merger
- Number of competitors per destination
- Average price ticket
- Load factor etc.

- OAG schedule analyzer - database of Official Airline Guide
- ENAC database
- A long-haul route - a non-stop fly with distance greater than 2000 km.
- Time = 10 years, 121 routes. N=35,371

Seasonality

Figure 1: Seasonality on some routes

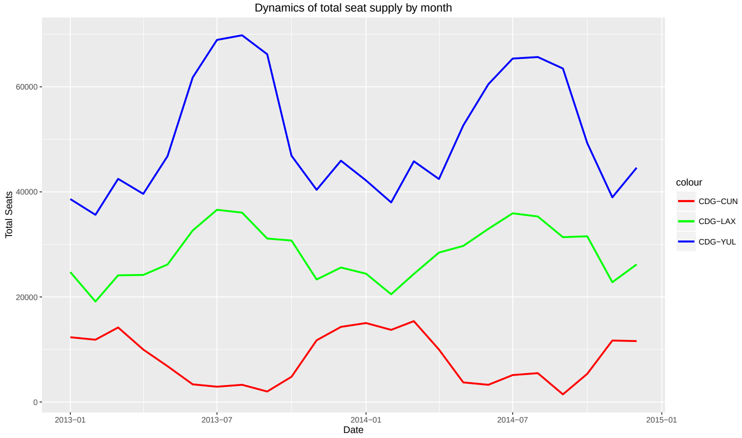

Table 1: Descriptive Statistics of variables

Statistic	Mean	St. Dev.	Min	Max
Distance in km	6,147.7	3,090.9	1,985	13,802
Flight frequency	54.7	51.9	1	548
Log of population	15.3	1.1	12.9	17.5
Number of companies	4.3	2.9	1	17
Ratio of weight A380	0.086	0.242	0.000	0.983
Competitors' ratio of weight A380	0.084	0.197	0.000	0.975
Log of annual traffic*	13.5	0.8	1.1	15.231

Notes: N=35,371, N*=33,983

$$FREQ_{ijt} = \beta_0 + \beta_1 NUMBCOMP_{it} + \beta_2 LOGPOP_{it} + \beta_4 COMPRATIO380_{ijt} + \epsilon_{ijt} \quad (1)$$

$FREQ$ is the frequency of flights supplied by airline j on the route i per month t.
$NUMBCOMP$ is the number of companies that operate on the route
$LOGPOP$ is the logarithm of population in the departure airport of the route i per year, proxy for demand for airline services.
$COMPRATIO380$ is the competitors' ratio of total weight (seats and cargo converted to kg) transported by aircraft A380 on the route to total weight transported by all type of aircraft. It reflects the intensity of utilization of A380 by competitors on the route with respect to other aircraft types.

Table 2: Model Regression

	Dependent variable: frequency of flights			
	(1)	(2)	(3)	(4)
	Robust FE	*Robust RE*	*Prais-Win.*	*Prais-Win.*
Number of companies	2.03***	1.90***	.27**	.25***
	(0.58)	(.57)	(0.09)	(.093)
Log of population	62.0***	52.6***	6.01***	–
	(7.54)	(6.4)	(2.42)	–
Log of annual traffic	–	–	–	.37*
				(.22)
Competitors Share A380	−7.05***	−5.53***	1.43**	1.25**
	(1.909)	(1.75)	(.66)	(.64)
Observations	35,371	35,371	35,371	33,983
Adjusted R^2	0.17	0.17	0.165	0.165
DW statistics	0.01	0.02	2.33	2.29
Note:				*p<0.1; **p<0.05; ***p<0.01