Student graduation: To what extent university's expenditure matter?

(Work in progress)

Javier García-Estévez; Néstor Duch
jagarcia@ub.edu

University of Barcelona
The Barcelona Institute of Economics

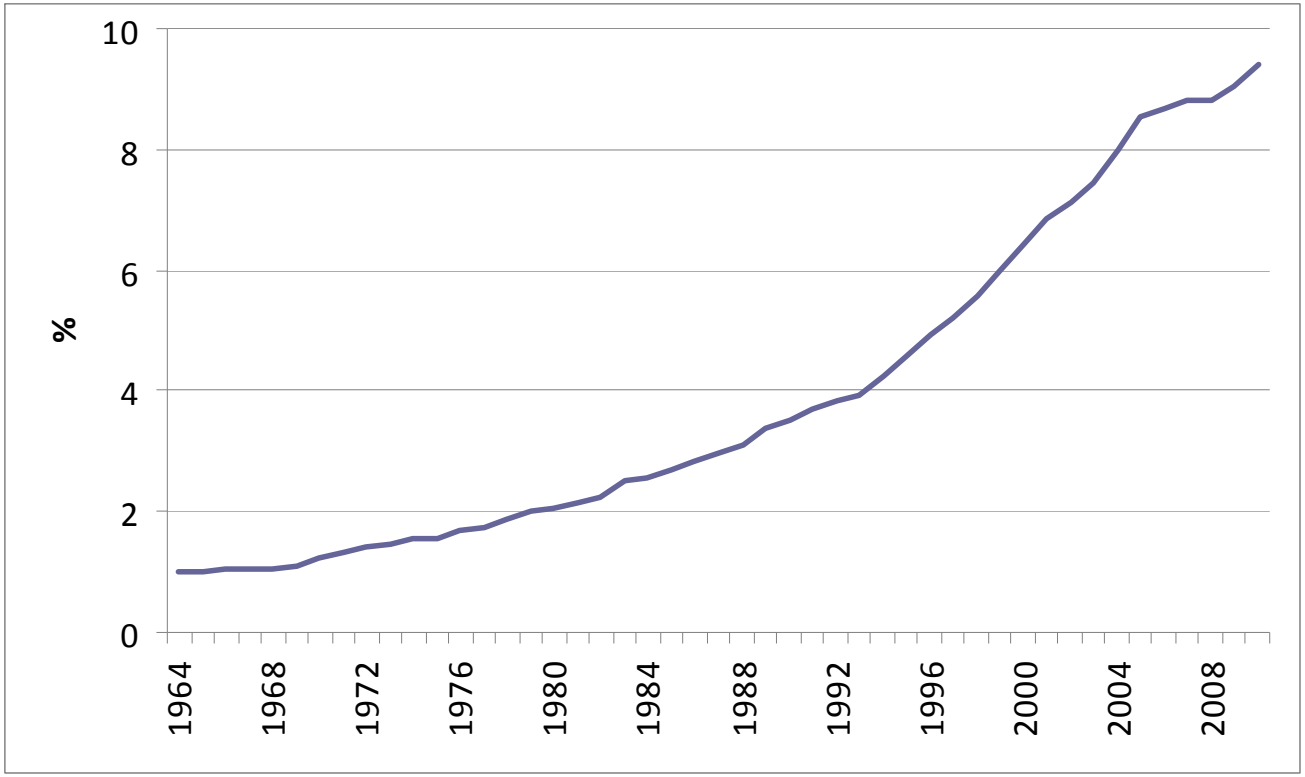
Motivation

- Human capital has become a significant issue in the economic literature (Lucas (1988), Romer (1990), & Barro (1991) and many more).
- The recent increase in demand for highly skilled workers in developed countries is mainly driven for technological change (Acemoglu 1998; Piva et al. 2005).
- There is, therefore, a persistent upskilling trend of the workforce across developed countries.
- In this scenario Human Capital is not just a key element for economic growth but also its demand is rising.
- Human Capital is one of the most important channels through which universities positively affect regional development (Audretsch et al., 2005).

Our objective and contribution

- Since the creation of Human Capital is one of the most important channels through which universities positively affect regional development (Audretsch et al., 2005),
  - ✓ We want to assess what factors determine the creation of human capital in ***universities***
- Previous studies have mostly used cross-section estimations. We adopt a ***panel model*** in order to better control unobserved universities characteristics.
- We analyse a new case of study: the whole **Spanish public university system**.
- At least two traits of the Spanish case are quite interesting to analyze:
  1. Spain has undergone fundamental economic and social changes recently. One of the most important was the substantial increase in the educational achievement of the labour force.
  2. The Spanish university system has quite interesting particularities.
     a. In most of OECD countries, public expenditure per student on HEIs **decreased** between 1995 & 2004, while in Spain, **it increased** appreciably by 71% (OECD 2008).
     b. Spain is the only OECD country where the absolute number of tertiary students **is decreasing** (e.g. by 3% in 2008) (OECD 2008).

Evolution of the share of Economically Active Population that has attained tertiary education, in Spain



Source: IVIE (The Valencian Institute of Economic Research). Over the past four decades, the share of economically active population that attained tertiary education increased from 1% to 9.4%

Literature review

1. Calculation of ***university efficiency***
   a. Non-parametric techniques (J. Johnes 2006; Archibald & Feldman 2008, among others)
   b. Parametric methodologies that analyse the presence of economies of scale and economies of scope in different countries, e.g. American universities (Groot et al. 1991; Dundar & Lewis 1995), UK (Glass et al. 1995; Izadi et al. 2002; G. Johnes & J. Johnes 2009), Japan (Hashimoto & Cohn 1997), and China (Longlong et al. 2009).

2. The determinants of ***enrolment*** in HEIs; Berger and Kostal (2002), Sá et al (2004), Perna and Titus and Bedard and Herman (2008).

3. The impact of expenditures on ***persistence and graduation rates*** (Ryan 2004; Webber & Ehrenberg 2010), ***student engagement*** (Pike et al. 2006), or by using a duration model, calculating the time-to-degree (Lassibille & Navarro 2011).

Methodology and data (II)

$$WG_{it} = \alpha_i + \tau_t + \lambda_j + \beta_1 Expenditures_{it} + \beta_2 Student_{it} + \beta_3 ability_{it} + \beta_4 Sci\_stu_{it}$$
$$\gamma_2 Supp\_stu_{it} + \gamma_3 publi_{it} + Pat_{it} + \mu_{it}$$

WG_{it}	Overall weighted-graduation rate of university *i* at year *t*
$Expenditures_{it}$	Expenditure per registered student (Total, personnel, student financial aid, and R&D)
$Student_{it}$	Number of Students (Undergraduate + Graduate)
$ability_{it}$	An average of the 75th percentile of the minimum score to access university
Sci_stu_{it}	Share of science students
$Supp\_stu_{it}$	Student percentage with financial support from Ministry of education
$publi_{it}$	Number of JCR Publications per *professor*
Pat_{it}	Number of Patent applications
α_i , τ_t , λ_j	*University, time and region fixed-effects*
	i =1,2,..., *45* universities, & ***t*** =1998, 2000,..., 2008

Dependent variable

$$WG_{it} = \sum_{j=1}^{3} \frac{G_{ijt}}{E_{ij,t-m}} \cdot S_{jit} \qquad S_{ijt} = \frac{G_{jit}}{G_{it}}$$

Where

WG_{it} = Overall Weighted-Graduation rate of university *i* at year *t,*

G_{ijt} = # of graduates of university *i*, cycle *j* and year *t*,

E_{ijt} = # of enrolled students at first year of university *i* cycle *j* and year *t-m*

S_{ijt} = Share of graduates of university *i*, cycle *j* and year *t, (it seeks to weight the duration of different cycles)*

i = University, *j*= cycles (undergraduate – long and short cycle – Msc and PhD),

j, m = 1… 4. When *j*= short cycle, *m*=3; if *j*= long cycle, *m*=5; when *j*= MSc, *m*=2, finally, if *j*=PhD *m*=3)

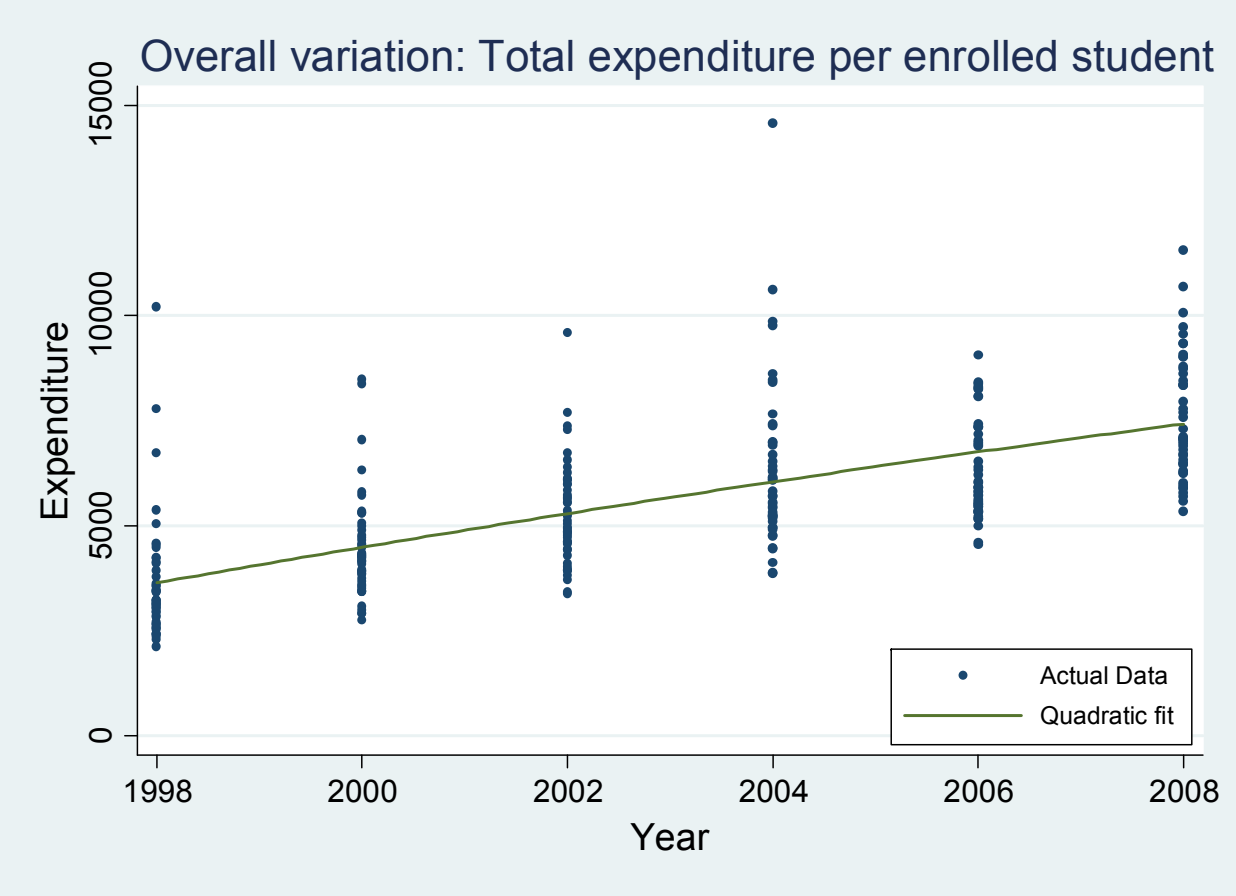
t = 1998 - 2008.

Descriptive statistics

	Mean	Standard Deviation overall	between	within	Min	Max
Overall Weighted-Graduation rate $_{it}$	0.6625	0.1525	0.0828	0.0955	0.3219	0.9846
Total expenditure $_{it}$	5.6594	2.1749	1.3422	1.7207	2.1239[1]	21.9961[2]
Personnel expenditure $_{it}$	3.0537	0.9510	0.5107	0.8051	0.7892	5.8690
Financial-aid to student $_{it}$	0.3279	0.1531	0.1463	0.0715	0.0248[3]	0.9322[4]
R&D expenditure $_{it}$	0.9182	0.6244	0.4898	0.3968	0.1426	3.4925
Student-teacher ratio $_{it}$	15.5202	3.9594	2.3347	3.2129	9.1824	51.5857
Undergra_stu $_{it}$	24.3505	16.0573	15.9428	2.8615	3.2230[5]	82.5000[6]
Fees $_{it}$	10.3834	1.4475	1.0995	0.9512	0	15.1156
Sci_stu $_{it}$	0.4478	0.1875	0.1873	0.0269	0.0097	1
Student Ability $_{it}$	6.5767	0.5576	0.4817	0.2867	5	7.9950
Pat $_{it}$	7.2128	7.5168	6.6258	3.6538	0	41

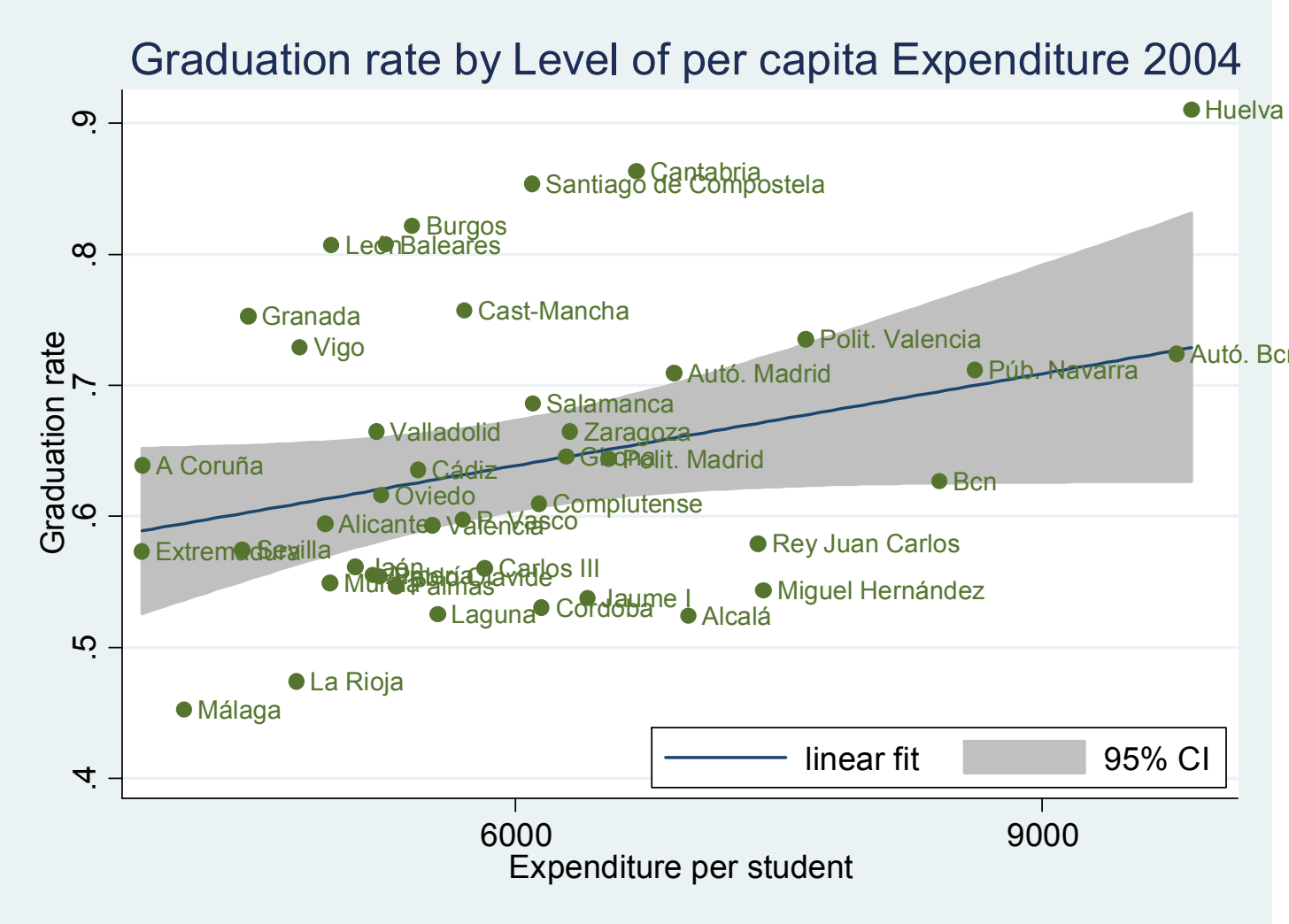
N = 271, n = 45, T=6. All financial data used in the study are expressed in terms of per enrolled student and have been adjusted to 2001 values.
[1] U. of Jaen; [2] U. Pompeu Fabra; [3] U. of Basque Country; [4] U. of Extremadura; [5] Pablo Olavide; [6] Complutense.

Graphic analysis (I)
Evolution of University total expenditure per enrolled student

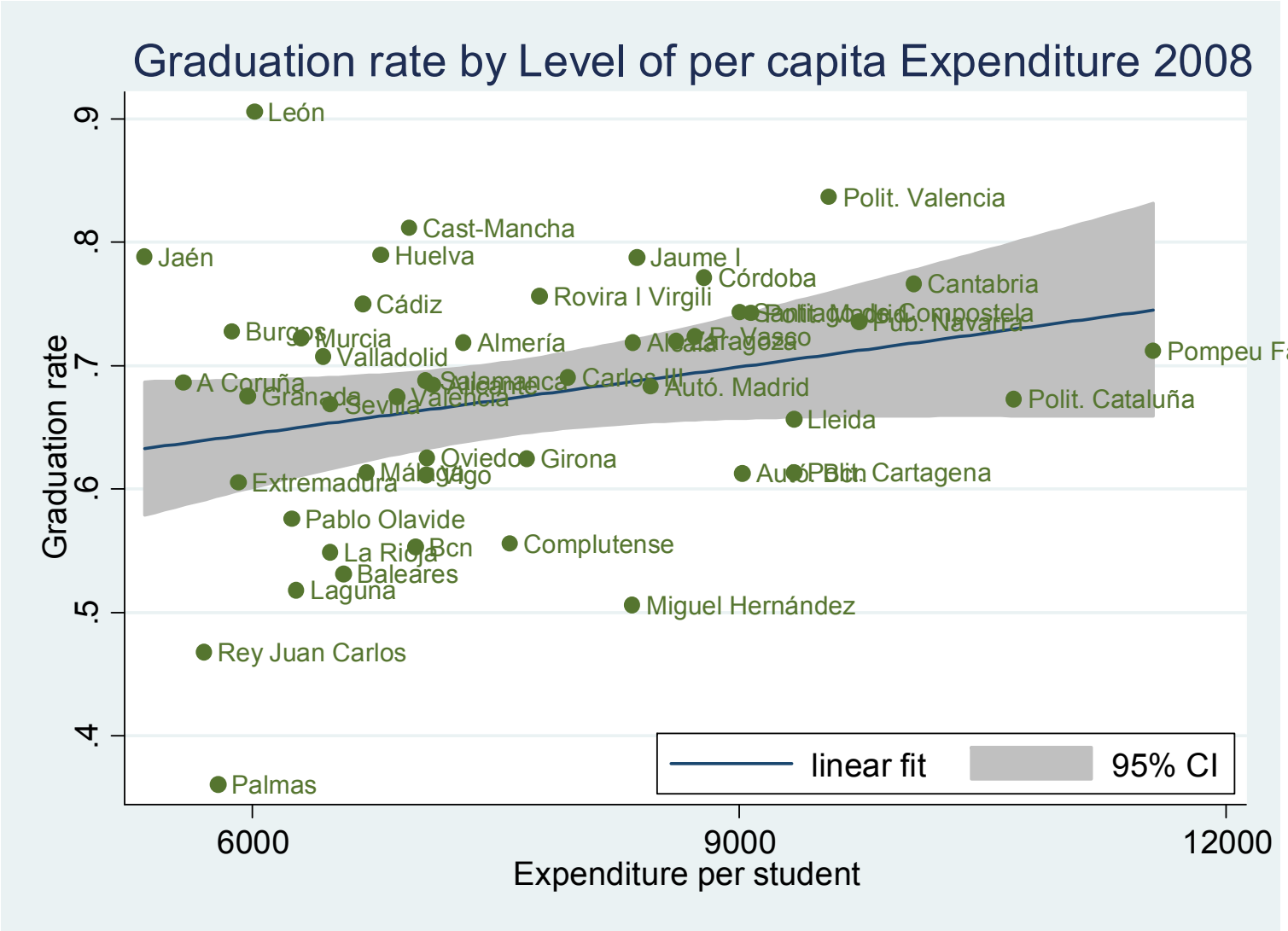


This Figure shows the trend of per capita university expenditure, which showed a sustained increase during the analysed period.

Graphic analysis (II)



Graphic analysis (III)



Preliminary results (I)

Panel model random effects

Dep. Var = Graduation rate $_{it}$	Expenditure categories			
	Total	Personnel	Student financial aid	R&D
Variables	(1)	(2)	(3)	(4)
Expenditure per student $_{i,t}$	0.027***	0.049**	0.341***	0.033
	(0.009)	(0.021)	(0.128)	(0.029)
Number of students $_{i,t}$	0.012**	0.004	0.008	0.005
	(0.005)	(0.005)	(0.007)	(0.008)
Student Ability $_{i,t}$	-0.005	0.004	0.010	-0.013
	(0.020)	(0.021)	(0.026)	(0.029)
Share of science students $_{i,t}$	0.086**	0.065	0.070	0.106
	(0.043)	(0.050)	(0.053)	(0.072)
Share of students with	0.681*	0.725**		0.239
Financial aid $_{i,t}$	(0.349)	(0.352)		(0.385)
Publications per professor $_{i,t}$	0.038	0.014	0.005	-0.059
	(0.057)	(0.061)	(0.079)	(0.098)
Constant	0.281*	0.239	0.351*	0.638***
	(0.158)	(0.180)	(0.204)	(0.228)
Adj. R-squared	0.3738	0.3554	0.3624	0.3941

Notes: Year and regional-fixed effects are included in all models. Robust Standard errors clustered at university level are shown in parenthesis. *,**,*** denotes the significance at 90%, 95% and 99%, respectively. Number of observations: 217. Number of Universities: 46. The expenditure variables are expressed in 2001 Euros and per student enrolled.

Preliminary results (II) Specification 2

Panel model random effects

Dep. Var = Graduation rate $_{it}$	Expenditure categories			
	Total	Personnel	Student financial aid	R&D
Variables	(1)	(2)	(3)	(4)
Expenditure per student $_{i,t}$	0.023**	0.051**	0.323***	0.033
	(0.009)	(0.020)	(0.116)	(0.030)
# of Undergraduates $_{i,t}$	-0.007	-0.009**	-0.009*	-0.004
	(0.005)	(0.004)	(0.005)	(0.005)
Undergraduates^2 $_{i,t}$	0.111	0.138*	0.123*	0.055
	(0.071)	(0.071)	(0.071)	(0.065)
# of Graduates $_{i,t}$	0.014	0.011	0.028	0.011
	(0.024)	(0.023)	(0.028)	(0.029)
Graduates^2 $_{i,t}$	-2.296	-2.569	-3.176	-0.944
	(2.275)	(2.290)	(2.649)	(2.304)
Student Ability $_{i,t}$	-0.002	0.006	0.008	-0.009
	(0.021)	(0.021)	(0.026)	(0.031)
Share of science students $_{i,t}$	0.072	0.038	0.027	0.095
	(0.067)	(0.068)	(0.080)	(0.106)
Share of students with	0.767**	0.827**		0.337
Financial aid $_{i,t}$	(0.327)	(0.324)		(0.408)
Publications per professor $_{i,t}$	0.066	0.047	0.018	-0.050
	(0.081)	(0.080)	(0.093)	(0.110)
# of Patent applications $_{i,t}$	0.002	0.003*	0.003*	0.001
	(0.002)	(0.002)	(0.002)	(0.002)
Constant	0.325*	0.267	0.429**	0.629**
	(0.175)	(0.179)	(0.203)	(0.267)
Adj. R-squared	0.3963	0.3926	0.4018	0.4035

Robustness check

- OLS estimates provide the average effect of an explanatory variable over the entire distribution of an outcome variable. Nonetheless in some contexts, this summary statistic may not be representative of the relationship at any part of the outcome distribution.
- To go beyond the underlying questions of economic and policy concerning of graduation rates, we use a quantile framework to study in more detail.
- Quantile regressions are often used to show that there are differential impacts of the variables of interest throughout the outcome distribution.
- We apply a new unconditional quantile estimation technique for panel data based on Firpo et al. (2009, *Econometrica*) and Powell (2011, *Rand*).
- The method consists in running a regression of a transformation - the Recentered Influence Function (RIF) - of the outcome variable on the explanatory variables.

  RIF-regression model: $E [RIF (Y, q_\tau) | X] = m_\tau (X)$

RIF in Stata: Some Details

rifreg fits a regression model of the re-centered influence function (RIF) of a distributional statistic of interest (quantile, variance or gini) of the marginal distribution of depvar on indepvars. In the case of quantiles, RIF-regressions can be thought of as unconditional quantile regressions. The influence function is a widely used tool in robust estimation; here it is recentered so the mean of the recentered influence function corresponds to the statistic of interest. In RIF-regressions, the depvar is replaced by the corresponding RIF of the statistic of interest.

Firpo estimator is impleted by

rifreg y x1 x2 x3 t i, quantile(0.2) bootstrap reps(200)

rifreg y x1 x2 x3 t i, quantile(0.4) bootstrap reps(200)

rifreg y x1 x2 x3 t i, quantile(0.6) bootstrap reps(200)

rifreg y x1 x2 x3 t i, quantile(0.8) bootstrap reps(200)

Unconditional quantile regression, Fixed-effects results

Dep. Var = Graduation rate $_{it}$	20^{th}	40^{th}	60^{th}	80^{th}
	(1)	(2)	(3)	(4)
Total expenditure	0.011*	0.013*	0.002	0.024
Std. Error	(0.006)	(0.007)	(0.013)	(0.016)
Student financial aid	0.146	0.448**	0.573***	0.388**
Std. Error	(0.150)	(0.172)	(0.176)	(0.194)

Concluding comments

This paper has tried to analyse the **university characteristics** which affect the graduation rate. To our knowledge, this is the first economic study for Spain taking into account institutional characteristics.

The results are largely consistent with recent studies in related topics. University expenditures are key determinants of the graduation rate over the last decade in Spain.

Further results obtained through unconditional quantile regression analysis show that a policy of increasing university expenditure only makes sense at **universities with low graduation rates**. In particular, there is room for improvement via increment of financial student-aid, at those universities whose graduation rate does not belong to the 20^{th} percentile.

These issues, nonetheless, appear to deserve more careful attention since any expenditure increase should be tied to results in terms of quality and efficiency.

Future research

1. Although high graduation rates have been viewed as a good indicator for institutional excellence, it is also recognized that graduation rates reflect admission standards, the academic strength of the enrolled students, and the resources devote to instruction, to remediation, and to retention. The influence of these last factors should be taken into account.

2. Measuring the quality both inputs and outputs is quite important in the analysis of higher education. Therefore, better measures of quality shall be included.

3. When information availability allows it, data at the institutional level can be expanded to have a student level component which could bring closer the two types of studies now in vogue.

Student graduation: To what extent university's expenditure matter?

(Work in progress)

Javier García-Estévez; Néstor Duch
jagarcia@ub.edu

University of Barcelona
The Barcelona Institute of Economics