

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

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 - an increased mobility of students,
 - a greater autonomy granted to universities
- This change is likely to get universities to engage in competition on the enrollment market.

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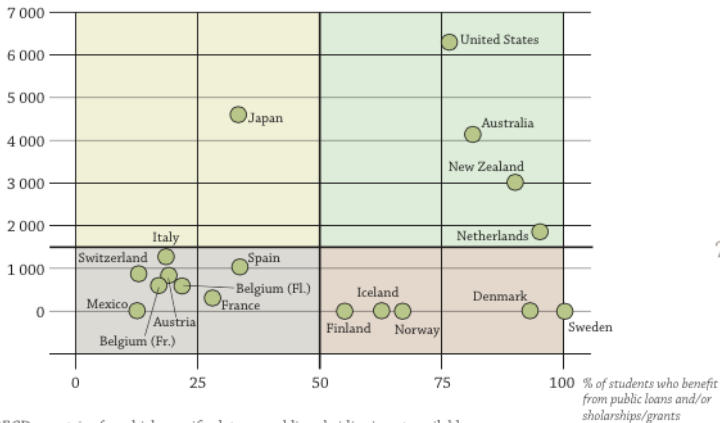
- **Stylized facts** Fig

Average annual tuition fees in USD



Source: OECD (2011), *Education at a Glance 2011*, Table B5.2, available at <http://dx.doi.org/10.1787/888932464030>.

Average tuition fees charged
by public institutions
in USD



Note: Chart excludes OECD countries for which specific data on public subsidies is not available.

Source: *Education at a Glance 2011: OECD Indicators*, Indicator B5 (www.oecd.org/edu/eag2011).

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- Tuition fee deregulation has led to increasing fees combined with relaxed controls on the number of students each university can enroll.
- In the UK: following the reform (2012), fees have more than tripled.

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- How can we explain the high level of tuition fees following the liberalization of tuition fees in some countries?

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 - students are required for the production of education,
 - they also provide funds to universities both by paying tuition fees, and by allowing universities to receive transfers from government.
 - Research requires money; more students enrolled may imply an increased research budget. **But**, increasing the size of the population of students may be costly.

Related literature

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- 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 (Chowdhury, 2009, Jacqmin and Wauthy, 2014)
- each university's capacity level is chosen endogenously.

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- when costs are sufficiently convex, universities adopt a high level of fees in *Bertrand competition* which can rise with the number of universities. Conversely, *Cournot competition* leads to a higher number of students enrolled than *Bertrand competition*,
- under certain conditions, the equilibrium adopted in *Bertrand competition* may be more efficient in terms of cost minimization than in *Cournot competition*.

The utility function

- In the same line as Jacqmin & 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.

The optimization problem of a university i

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

$$\text{Max } U_i = \gamma n_i + S_i \quad \text{s.t.} \quad S_i + \delta k_i + \max(0; \mu(n_i - k_i)^2) = n_i(f_i + s) \quad (3)$$

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- 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. The student population is therefore normalized to the unit.

The Model

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- 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 in the rival university.

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- 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 in the rival university.

- Consider the utility of university i in the second stage, conditional on k_i :

$$U_i(n_i; N_i; k_i) = n_i ((1 - n_i - N_{-i}) + s + \gamma) - \delta k_i - \max(0; \mu(n_i - k_i)^2)$$

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- 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:

$$\begin{aligned}
 & U_i(f_i, f_{-i}, k_i) \\
 = & \begin{cases} -\delta k_i & \text{if } f_i > f_{min} \\ (f_i + \gamma + s) \frac{N(f_i)}{m} - \delta k_i - \max(0; \mu(\frac{N(f_i)}{m} - k_i)^2) = U_d(m) & \text{if } f_i = f_{-i} \\ (f_i + \gamma + s)N(f_i) - \delta k_i - \max(0; \mu(N(f_i) - k_i)^2) = U_M(m) & \text{if } f_i < f_{-imin} \end{cases}
 \end{aligned}$$

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 different parameters on the equilibrium results:

$$\frac{\partial n_c^*}{\partial \mu} < 0 \quad \text{if} \quad \mu > \sqrt{\frac{3}{4}}$$

$$\frac{\partial n_c^*}{\partial \delta} < 0 \quad \text{and} \quad \frac{\partial n_c^*}{\partial \gamma} > 0 \quad \text{and} \quad \frac{\partial n_c^*}{\partial s} > 0$$

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- Impact of the number of universities on the equilibrium results:

$$\frac{\partial k_c^*(m)}{\partial m} < 0$$

$$\frac{\partial n_c^*(m)}{\partial m} < 0 \quad \text{and} \quad \frac{\partial N_c^*(m)}{\partial m} > 0$$

Equilibria in the Bertrand competition model

Proposition

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

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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Comparison of equilibria: Cournot vs Bertrand

Proposition

$\forall \gamma, s, \delta > 0$ 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 $\mu \leq \underline{\mu} = 0.4589$, $N_c^*(m) \leq N_b^*(m)$,
- 2 if $\mu > \underline{\mu} = 0.4589$, $N_c^*(m) > N_b^*(m)$.

- 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:

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

Proposition

The following table presents the 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	$k_c^{min} < k_c^*$	$k_b^{min} > k_b^*$	$k_b^{min} = k_b^* = \tilde{k}_b$
number of students/fees	$n_c^{min} < n_c^*$	$f_b^{min} < f_b^*$	$f_b^{min} = f_b^* = \tilde{f}_b$

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.

Conclusion

Some limits and possible extensions:

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