

How Do Universities Compete for Students? Two Competing Strategies and Their Impact on Capacity and Tuition Fees

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Introduction

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- Main question: how can universities' strategic behavior affect the provision of higher education and at what price?
- Universities are confronted with a new environment characterized by:
 - the harmonization of higher education systems with the Bologna process (more specifically in undergraduate studies),
 - increased student mobility,
 - a greater autonomy granted to universities.
- These changes are likely to get universities to engage in competition on the enrollment market.

Introduction

Research issues

- Issue 1: how does competition between universities affect:
 - the size of universities (capacity),
 - the choice of the number of students enrolled and/or the level of fees?
- Issue 2: how does the number of universities impact social welfare: is it better to have many small universities or a few large universities?

Introduction

Observation: two different university systems

- *Anglo-Saxon system:* universities can set their own fees (as in the UK, the USA, and Canada, among others).
- *European system:* universities cannot use a variable pricing strategy as a response to their new environment (as in France, Spain, Italy, and Germany). Tuition fees are set by public authorities, without control over the number of students enrolled.

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Stylized facts

	Annual average fees (€) ^a	Entry rates into higher education ^b	Average nbr of students per university	% of small univ. (< 10000)	% of great univ. (> 25000)
Germany	No fees	53,18%	22 646	13%	42,5%
France	[189-261]	40,85%	21 646	19%	33,5%
Italy	[200-1000]	47,2%	22 564	31%	38%
Spain	[1000-2000]	52,1 %	27 547	17,7%	46%
Netherlands	2000	65,27	17 066	21%	21%
Canada	[3000-4000]	-	13 670	54%	22%
UK	[5000-11000]	67,44%	14 678	38%	15,7%
USA	[3500-20000]	71,02%	12 422	58,5%	14,6%

Table 1: Fees and size of public universities in 2014-15

^aNational Student Fee and Support Systems 2014/15, European Commission

^bOECD (2014), Education at a glance, OECD, Publishing, Paris, Indicator C3

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- 4 the average number of students per university is lower in the Anglo-Saxon system.

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 - In the UK: following the reform (2012), fees have more than tripled. Over this period, no improvement in teaching has been noted.

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- The fact that universities pursue both teaching and research objectives affects how they compete for students:

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 - Students are at once inputs and clients of the educational process (Rothschild and White, 1995)

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- The fact that universities pursue both teaching and research objectives affects how they compete for students:
 - Students are at once inputs and clients of the educational process (Rothschild and White, 1995)
 - Research requires money; more students enrolled may imply an increased research budget. **However**, increasing the size of the student population may be costly.

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Related literature

Theoretical papers focus on:

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- 3 the allocation of academics' time (Del Rey, 2001, Beath et al, 2003, Gauthier and Wauthy, 2007, Grazzini et al, 2011),
- 4 the impact of different funding systems (Beath et al, 2012).

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- we assume the existence of capacities in the production of education,
- a university can enroll beyond capacity but at a strictly convex cost (Dastidar, 1995, Chowdhury, 2009, Jacqmin and Wauthy, 2014)
- each university's capacity level is chosen endogenously (Cabon and Drouhin, 2014).

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- Universities adopt a high level of fees in *Bertrand competition* which can rise with the number of universities.
- *Cournot competition* leads to a higher number of students enrolled in each university than *Bertrand competition*.
- The equilibrium adopted in *Bertrand competition* may be more efficient in terms of cost minimization than in *Cournot competition*.
- An increase in the number of universities has a positive impact on social welfare, except when the capacity is too high in Cournot competition.

The model

The utility function

- In line with Jacquemin & Wauthy (2014), the objective function of universities is specified as follows:

$$\text{Max } U_i(T, R) \quad (1)$$

with $\frac{\partial U_i}{\partial T} > 0$ and $\frac{\partial U_i}{\partial R} > 0$

- Students are required for the provision of education: the level of teaching is equal to the enrollment of students n_i weighted according to the parameter $0 < \gamma < 1$:

$$T = \gamma n_i$$

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- Students provide the funds a university needs to operate either directly through fees (f) or indirectly via the government (per-student subsidy s). R represents each university's expenditure on research. Here, the research output S_i depends only on the money invested in it:

$$R = S_i$$

The cost function

The cost function of each university i is given by

$$C_i(n_i, k_i) = \begin{cases} \delta k_i & \text{if } 0 \leq n_i \leq k_i \\ \delta k_i + \mu(n_i - k_i)^2 & \text{if } n_i > k_i \end{cases} \quad (2)$$

where $\mu > 0$. Cost parameters (δ and μ) are similar for all universities and constant.

n_i : the number of students enrolled at a university i ,

k_i : the capacity of a university i .

The optimization problem of a university i

- The optimization problem of a university i is thus defined as:

$$\text{Max } U_i = \gamma n_i + S_i \quad \text{s.t.} \quad S_i + C_i(n_i, k_i) = n_i(f_i + s) \quad (3)$$

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- There are m identical universities: there is no differentiation in curriculum, and/or in other non-price dimensions (location, admission standard or financial endowment...)
- Universities are committed to satisfying all the demand they face once the capacity level is chosen.
- We assume that potential students will not differ in their willingness to enroll and each student gets one unit of education.

The Cournot competition Model

- **Sequential game in Cournot competition:**

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 - ① First stage: each university i chooses its level of capacity k_i taking into account the threshold capacity of other universities k_{-i} ,
 - ② Second stage: each university i selects a number of students enrolled n_i for a given level of capacity k_i and for a given number of students at other universities.
- Consider the utility of university i in the second stage, conditional on k_i :

$$U_i(n_i; N_{-i}; k_i) = n_i ((1 - n_i - N_{-i}) + s + \gamma) - C_i(n_i, k_i)$$

$$\text{with } N_{-i} = \sum_{\substack{j=2 \\ j \neq i}}^m n_j.$$

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The Bertrand competition model

- **Sequential game in Bertrand competition:**

- 1 First stage: universities determine their capacity levels anticipating the effect on the price equilibria in the second stage of the game.
 - 2 Second stage: universities determine their tuition fees for a given capacity.
- The utility function of each university can be rewritten:

$$U_i(f_i, f_{-i}, k_i) = \begin{cases} -\delta k_i & \text{if } f_i > f_{-i}^{\min} \\ (f_i + \gamma + s) \frac{N(f_i)}{m} - C_i\left(\frac{N(f_i)}{m}, k_i\right) & \text{if } f_i = f_{-i} \\ (f_i + \gamma + s) N(f_i) - C_i(N(f_i), k_i) & \text{if } f_i < f_{-i}^{\min} \end{cases}$$

with f_i , the fee of the university i , and $f_{-i}^{\min} = \text{Min}\{f_1, \dots, f_{i-1}, f_{i+1}, \dots, f_m\}$
 $N(f_i)$: total number of students enrolled when the university i sets f_i

Equilibria in the Cournot competition model

The symmetric subgame perfect equilibrium values are:

$$n_c^*(m) > k_c^*(m)$$

if and only if $\delta > \underline{\delta}$

Equilibria in the Cournot competition model: comparative statics

Impact of the number of universities on the equilibrium results:

- the capacity $k_c^*(m)$ is decreasing with m ,

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- the total number of students enrolled $N_c^*(m)$ is increasing with m .

Equilibria in the Bertrand competition model

Proposition 1

In the second stage, (f_1, f_2, \dots, f_m) is a pure-strategy Nash equilibrium if and only if $f_1(k_1) = f_2(k_2) = \dots = f_m(k_m) = f^N(k_i)$, such that

If $\mu < \frac{m}{m-1}$ Case 1	If $\mu = \frac{m}{m-1}$ Case 2	If $\mu > \frac{m}{m-1}$ Case 3
$f^N = \bar{f}(k_i, m) =$ $\frac{\mu(m+1) - m(\gamma+s) - 2m\mu k_i}{m + \mu m + \mu}$	$f^N = \tilde{f}(k_i, m) =$ $\frac{(m+1) - (m-1)(\gamma+s) - 2mk_i}{2m}$	$f^N = f^*(k_i, m) =$ $\frac{m(1-\gamma-s) + 2\mu(1-mk_i)}{2(m+\mu)}$

Equilibria in the Bertrand competition model

Corollary 2

We verify that: $\forall \mu, \gamma, s, \delta > 0$ and $m \geq 3$,

$$\left\{ \begin{array}{l} \bar{k}_b^*(m) < \bar{n}_b^*(m) \\ \tilde{k}_b^*(m) < \tilde{n}_b^*(m) \\ k_b^*(m) < n_b^*(m) \end{array} \right.$$

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- **Cases 2 and 3:** $\mu \geq \frac{m}{m-1}$
 - the capacity $k_b^*(m)$ is decreasing with m ,
 - the level of fees $\bar{f}_b^*(m)$ is constant with m ,
 - the total number of students enrolled $N_b^*(m)$ is constant with m .

Comparison of equilibria: Cournot vs Bertrand

Proposition 3

$\forall \gamma, s, \delta > 0$ and $m \geq 2$, we verify that:

- The equilibrium level of capacity:

$$k_b^*(m) < k_c^*(m)$$

- The total number of students enrolled:
 - 1 if $\mu \leq \underline{\mu} = 0.4589$, $N_c^*(m) \leq \bar{N}_b^*(m)$,
 - 2 if $\mu > \underline{\mu} = 0.4589$, $N_c^*(m) > N_b^*(m)$.

Efficient capacity and comparison with equilibria

- Because of the U-shaped average cost in k , there exists an efficient capacity which minimizes the average cost:

$$\text{Min}_{n_i} AC(k_i, n_i) = \text{Min}_{n_i} \left[\frac{C(k_i, n_i)}{n} \right]$$

- The capacity which minimizes the average cost for a given number of students enrolled is:

$$k_{\min} = \frac{2\mu n_i - \delta}{2\mu}$$

Efficient capacity and comparison with equilibria

Proposition 4

Comparison between the equilibrium results of the two competition strategies with the efficient solution:

	Cournot equilibrium vs efficient solution	Bertrand equilibrium vs efficient solution	
		$\mu < \frac{m}{m-1}$	$\mu \geq \frac{m}{m-1}$
capacities	$k_c^{min} < k_c^*$	$k_b^{min} > k_b^*$	$k_b^{min} = k_b^* = k_b$
number of students/fees	$n_c^{min} < n_c^*$	$f_b^{min} < f_b^*$	$f_b^{min} = f_b^* = f_b$

Impact of the number of universities on social welfare

Proposition 5

In the **Bertrand competition**, social welfare is **always increasing** with the number of universities m

Proposition 6

In the **Cournot competition**, social welfare may decrease with the number of universities when the capacity is too high:

$$\delta \leq \underline{\delta} \Leftrightarrow n_c^*(m) \leq k_c^*(m)$$

otherwise, social welfare is increasing with m .

Conclusion

Regarding our results:

- Higher tuition in most countries which have adopted a deregulated system can now be explained by our model,
- Cournot competition is likely to induce too high a capacity level in terms of the minimization of the average cost for the university,
- Bertrand competition seems more efficient from this point of view, but only if the cost is sufficiently convex.
- An increase in the number of universities improves social welfare, except in Cournot competition when the capacity is too high.

Conclusion

Some limits and possible extensions:

- the price elasticity of demand,
- the access to financial support or other aid for students,
- differentiation in curriculum, and/or other non-price dimensions,
- student selection.