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Demand for higher education programs: the impact of the Bologna process [*]

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Abstract

The Bologna process aims at creating a European Higher Education Area where inter-country mobility of students and staff, as well as workers holding a degree, is facilitated. While several aspects of the process deserve wide public support, the reduction of the length of the first cycle of studies to three years, in several continental European countries where it used to last for four or five years, is less consensual. The paper checks the extent of public confidence in the restructuring of higher education currently underway, by looking at its implications on the demand for academic programs. It exploits the fact that some programs have restructured under the Bologna process and others have not, in Portugal. Precise quantification of the demand for each academic program is facilitated by the rules of access to higher education, in a nation-wide competition, where candidates must list up to six preferences of institution and program. We use regression analysis applied to count data, estimating negative binomial models. Results indicate that the programs that restructured to follow the Bologna principles were subject to higher demand than comparable programs that did not restructure, as if Bologna were understood as a *quality stamp*. This positive impact was reinforced if the institution was a leader, i.e. the single one in the country that restructured the program. Still an additional increase in demand was experienced by large programs that restructured to offer an integrated master degree, thus conforming to Bologna principles while not reducing the program duration.

KEYWORDS: education policy; European Higher Education Area; economic, social and cultural integration; count data.

JEL CODES: I28, I21, F15.

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1 Introduction

The Bologna process is a far-reaching reform, involving currently 45 countries, which aims at the creation of an European Higher Education Area by 2010. Major steps in that direction, currently underway, include the creation of a comparable structure of academic degrees, mutual recognition of diplomas and course units, the assessment of academic institutions and programs based on common quality standards, and direct incentives to geographical mobility of students and staff. Implementation of a common structure of academic degrees means that some continental European countries are having to move from a four- or five-year first cycle of studies into a shorter three-year one, which led to controversy. On one hand, the advantages of having a degree recognized in a wider geographical space are praised, together with the redevelopment of curricula that makes learning more student-centered and enables entering the labor market earlier. On the other hand, distrust has been expressed over the academic contents and adequacy to labor market needs of the competencies transmitted in a shorter three-year program, with fears that the employability of graduates will be reduced, when compared to graduates of the longer cycle.

This study aims at checking the degree of public confidence in the restructuring of the first cycle of higher education studies currently underway under the Bologna process. More precisely, we concentrate on the reaction of students, to analyze the change in demand for academic programs by candidates to the first cycle of higher education, comparing programs that have already restructured to those that have not.

We take advantage, first of all, of the legal setting in Portugal, where institutions were given the option to adjust their academic programs to the Bologna curricula starting in the academic year 2006/07, or to defer adjustment to one of the two following years. Therefore, in 2006/07 a group of early implementers coexists with a group of programs that still have not undergone change, and students are free to choose where they would like to be admitted. Secondly, the analysis is facilitated by the system of access to higher education in Portugal. Candidates must clearly rank

up to six choices of institution and academic program, and a national competition follows, run by the Ministry of Education, which allocates candidates based on their relative performance and the number of available vacancies posted by each institution for each program. Thirdly, we have a good dataset on the application process, which renders this analysis feasible.

Section 2 describes the main characteristics of the Bologna process. Section 3 explains its implementation in Portugal, clarifying how it provides good conditions for economic analysis, and describes the system of access to higher education. Section 4 presents the data set and section 5 describes the method and major problems to be tackled. Section 6 discusses the results, before concluding comments are presented.

2   The Bologna process

The Bologna process aims at creating a European Higher Education Area, where internal mobility of students, teachers, and administrative staff is facilitated, whose competitiveness attracts students from outside and contributes to the broader aim of turning Europe into a leading knowledge-based society. The main pillars of the process include:

- Comparability of the degree structure, based on three cycles: the bachelor degree (three years, according to the dominant model), the master (normally two years), and the doctorate.

- Mutual recognition of degrees, other awards, and course units. Further to a comparable degree structure, a system of academic credits was created, whose accumulation and transferability across countries is guaranteed, enabling mutual recognition of degrees, other academic qualifications, and periods of study abroad. In the same line, a Diploma Supplement was introduced, which describes the degree and qualifications obtained, in terms of workload, level, and learning outcomes. The overall aim is to improve transparency of higher education degrees and to render more flexible progression into further studies and access to the labor market, while improving the attractiveness of the

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European higher education system.

- Assessment and accreditation of institutions and academic programs based on shared quality standards and procedures.

- Development of mobility programs by student, teaching, research and administrative staff, including measures such as the portability of national loans and grants.

- External dimension of the process, through exchange and cooperation with other parts of the world (for example, Latin American and the Caribbean).

Major steps in the definition of this strategy were taken in Ministerial Conferences at Sorbonne 1998, Bologna 1999, Prague 2001, Berlin 2003, and Bergen 2005.

Even though the process is far-reaching and multifaceted, much attention has been devoted to the changes in the degree structure. Indeed, according to the model that predominated in several continental European countries, the first higher education degree was obtained after four to five years of successful study. Therefore, the curricula changes necessary to bring the first degree down to three-years are being implemented amidst some controversy.

On one hand, the advantages of having a comparable degree structure are stressed, as the system becomes more transparent and obstacles to the mobility of students and workers are reduced. However, the new curricula are often interpreted as a compressed version of the longer courses, and critics claim that there will not be enough time for assimilation, reflection and a critical approach to learning, which will undermine the quality of the degree. Under these circumstances, the employability of the new graduates might be reduced, when competing with graduates from the previous system of a longer first cycle. Moreover, there is the fear that public funding will be restricted to the first (three-year) cycle, thus imposing a higher burden on students if they want to progress beyond the first degree, when compared to the system that used to guarantee public funding for four or five years.

The relevance attached to this issue varies across scientific fields, with the problem usually not raised in the humanities, while it is highlighted in several countries for occupations regulated by professional bodies (Reichert and Tauch, 2005: 13) and subject to specific European Union coordination mechanisms (see the case of architecture and health sciences).

Between optimism and scepticism, it is not certain how the behavior of students and labor market agents will change during the period of adjustment to the Bologna changes in higher education curricula.

3 The Portuguese setting

3.1 Implementation of the Bologna curriculum changes

Portugal subscribed to the Bologna declaration in 1999. The process was regulated by national legislation on the quality of higher education (in 2003), on the credit and classification systems, the Diploma Supplement, and other instruments for geographical mobility (in 2005). Like in other continental European countries, the restructuring of the system of degrees, with the reduction of the length of the first cycle of studies, was one of the more debated changes. In fact, the common duration of a higher education degree used to be in Portugal five years, until 1997, when it was reduced to four years; the Bologna process further imposes a reduction to three years, translated into general national legislation in 2005 and further regulated in 2006.

There is nevertheless the possibility to keep the duration of a program longer. Whereas the first cycle (*licenciatura*) has a normal duration of three years and the second cycle (*mestrado*) has a normal duration of one and a half or two years, in special cases it is feasible to offer a combined degree, the so-called integrated master, lasting for five to six years.

Institutions could choose to start implementing the Bologna changes to the program curricula in the academic year of 2006/07 or one of the two following years.[1]

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[1]Changes taking effect in 2006/07 had to be sent to the Government until March 31, 2006, and changes to take effect in 2007/08 have to be sent until November 15, 2006.

This restructuring of curricula was received with the mixture of optimism and scepticism previously highlighted in the general description of the Bologna process. As a result, different higher education institutions adopted different strategies in terms of the starting year chosen to adopt the new system, in a framework of increasing competition to attract students. Some saw the prompt implementation of the Bologna changes as an opportunity to establish or reinforce a reputation of an up-to-date institution, whose graduates would benefit from the opportunities of a wider labor market. Institutions taking the lead might gain a comparative advantage over the late-comers, not just attracting more applicants in the first year after restructuring, but also gaining a reputation beneficial for future years. Other institutions, instead, opted to delay the process, arguing that changes should be thought over, and that the labor market would penalize the graduates from the new shorter first cycle.

For example, the Academic Senate of the University of Coimbra adopted a general rule deferring to 2007/08 the adoption of the new model (with exceptions authorized for programs on which a national consensus for change had been reached among institutions). This decision contrasted to that of Universidade Nova de Lisboa, which moved ahead restructuring most of its programs, even before national legislation regulating the process was passed.

In this framework, with a group of institutions and programs clearly affected by the Bologna restructuring of the first cycle of studies, and a control group, not adopting that model, students may themselves have opted for contrasting strategies. Some may associate Bologna with a quality stamp and a guarantee of recognition of the degree in a wider geographical space, yielding better employment opportunities, whereas others may attach a higher reputation to a more established older program.

Under this setting, Portugal provides favorable conditions to test the degree of public understanding or trust in the Bologna process. In particular, candidates to a higher education degree will be the agent we consider, and their demand for university programs the precise indicator under scrutiny, contrasting programs that have adjusted to the Bologna process with those that have not yet.

This analysis is rendered feasible by the fact that admission into higher education in Portugal is strictly regulated and implemented through a nation-wide competition, where candidates must clearly state their preferences for institutions and academic programs. Demand can thus be quantified in an unequivocal way.

3.2   Access to higher education

Public higher education comprises in Portugal the University and Polytechnic systems.[2] This study concentrates on the University subsystem, given that it has a more homogenous set of rules in the national competition to allocate students.

Enrollment in higher education is limited by a system of *numerus clausus*. The number of vacancies is defined yearly by each institution, subject to communication to the Ministry of Science, Technology and Higher Education.[3] The application process takes place at the centralized national level. Each candidate ranks up to six priorities, each comprising a pair institution/program. The nation-wide competition that follows allocates the candidates based on their grade point average and the stated ranking of preferences.

Successful completion of secondary education is a prerequisite for admission into higher education by students younger than 23 years.[4] In addition, candidates must pass national admission exams. Definition of the number of exams, their subjects, the minimum classification required, the weighting scheme to compute the final grade point average, and the minimum grade point average required, rests with each institution.[5] In any case, the number of exams required must be one or two, and the computation of the final grade point average (expressed in a scale of 0 to 200) for ranking the applicants to each institution and program must obey the following rules: the grade point average at completion of secondary school, which takes into consideration the three final years of secondary school, must have a weight of at least 50 percent; the specific national admission exam(s) must have

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[2]As well as the military and police institutions.

[3]Who can, under special circumstances, change the proposal. For a few programs, joint approval by this Ministry and a second one is required.

[4]25 years old, until 2005. Older candidates who do not hold a secondary school degree are subject to a different set of exams specific to each program.

[5]In special cases where physical, vocational or other abilities are relevant, other specific admission requirements may apply (*pré-requisitos*).

a weight of at least 35 percent.[6]

Certain admission exams are known to place tougher requirements on the applicants. Traditionally hard subjects are: mathematics, where only 26% of the students obtained in 2006 a passing grade (27% in 2005, and 31% in 2004 and 2003); physics, where the share of students passing the exam was 30%, 47%, 37%, and 22%, respectively in 2006, 2005, 2004, and 2003; and chemistry, where those shares were, respectively, 35%, 52%, 41% and 53%.

The allocation of candidates comprises two major phases: the first one takes place in July; the second takes place in August and includes the vacancies that have not been filled in the first phase. Students who were not successful in the first phase, or who were successful but wish to change the institution/program where they were placed, and those who had not applied in the first phase (either because they did not yet fulfill all the requirements or because, though fulfilling the requirements, had decided not to apply), are eligible to apply in the second phase.[7]

4   Data set

The data used is made publicly available by the Ministry of Science, Technology and Higher Education, on a web site of the Department of Higher Education (DGES) dedicated to announce the results of the allocation of candidates to higher education programs.[8]

Data for the academic years 2003/2004 until 2006/2007 have been collected. The following variables are available: overall demand for each program (total number of students listing the pair institution/program among their preferences, irrespective of its ranking), as well as the number of students who have selected each program as their first choice, second choice and so forth (up to a maximum

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[6]If other special requirements apply, they cannot be attached a weight larger that 15 percent.

[7]In the first phase, there is a small share of vacancies on which specific kinds of candidates are given preference: handicapped individuals, Portuguese emigrants returning home, those under a military work contract (*contingentes especiais*), and those coming from specific regions (Azores or Madeira islands). In the case of Polytechnic schools, further priority is assigned to candidates living in the geographic area of influence of the school (*preferência regional*) or those having completed specific tracks that are more work-oriented, in the secondary education (*preferências habilitacionais*). Institutions where vacancies remain after the second phase may decide to have a third phase, run at the institution level.

[8]*Direcção Geral do Ensino Superior*, at http://www.acessoensinosuperior.pt.

of six that can be listed); number of vacancies available for each program in each of the two stages of the application process; national admission exams required by the program, with the major ones being mathematics, physics, chemistry, biology and portuguese; the field of study of the program.[9]

The appendix provides descriptive statistics on the dataset.

5 Model under estimation

The dependent variable in our model is a nonnegative integer: the demand for university programs, i.e the number of candidates who choose the program. The distribution of the variable is skewed to the left. As such, an adequate tool to model the process is the count data regression analysis. Given the panel structure of the data, we considered both the fixed effects Poisson and the negative binomial regression models, to take into account the unobserved heterogeneity across academic programs.

From the descriptive statistics we learn that the dependent variable shows raw overdispersion. This indicates that the negative binomial regression model might be more appropriate for our data, since it relaxes the hypothesis of equal mean and variance, which we tested by comparing both models through a likelihood ratio test. The results indeed indicate clearly that the negative binomial model is more appropriate and therefore we just report its results.[10]

The negative binomial model with fixed effects is specified as

$$\Pr\left(Y_{it} = y_{it} | \delta_i\right) = \frac{\Gamma\left(\lambda_{it} + y_{it}\right)}{\Gamma\left(y_{it}\right)\Gamma\left(y_{it} + 1\right)} \left(\frac{1}{1 + \delta_i}\right)^{\lambda_{it}} \left(\frac{\delta_i}{1 + \delta_i}\right)^{y_{it}} \tag{1}$$

where y_{it} is the count for our dependent variable for the ith group (academic program) in period t, $\lambda_{it} = \exp(\mathbf{x}_{it}\beta)$, δ_i is the dispersion parameter, and $\mathbf{x}_{it}$ is a vector of regressors. This specification assumes constant dispersion within groups, equal to $1 + \delta_i$. The mean and variance of y_{it} are defined as $\delta_i \lambda_{it}$ and $\delta_i \lambda_{it}\left(1 + \delta_i\right)$,

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[9]We have consistently used the classification adopted by the Ministry in 2006, which includes ten areas: agriculture, architecture, natural sciences, law and social sciences, economics and business, sports and arts, education, humanities, health, and technologies.

[10]Results of the Poisson model are available from the authors upon request.

respectively.[11]

The vector of regressors $\mathbf{x}_{it}$, the program attributes, includes whether it requires a national admission exam in a particular subject (dummy variables for mathematics, physics, chemistry, biology and portuguese) and its scientific field (captured by 9 dummy variables, interacted with year dummy variables). We moreover control for the phase of the application process, with a dummy variable equal to one in the second phase. Given sharp differences in the dimension of the different programs and across different institutions, we must also control for the size of the program (number of vacancies posted). The crucial variable, *Bologna*06, achieves the value one if the program was restructured to adapt to the Bologna principles, and zero otherwise.

Controlling for the subjects required as admission exams is particularly relevant. Indeed, a generally poor performance in the admission exam in a certain subject reduces the size of the population that can potentially apply to programs requiring that exam.

Also, different scientific fields reacted differently to the implementation of the Bologna process (consider for example the contrast between humanities and other fields). Estimation of the model including field-specific effects can control for these differences.

Two alternative concepts are used to quantify the demand for each program at an institution[12]:

- Hits: number of applicants who placed that program in that institution among their choices (irrespective of its ranking, from first to sixth).

- First choice: number of applicants who placed that institution and program as their first choice.

Three alternatives were used to define the group affected by the Bologna curriculum changes, to capture differences in the extent to which a program can be

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[11]The estimation of the fixed effects negative binomial regression model was implemented through conditional maximum likelihood using the Stata command xtnbreg.

[12]The comments on the distribution of the dependent variable, made at the beginning of this section, apply to either variable.

affected as a result of having been restructured (intuitively, it would be like having different intensities of treatment):

- Bologna implementer: a program at an institution, which has been restructured according to the Bologna process.

- Bologna leader: a Bologna implementer that was the only institution in the country that restructured that program. This group corresponds to the early-implementers, who made an early move expecting to gain from its timing. It is a group more likely to be affected (either gaining or losing) by the change, since candidates wishing to enter this program can choose to go for a Bologna program or not.

- Bologna implementer without shortening the duration of the program (*integrated master*): the possibility used by some institutions to restructure a program while nevertheless keeping a duration longer than the normal Bologna duration for the first cycle is explicitly taken into account. We distinguish between programs that reduced their duration and those that, though having restructured to conform to the Bologna principles, offer a joint first and second cycle degree, thus keeping a longer duration.

Comparison of the first and last specifications allows in particular to check the relevance attached by candidates to the *stamp* associated with Bologna and its reputation, and to the change in the duration of the program.

The different alternatives used to quantify demand and to define the affected group provide robustness checks on our results. Nevertheless, several potential problems must still be tackled by the empirical specification. First of all, there could have been endogenous adoption on the new academic model. The timing and extent of adaptation to the Bologna principles may be viewed as a political decision by the institutions, who may self-select into restructuring promptly or delaying adjustment, based on, among other factors, expectations about demand for their programs. Our specification controls for this possibility, as it includes program-specific fixed effects. These program-specific effects may capture factors

other than its strategy, such as the amount of resources, reputation, or regional conditions.

Moreover, the time trend in demand may be different across programs offered by different institutions. If so, the impact captured may reflect underlying trends taking place across programs irrespective of the adoption of the Bologna changes. For example, in a framework of increasing competition among institutions to attract students, it is likely that universities perceived as having lower quality will suffer declining demand, irrespective of whether they implement the Bologna restructuring. To control for this possibility, we will consider also the pre-intervention period. We will therefore repeat the exercise, checking whether the affected group (programs that underwent change in 2006), were already before that period subject to different demand. This specification can thus provides an answer to the question: If no change in the curricula had taken place, would we nevertheless have seen a different trend in demand for the programs that adopted the Bologna changes in 2006 and those that did not? We would expect the estimated coefficient on the Bologna variable for 2005 and its interactions to be statistically non-significant.

6 Impact of the Bologna process

Table 1 reports on the estimation of alternative specifications of the model, in every case using the variable *hits* to quantify the demand for a program, i. e. the total number of candidates that list the program among their preferences, irrespective of its rank position.

Table 1: Demand for academic programs (total number of students choosing the program), negative binomial model

Variable	Spec. 1	Spec. 2	Spec. 3
Size of program (vacancies)	.003***	.003***	.003***
	(.0002)	(.0002)	(.0002)
Bologna06	.13***	.145***	.222**
	(.041)	(.041)	(.104)
Bologna06 * size program	0***	0***	-.001***
	(.0005)	(.0005)	(.0005)
Exam:			
maths	-.401***	-.464***	-.459***
	(.046)	(.047)	(.047)
physics	-.358***	-.327***	-.357***
	(.092)	(.094)	(.094)
chemistry	-.157**	-.092	-.118*
	(.07)	(.07)	(.071)
biology	-.443***	-.457***	-.46***
	(.055)	(.055)	(.055)
portuguese	.123**	.103*	.09*
	(.05)	(.053)	(.054)
Phase 2	-1.055***	-1.061***	-1.065***
	(.016)	(.016)	(.016)
Year:			
2004	-.218***	-.467***	-.469***
	(.017)	(.04)	(.04)
2005	-.252***	-.535***	-.539***
	(.017)	(.044)	(.044)
2006	-.264***	-.432***	-.465***
	(.021)	(.057)	(.074)
Field of study * year	no	yes	yes
Bologna06 * field study:			
agriculture			-.229
			(.206)
law, social sc.			-.164
			(.122)
architecture			-.371**
			(.157)
natural sc.			-.256*
			(.139)
economics, business			-.087

... table 1 continued

Variable	Spec. 1	Spec. 2	Spec. 3
			(.139)
sports, arts			.218
			(.211)
education			.341*
			(.199)
health			-.058
			(.262)
technologies			.184
			(.123)
N	3745	3745	3745
N-g	665	665	665
LL	-13868.21	-13766.12	-13748.34
g-avg	5.6	5.6	5.6

Significance levels: $*: 10\%$ $**: 5\%$ $***: 1\%$. (Standard errors in parentheses). N is the number of observations, N-g is the number of groups institution/program, LL stands for log-likelihood, and g-avg is the average number of observations per group.

As expected, larger programs (posting more vacancies) are subject to larger demand. The demand for a higher education program is strongly affected by the performance of the candidates in the national admission exams. Indeed, requirement of an entry exam on biology, mathematics, physics or chemistry lowers the demand for the program. Controlling for the second phase of the application process is relevant since, as described in section 3.2, this is a residual phase, for vacancies not previously filled and students who were not placed in the first phase or who wish to be placed elsewhere. Therefore, the second phase gathers, quite naturally, a remarkably lower number of applications. Overall demand for university programs declined in 2004 (relative to 2003, the omitted category) and it remained stable ever since (note that the estimated coefficients for the years 2004 onwards are not significantly different).

Programs that restructured to follow the Bologna principles were subject to an increase in demand, when compared to programs that did not restructure. Indeed, those that restructured were subject to 13% higher demand (see specification 1). This effect takes place irrespective of the dimension of the program (see the mag-

nitude of the coefficient on the number of vacancies interacted with the Bologna dummy variable). The previous result is robust to the introduction (in specification 2) of controls for the different trend over time in demand across scientific fields.

Specification 3 further allows the impact of the adoption of the Bologna principles to be heterogenous across scientific fields. This is particularly relevant if one keeps in mind that different areas welcomed with different degrees of enthusiasm or skepticism the changes. The findings in column 3 indicate that in humanities (the omitted category), restructuring of the programs according to the Bologna process was associated with a 22% increase in demand (see the coefficient on the overall Bologna dummy); that impact was not significantly different for programs in law, economics, health, sports and arts, and agriculture. The impact was negative for programs in the architecture area[13], whereas it was statistically insignificant in the natural sciences (as the sum of the coefficients on this dummy and the overall Bologna dummy is not statistically different from zero). Education was unequivocally the area in which candidates perceived the Bologna changes as most of an opportunity, as suggested by the sharp increase in demand.

Table 4 in appendix reports comparable results considering as dependent variable the number of applicants who ranked the program as their first choice only. Specifications 1 and 2 report findings very similar to the previous ones: having restructured to follow Bologna is associated with a 11% to 14% increase in the demand for a program. Specification 3 highlights the positive impact of the Bologna restructuring on the first choice of programs by candidates in the fields of education and technologies.

We further checked whether the impact of the Bologna process could be different, depending on the *intensity* of the changes. First of all, we considered whether being a national leader in a certain program implementing the Bologna curricula is associated with some benefit (or penalty) in terms of demand by prospective students. Secondly, we checked whether restructuring to offer a joint first and second cycle degree (the so-called integrated master) of a longer duration yields

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[13]Which includes not just strictly architecture, but also programs such as design.

some benefit in terms of demand.

In table 2, specification 4 indeed reveals that being a leader in the implementation of the Bologna curricula changes led to an increase in demand for a program, above the increase experienced by Bologna implementers in general. This effect holds irrespective of the size of the program.

Specification 5 considers the impact of restructuring to offer an integrated master program. Results indicate that there was indeed a positive impact on demand for programs that restructured and kept a long duration, above the impact for Bologna implementers in general; however, this increase in demand took place only for large programs.

Once we check jointly the impact of being a Bologna leader and the impact of having restructured to offer a long integrated master program (specification 6), the previous results hold: national leaders in the adaption of the curricula to the Bologna principles attracted more applicants than Bologna changers in general, and a further increase in demand was directed at large programs that became an integrated master under the Bologna setting.

Table 2: Demand for academic programs (total number of students choosing the program), including Bologna leader and integrated master variables, negative binomial model

Variable	Spec. 4	Spec. 5	Spec. 6
Size of program (vacancies)	.003***	.003***	.003***
	(.0002)	(.0002)	(.0002)
Bologna06	.19*	.256**	.221**
	(.106)	(.105)	(.107)
Bologna06 * size program	0**	-.002***	-.001***
	(.0005)	(.0007)	(.0007)
Bologna leader	.155**		.152*
	(.079)		(.079)
Bologna leader * size program	-.001		-.001
	(.001)		(.001)
Integrated master		.015	.03
		(.099)	(.1)
Integrated master * size program		.002**	.002**
		(.001)	(.001)
Exam:			
maths	-.461***	-.456***	-.458***
	(.047)	(.047)	(.047)
physics	-.364***	-.349***	-.358***
	(.094)	(.093)	(.094)
chemistry	-.115	-.117*	-.115*
	(.071)	(.071)	(.071)
biology	-.46***	-.46***	-.46***
	(.055)	(.055)	(.055)
portuguese	.089*	.089*	.087
	(.054)	(.054)	(.054)
Phase 2	-1.067***	-1.067***	-1.068***
	(.016)	(.016)	(.016)
Year:			
2004	-.469***	-.468***	-.468***
	(.04)	(.04)	(.04)
2005	-.54***	-.539***	-.54***
	(.044)	(.044)	(.044)
2006	-.466***	-.465***	-.465***
	(.074)	(.074)	(.074)
Field of study * year	yes	yes	yes
Bologna06 * field study:			

Continued on next page...

... table 2 continued

Variable	Spec. 4	Spec. 5	Spec. 6
agriculture	-.246	-.27	-.288
	(.206)	(.206)	(.206)
law, social sc.	-.168	-.151	-.161
	(.123)	(.123)	(.123)
architecture	-.398**	-.399**	-.434***
	(.158)	(.159)	(.16)
natural sc.	-.264*	-.263*	-.275**
	(.139)	(.139)	(.139)
economics, business	-.09	-.068	-.07
	(.139)	(.139)	(.139)
sports, arts	.143	.208	.124
	(.215)	(.211)	(.215)
education	.318	.359*	.311
	(.204)	(.199)	(.204)
health	-.076	-.241	-.269
	(.261)	(.267)	(.268)
technologies	.172	.11	.088
	(.124)	(.134)	(.135)
N	3745	3745	3745
N-g	665	665	665
LL	-13746.45	-13744.99	-13743.11
g-avg	5.6	5.6	5.6

Significance levels: $*: 10\%$ $**: 5\%$ $***: 1\%$. (Standard errors in parentheses). N is the number of observations, N-g is the number of groups institution/program, LL stands for log-likelihood, and g-avg is the average number of observations per group.

Table 5 in appendix shows results of the same specifications, considering as dependent variable the number of candidates who chose the program as their first option only. Results highlight that the impact of the Bologna changes was more pronounced in education and technologies, while being a leader or having restructured to become an integrated master does not yield a significant impact on the first option listed by candidates.

One final issue remains to be tackled, that of checking if the impact we are capturing was indeed a result of the Bologna changes or a trend taking place anyhow, due to factors other than Bologna, which would have taken place even if the program had not been restructured. We therefore run the previous models including a

new variable, *Bologna*05, which assumes the value 1 in the year 2005 (previous to the implementation of any Bologna changes) for the programs that later (in 2006) were restructured. We expect the estimated coefficients on this variable and its interactions to be non-significant, meaning that programs implementing Bologna in 2006 were not subject to a different trend in demand already before that period. Table 3 adds this variable and its interactions to the final specification in table 1 (calling it specification 7) and to the specifications in table 2 (specifications 8 to 10).

Table 3: Demand for academic programs (total number of students choosing the program), including Bologna 2005 variable, negative binomial model

Variable	Spec. 7	Spec. 8	Spec. 9	Spec. 10
Size of program (vacancies)	.003***	.003***	.003***	.003***
	(.0002)	(.0002)	(.0002)	(.0002)
Bologna06	.224**	.193*	.259**	.225**
	(.107)	(.109)	(.108)	(.11)
Bologna06 * size program	-.001***	0**	-.002***	-.001***
	(.0005)	(.0005)	(.0007)	(.0007)
Bologna leader		.151*		.148*
		(.079)		(.078)
Bologna leader * size program		-.001		-.001
		(.001)		(.001)
Integrated master			.015	.029
			(.098)	(.099)
Integrated master * size program			.002**	.002**
			(.001)	(.001)
Bologna05	.009	.008	.01	.009
	(.101)	(.101)	(.101)	(.101)
Bologna05 * size program	.0001	.0001	.0001	.0001
	(.0005)	(.0005)	(.0005)	(.0005)
Exam:				
maths	-.46***	-.462***	-.457***	-.459***
	(.047)	(.047)	(.047)	(.047)
physics	-.358***	-.365***	-.35***	-.358***
	(.094)	(.094)	(.094)	(.094)
chemistry	-.118*	-.115	-.117*	-.116*
	(.071)	(.071)	(.071)	(.071)
biology	-.46***	-.46***	-.459***	-.459***

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Variable	Spec. 7	Spec. 8	Spec. 9	Spec. 10
	(.055)	(.055)	(.055)	(.055)
portuguese	.089*	.088	.087	.086
	(.054)	(.054)	(.054)	(.054)
Phase 2	-1.065***	-1.067***	-1.068***	-1.069***
	(.016)	(.016)	(.016)	(.016)
Year:				
2004	-.469***	-.469***	-.469***	-.469***
	(.04)	(.04)	(.04)	(.04)
2005	-.542***	-.543***	-.542***	-.543***
	(.048)	(.048)	(.048)	(.048)
2006	-.466***	-.467***	-.466***	-.467***
	(.074)	(.074)	(.074)	(.074)
Field of study * year	yes	yes	yes	yes
Bologna06 * field study:				
agriculture	-.26	-.275	-.302	-.318
	(.213)	(.213)	(.213)	(.213)
law, social sc.	-.158	-.163	-.147	-.156
	(.126)	(.127)	(.126)	(.127)
architecture	-.376**	-.4**	-.404**	-.437***
	(.164)	(.165)	(.165)	(.166)
natural sc.	-.265*	-.271*	-.272*	-.283**
	(.144)	(.144)	(.144)	(.144)
economics, business	-.036	-.039	-.017	-.019
	(.145)	(.145)	(.144)	(.145)
sports, arts	.213	.14	.203	.121
	(.228)	(.233)	(.228)	(.233)
education	.436**	.415**	.453**	.407*
	(.206)	(.21)	(.205)	(.21)
health	-.049	-.064	-.223	-.25
	(.276)	(.275)	(.279)	(.28)
technologies	.226*	.214*	.151	.13
	(.127)	(.128)	(.137)	(.138)
Bologna05 * field study:				
agriculture	-.116	-.111	-.118	-.112
	(.204)	(.204)	(.204)	(.204)
natural sc.	-.032	-.027	-.035	-.03
	(.143)	(.143)	(.143)	(.143)
architecture	-.017	-.013	-.017	-.014
	(.159)	(.159)	(.159)	(.159)

... table 3 continued

Variable	Spec. 7	Spec. 8	Spec. 9	Spec. 10
economics, business	.171	.17	.169	.169
	(.142)	(.142)	(.142)	(.142)
sports, arts	-.015	-.014	-.016	-.016
	(.264)	(.264)	(.264)	(.264)
education	.292	.295	.292	.294
	(.21)	(.21)	(.21)	(.21)
law, social sc.	.014	.013	.01	.01
	(.121)	(.121)	(.121)	(.121)
health	.008	.013	.031	.034
	(.267)	(.266)	(.265)	(.265)
technologies	.132	.132	.131	.131
	(.118)	(.118)	(.118)	(.118)
N	3745	3745	3745	3745
N-g	665	665	665	665
LL	-13742.13	-13740.31	-13738.68	-13736.88
g-avg	5.6	5.6	5.6	5.6
$\chi^2_{(11)}$	12.67	12.54	12.86	12.72

Significance levels: $*$: 10% $**$: 5% $***$: 1%. (Standard errors in parentheses). N is the number of observations, N-g is the number of groups institution/program, LL stands for log-likelihood, and g-avg is the average number of observations per group. The $\chi^2_{(11)}$ is the joint test on the Bologna 2005 variable and its interactions.

It is reassuring to find that, as expected, belonging to the affected group of programs before the restructuring was implemented, did not have any significant impact on the demand for a degree. Table 3 indeed shows that the coefficients on the Bologna05 variable and its interactions are non-significant. Therefore, the demand for Bologna and non-Bologna degrees was not undergoing different trends before the institutional changes were implemented, pointing to the validity of the exercise we performed.

7 Conclusion

We have checked the impact on the demand for academic programs resulting from the remarkable changes in the curricula currently taking place under the Bologna process. The relevance of the issue follows from the mix of enthusiasm and some criticism that these changes have raised, in countries where the first cycle of higher

education used to last for four or five years and is now reduced to a normal duration of three years. Analysis of the issue is feasible in Portugal, since the procedure of application to higher education takes place at the centralized national level and candidates must clearly list their preferences in terms of programs and institutions. We explored the fact that in the academic year 2006/07, some programs underwent restructuring, whereas other did not.

Results clearly indicate that programs that changed their curricula to conform with the Bologna principles were subject to an increase in demand by prospective students. That positive impact on demand was more pronounced if the institution took the lead, being the only institution in the country that restructured the program. We also found that large programs that changed their curriculum to offer an integrated master, thus conforming to the Bologna principles while not reducing the duration of the program, were subject to a further increase in demand. Moreover, we have confirmed that the impact we are capturing is not due to trends taking place irrespective of the adoption of the Bologna principles. Indeed, our tests indicate that the demand for Bologna and non-Bologna degrees was not undergoing different trends before the institutional changes were implemented.

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Appendix: additional tables and figures

Table 4: Demand for academic programs (number of students choosing the program as their first choice), negative binomial model

Variable	Spec. 1	Spec. 2	Spec. 3
Size of program (vacancies)	.002***	.002***	.002***
	(.0002)	(.0002)	(.0002)
Bologna06	.111**	.143***	.054
	(.049)	(.05)	(.137)
Bologna06 * size program	0*	0**	-.001***
	(.0006)	(.0006)	(.0006)
Exam:			
maths	-.599***	-.626***	-.621***
	(.063)	(.063)	(.063)
physics	-.317***	-.323***	-.364***
	(.115)	(.118)	(.118)
chemistry	-.1	-.037	-.06
	(.096)	(.097)	(.097)
biology	-.644***	-.654***	-.648***
	(.071)	(.072)	(.072)
portuguese	.104	.072	.044
	(.066)	(.069)	(.069)
Phase 2	-.897***	-.898***	-.902***
	(.02)	(.02)	(.02)
Year:			
2004	-.214***	-.483***	-.48***
	(.02)	(.055)	(.055)
2005	-.26***	-.523***	-.526***
	(.021)	(.059)	(.059)
2006	-.281***	-.498***	-.454***
	(.026)	(.076)	(.094)
Field of study * year	no	yes	yes
Bologna06 * field study:			
agriculture			-.244
			(.293)
law, social sc.			.082
			(.156)
architecture			-.172
			(.196)
natural sc.			-.223
			(.186)

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... table 4 continued

Variable	Spec. 1	Spec. 2	Spec. 3
economics, business			.074
			(.174)
sports, arts			.121
			(.271)
education			.772***
			(.234)
health			-.117
			(.333)
technologies			.435***
			(.163)
N	3745	3745	3745
N-g	665	665	665
LL	-9461.225	-9399.144	-9379.973
g-avg	5.6	5.6	5.6

Significance levels: $*:10\%$ $**:5\%$ $***:1\%$. (Standard errors in parentheses). N is the number of observations, N-g is the number of groups institution/program, LL stands for log-likelihood, and g-avg is the average number of observations per group.

Table 5: Demand for academic programs (number of students choosing the program as their first choice), including Bologna leader and integrated master variables, negative binomial model

Variable	Spec. 4	Spec. 5	Spec. 6
Size of program (vacancies)	.002***	.002***	.002***
	(.0002)	(.0002)	(.0002)
Bologna06	.065	.077	.088
	(.139)	(.138)	(.14)
Bologna06 * size program	-.001***	-.001***	-.001***
	(.0006)	(.0007)	(.0008)
Bologna leader	-.061		-.054
	(.097)		(.097)
Bologna leader * size program	.001		.002
	(.002)		(.002)
Integrated master		.097	.1
		(.121)	(.123)
Integrated master * size program		.001	.002
		(.001)	(.001)
Exam:			
maths	-.621***	-.616***	-.616***
	(.063)	(.063)	(.063)
physics	-.363***	-.362***	-.359***
	(.118)	(.118)	(.118)
chemistry	-.061	-.06	-.061
	(.097)	(.097)	(.097)
biology	-.648***	-.648***	-.648***
	(.072)	(.072)	(.072)
portuguese	.042	.043	.04
	(.069)	(.069)	(.069)
Phase 2	-.9***	-.904***	-.902***
	(.02)	(.02)	(.02)
Year:			
2004	-.48***	-.48***	-.48***
	(.055)	(.055)	(.055)
2005	-.526***	-.525***	-.526***
	(.059)	(.059)	(.059)
2006	-.454***	-.454***	-.454***
	(.094)	(.094)	(.094)
Field of study * year	yes	yes	yes
Bologna06 * field study:			

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... table 5 continued

Variable	Spec. 4	Spec. 5	Spec. 6
agriculture	-.239 (.293)	-.309 (.294)	-.308 (.294)
law, social sc.	.08 (.157)	.091 (.156)	.085 (.157)
architecture	-.17 (.198)	-.214 (.198)	-.224 (.201)
natural sc.	-.224 (.186)	-.225 (.186)	-.23 (.186)
economics, business	.077 (.174)	.089 (.174)	.093 (.174)
sports, arts	.146 (.277)	.111 (.272)	.123 (.278)
education	.76*** (.242)	.782*** (.234)	.747*** (.241)
health	-.106 (.335)	-.345 (.343)	-.345 (.344)
technologies	.436*** (.163)	.326* (.176)	.315* (.177)
N	3745	3745	3745
N-g	665	665	665
LL	-9379.601	-9377.576	-9376.9
g-avg	5.6	5.6	5.6

Significance levels: $*: 10\%$ $**: 5\%$ $***: 1\%$. (Standard errors in parentheses). N is the number of observations, N-g is the number of groups institution/program, LL stands for log-likelihood, and g-avg is the average number of observations per group.

Table 6: Demand for academic programs (number of students choosing the program as their first choice), including Bologna 2005 variable, negative binomial model

Variable	Spec. 7	Spec. 8	Spec. 9	Spec. 10
Size of program (vacancies)	.002***	.002***	.002***	.002***
	(.0002)	(.0002)	(.0002)	(.0002)
Bologna06	.079	.092	.102	.115
	(.141)	(.143)	(.142)	(.144)
Bologna06 * size program	-.001***	-.001***	-.001***	-.001***
	(.0006)	(.0006)	(.0007)	(.0008)
Bologna leader		-.066		-.059
		(.096)		(.096)
Bologna leader * size program		.002		.002
		(.002)		(.002)
Integrated master			.095	.098
			(.12)	(.121)
Integrated master * size program			.001	.002
			(.001)	(.001)
Bologna05	.097	.098	.097	.098
	(.13)	(.13)	(.13)	(.13)
Bologna05 * size program	.00004	.00002	.00006	.00004
	(.0006)	(.0006)	(.0006)	(.0006)
Exam:				
maths	-.625***	-.625***	-.62***	-.62***
	(.063)	(.063)	(.063)	(.063)
physics	-.362***	-.361***	-.36***	-.357***
	(.118)	(.119)	(.118)	(.118)
chemistry	-.063	-.065	-.063	-.065
	(.098)	(.098)	(.097)	(.097)
biology	-.65***	-.65***	-.65***	-.65***
	(.072)	(.072)	(.072)	(.072)
portuguese	.038	.036	.037	.034
	(.069)	(.069)	(.069)	(.069)
Phase 2	-.903***	-.901***	-.906***	-.903***
	(.02)	(.02)	(.02)	(.02)
Year:				
2004	-.482***	-.482***	-.482***	-.482***
	(.055)	(.055)	(.055)	(.055)
2005	-.547***	-.548***	-.547***	-.548***
	(.066)	(.066)	(.066)	(.066)
2006	-.461***	-.461***	-.46***	-.461***

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Variable	Spec. 7	Spec. 8	Spec. 9	Spec. 10
	(.094)	(.094)	(.094)	(.094)
Field of study * year	yes	yes	yes	
Bologna06 * field study:				
agriculture	-.297	-.292	-.361	-.36
	(.302)	(.302)	(.302)	(.302)
law, social sc.	.071	.069	.079	.073
	(.161)	(.162)	(.161)	(.162)
architecture	-.239	-.238	-.28	-.291
	(.204)	(.206)	(.206)	(.208)
natural sc.	-.212	-.213	-.215	-.22
	(.192)	(.193)	(.192)	(.193)
economics, business	.08	.082	.095	.099
	(.18)	(.18)	(.18)	(.18)
sports, arts	.125	.154	.114	.13
	(.29)	(.296)	(.291)	(.296)
education	.712***	.698***	.721***	.686***
	(.246)	(.253)	(.246)	(.253)
health	-.156	-.145	-.377	-.377
	(.355)	(.356)	(.361)	(.362)
technologies	.496***	.498***	.388**	.378**
	(.168)	(.168)	(.18)	(.182)
Bologna05 * field study:				
agriculture	-.199	-.2	-.201	-.201
	(.279)	(.279)	(.279)	(.279)
natural sc.	.031	.029	.029	.028
	(.184)	(.184)	(.184)	(.184)
architecture	-.23	-.232	-.23	-.232
	(.198)	(.198)	(.198)	(.198)
economics, business	.003	.003	.002	.003
	(.174)	(.174)	(.174)	(.174)
sports, arts	-.017	-.013	-.019	-.014
	(.301)	(.3)	(.301)	(.3)
education	-.223	-.225	-.223	-.225
	(.272)	(.272)	(.272)	(.272)
law, social sc.	-.05	-.049	-.052	-.051
	(.151)	(.151)	(.151)	(.151)
health	-.131	-.133	-.125	-.125
	(.308)	(.308)	(.307)	(.307)

... table 6 continued

Variable	Spec. 7	Spec. 8	Spec. 9	Spec. 10
technologies	.189	.189	.188	.189
	(.152)	(.152)	(.152)	(.152)
N	3745	3745	3745	3745
N-g	665	665	665	665
LL	-9371.509	-9371.066	-9369.098	-9368.335
g-avg	5.6	5.6	5.6	5.6
$\chi^2_{(11)}$	16.95	17.09	16.98	17.15

Significance levels: $*$: 10% $**$: 5% $***$: 1%. (Standard errors in parentheses). N is the number of observations, N-g is the number of groups institution/program, LL stands for log-likelihood, and g-avg is the average number of observations per group. The $\chi^2_{(11)}$ is the joint test on the Bologna 2005 variable and its interactions.

Table 7: Summary statistics

Variable	Mean or Pct.	Std. Dev.
Demand: number of *hits*	139.1	207.8
Demand: first option	31.9	61.7
Bologna06	0.116	0.32
Bologna leader	0.05	0.218
Integrated master	0.02	0.141
Phase 2	0.49	
Size of the program (vacancies)	32.7	39.7
Exams:		
maths	0.377	
physics	0.046	
chemistry	0.083	
biology	0.111	
portuguese	0.083	
Field of study:		
agriculture	0.054	
architecture	0.070	
natural sciences	0.131	
law, social sciecnes	0.148	
economics, business	0.073	
sports, arts	0.033	
education	0.078	
humanities	0.154	
health	0.042	
technologies	0.217	
N	3745	

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