Entry games for the airline industry

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Outline

Motivation I

- Entry games have been very popular in the empirical IO literature, mainly because they can estimate features of some industry while observing the decision of firms to enter or not in independent markets and their characteristics (see Berry and Reiss, 2007, for a survey).
- It characterizes the degree of competition in a given market, a notion badly characterized by the HHI (see Sutton 1991).
- An entry game endogeneizes the market structure. As we specify and estimate a semi-structural model, it can be used for counter-factual simulations.
- It can be estimated from data that are easily accessible. For example, in the airline sector, except for the US market, there is some difficulties to collect data with real trips including airfares. But it is easier to observe which O/D market the airlines are operating on. In other words, we observe more easily the decision to enter in a given market.
- They can answer, for example, to the following questions:

Motivation II

- Does a specific market have too many (or too few) competitors ?
- If one flag carrier disappears, how many low cost carriers can replace it ?
- Given the characteristics of a given city A, can a direct flight from A to B be profitable (in duopoly for example) ?
- From which number of identical competitors, is the market close to behave like in the pure competitive case ?
- Does airline A have a higher impact than airline B on other airlines' profit?

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The game in a nutshell I

A simple version of an entry game is, for N airlines in market m:

$$\pi_{i,m}(N^*) = \pi(X_m, Z_{i,m};\theta) - h(N^*;\delta) + \varepsilon_{i,m}. \quad (1)$$

The profitability of one active firm depends on

- A gross profitability which depends on market and firm characteristics, X_m and $Z_{i,m}$. One can incorporate network characteristics to handle the airline specific's case.
- Its number of competitors, N^*.
- An idiosyncratic profit shock (observed or not by the competitors but not by the econometrician).
- Some parameters θ and δ to be estimated (think about a linear model for simplicity).

The game in a nutshell II

The firm decides to enter in a given market if its profitability (or expected profitability) is positive. Otherwise, it stays out of the market.

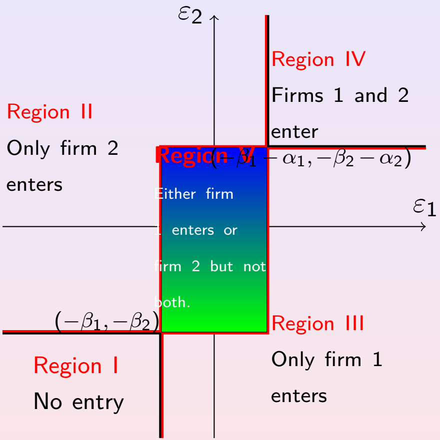
More complicated profit functions could be considered (heterogeneous effects, different types, quality choices, etc.).

We focus here on Nash equilibria in pure strategy (but the discussion does not depend on the equilibrium concept).

From the model to the estimation

- The goal of the empirical economist is to estimate these three subparts from the observation of different market structures. What makes a market having 3 airlines operating and another one only 2 ? In particular, we are interested in the interaction term.
- **Estimating the decision of firms with a standard binary choice model, like a probit/logit is a very bad idea !**
  - The decision of the other firms to enter or not is endogenous too and it should be instrumented (any attempt to replace that by the HHI or a measure of the level of competition is also hopeless). It is possible but notoriously complicated (it's not IV linear regression).
  - Omitting the decision of the other firms in the binary choice model is also wrong and lead to inconsistent estimates.
- One should solve the system simultaneously (all the decisions of the firms together).

The multiple equilibria problem I



Berry (1992) generalizes it to N potential entrant firms.

The multiple equilibria problem II

- Multiple equilibria: the game does not uniquely predict one outcome (whatever the notion of equilibrium used). There is no more one-to-one mapping between the outcomes and the regions of profit shocks.
- There are various ways to solve for this problem which have been used in the literature (Berry, 1992, Cleeren et al, 2002, Ciliberto and Tamer, 2009, Bontemps and Kumar, 2019).
- There is a need for applied economists to invest on less standard techniques (simulated methods, moment inequality models, etc.)

A few papers I

- Berry (1992) proposes a method to handle the multiple equilibria problem and estimate the impact of airport presence on the decision to enter
- Sampaio (2007) uses Cleeren et al. (2010)'s model to study competition between low-cost and full-service airlines. The model is estimated with the assumption that full-service carries enter the market first and then low-cost carriers make their decisions. Results suggest the existence of strong competition effects on this industry. Entry of same type rivals has a large significant effect on profits. Besides, entry of low-cost carriers seems to affect more profits of full-service airlines than vice-versa.

A few papers II

- Dunn (2008) also introduces product quality to entry models. He studies competition between airlines offering non-stop and one-stop routes to investigate cannibalization and business stealing competition effects. One-stop routes passing through hubs are taken as fixed, and entry with non-stop services is modeled with a game theoretical model à la Berry (1992). However, the inclusion of a cannibalization effect in the model implies multiple equilibria in the total number of firms with non-stop operations in a market, and, to deal with this problem, the author selects the equilibria with the highest number of entrants. Their results suggest both the presence of strong competition effects as well as relevant cannibalization effects.

A few papers III

- On the same direction of Mazzeo (2002) and Cleeren et al. (2010), Blevins (2015) investigates entry models with complete information and sequential movement in the US domestic industry. Now, the order of moves is not observed (or assumed) by the econometrician. Instead it is estimated alongside the coefficients of the profit function. In contrast to Mazzeo (2002) and Cleeren et al. (2010), and similar to Berry (1992), the model focus on pure entry, without product differentiation, but it allows firm observed heterogeneity.
- Ciliberto and Tamer (2009) introduce much more heterogeneity on firms' profit functions. They also apply their model to the US domestic airline industry and allow each variable (market and firm observed characteristics) and competition effect to potentially differ among airlines. The complicated multiple equilibria problem (there is no obvious outcome invariant in the multiple equilibria regions) is tackled by using moment inequalities. They found evidence of a greater impact of an entry of Southwest on the three major airlines' profits compared to the impact of the entry of another major airline.

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Illustration on European Data

- We now illustrate the approach by estimating a static entry game with complete information on western European data for the year 2015. The data were collected from the Official Airline Guide database (OAG) which contains all posted flights for the year 2015, their schedules and eventually, their code share agreements.
- A market is defined as an Origin/Destination flight (non directional) between two European cities. We therefore group the different airports of a given city (London, Paris).
- We restrict our investigations to the decision to operate between the 50 largest cities of Western Europe. The distance between these cities and the socioeconomic variables such as GDP and population of the metropolitan areas are collected from additional statistical sources (Eurostat).
- We eliminate markets for which the distance between the cities is less than 150 kilometers. 1204 potential markets remain.
- Contrary to the US market, the western European market has more players. The top 15 airlines count for 85% of the traffic.

Descriptive statistics I

In 2015, 900 million passengers were transported. The most frequented routes were Paris-Toulouse and Barcelona-Madrid with respectively 3.5 and 2.5 millions of passengers. Out of the possible 1204 markets, we observe 670 existing connections.

Airline	Type	Nb Routes Served 2015	2014	Tot_seat	Share cumul.
Ryanair	L	195	173	36036441	11.5%
Easyjet	L	158	139	31244528	9.9%
Vueling	M	88	76	15875178	5.1%
Norwegian	L	73	68	11164021	3.6%
LH	M	71	71	39218702	12.5%
G-wings	L	69	58	9592148	3.1%
SK	M	64	61	16155919	5.1%
AB	M	47	46	12324708	3.9%
BA	M	39	38	22270455	7.1%
Air France	M	38	38	22086929	7.0%
TP	M	38	38	8253202	2.6%
Alitalia	M	36	29	10334054	3.3%

Descriptive statistics II

Number of markets served between the top 50 cities of Western Europe.

N 2015	Freq.	Percent	Cum.
0	534	44.35	44.35
1	268	22.26	66.61
2	223	18.52	85.13
3	108	8.970	94.10
4	55	4.570	98.67
5	11	0.910	99.58
6	4	0.330	99.92
7	1	0.0800	100
Total	1,204	100	

Number of competitors per market.

Regression results I

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	-1.3590	0.1782	-7.63	0.0000
Pop	0.5782	0.0244	23.65	0.0000
Gdppercap	0.0203	0.0031	6.50	0.0000
Dist	0.3987	0.1753	2.27	0.0231
Dist2	-0.1052	0.0621	-1.69	0.0903
Sun	0.0597	0.1654	0.36	0.7181

Regression of N on the market characteristics

Regression results II

The percentage of good predictions is equal to 78.1%. The probit model is rejected by the data.

	Estimate (Std. Error)	Probit
(Intercept)	-2.616 (0.044)	-3.163 (0.123)
Pop	0.090 (0.009)	0.060 (0.013)
Gdppercap	-0.0003 (0.0001)	-0.004 (0.002)
Dist	0.342 (0.033)	0.560 (0.119)
Dist2	-0.126 (0.012)	-0.178 (0.042)
Sun	0.0002 (0.002)	-0.068 (0.101)
LC	-0.121 (0.058)	-0.001 (0.040)
City2	1.518 (0.056)	0.783 (0.040)
Nbroutes	0.047 (0.002)	0.076 (0.002)
δ	0.274 (0.030)	
ρ	0.306 (0.025)	

Simulated Maximum Likelihood estimates.

Optimal number of competitors I

N_{2015}	Predicted	Diff	Market	Distance	2019 (airline)
0	1.58	1.58	Brussel-Glasgow	808	$\surd$ (Ryanair)
0	1.7	1.7	Bordeaux-Manchester	955	$\surd$ (Ryanair& Easyjet)
0	1.86	1.86	Berlin-Marseille	1177	$\surd$ (Easyjet)
0	1.74	1.74	Lille-Roma	1200	No airline
0	1.68	1.68	Birmingham-Stockholm	1360	$\surd$ (SAS)
0	1.68	1.68	Glasgow-Milan	1504	No airline
0	1.9	1.9	Birmingham-Lisbon	1623	No airline
0	1.54	1.54	Athens-Toulouse	1996	$\surd$ (Aegean Airlines)
0	2.48	2.48	Athens-Valencia	2119	$\surd$ (Aegean Airlines)
0	2.12	2.12	Athens-Malaga/Sevilla	2615	$\surd$ (Aegean Airlines)

Market where entry is predicted.

Optimal number of competitors II

N_{2015}	N_{model}	Diff	Market	Distance	N_{2019}
5	1.24	-3.76	Roma-Vienna	777	3
5	1.68	-3.32	Paris-Palermo	1471	2
6	2.74	-3.26	Porto-Paris	1224	6
4	0.96	-3.04	Copenhagen-Dublin	1239	3
7	4.04	-2.96	Lisbon-Paris	1454.5	5
5	2.3	-2.7	Copenhagen-Roma	1535.4	3
4	1.48	-2.52	Barcelona-Birmingham	1273	2
4	1.5	-2.5	Glasgow-Sevilla	1966.5	4
4	1.5	-2.5	Marseille-Roma	608	3
4	1.54	-2.46	Madrid-Porto	436	4

Market with too many entries.

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Conclusion

- Everything is available now to see more studies on the market structure of the airline industry outside the US (Europe, Asia, Africa).
- Decisions to operate or not between two cities is easily available (OAG data, or web-scrapping through meta search engines).
- Econometric procedures are available. Some have higher entry costs because they are non standard.
- The goal is to be able to estimate games with multiple equilibria.
- Simple assumptions may be relaxed (think about Berry's specification) but, there is no free lunch, it is at a higher cost.
- Dynamic games may be considered.