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ABSTRACT

Admission Conditions and Graduates' Employability*

We evaluate the information content of admission conditions for study programs' quality by investigating its relationship with graduates' employability. We find that study programs with larger *numeri clausi* are associated with a higher probability of finding a job. Additionally, compulsory admission exams seem to be informative about study programs' quality. Namely, study programs requiring the Math exam appear to be linked with lower unemployment propensity. Cardoso et al. (2008), however, found that those programs face lower demand when compared to other studies. These paradoxical results suggest that students' choices may be based on insufficient information on returns to higher education investment. That information failure indicates that a Government intervention may be due.

JEL Classification: C21, I21, J23, J64

Keywords: higher education, unemployment propensity, fractional models

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1 Introduction

Over the last decades, the Portuguese higher education sector witnessed an expansion with no precedent. In the 90s, the number of students enrolled in tertiary education has doubled, reaching 400,000 in 2000. Since then, demographic changes and large investments produced excess capacity, raising questions about public expenditure in tertiary education and quality issues. In this context of excess supply and the consequent increasing competition for students, admission conditions may be seen as an instrument of a differentiation strategy (OECD, 2006). Simultaneously, Higher Education Institutions (HEIs) have undergone an increasing pressure to contribute to economic and social goals and to be more responsive to labour market needs (OECD, 2008), which has resulted in greater focus on accountability and quality assurance mechanisms. Although quality issues have been brought to the public discussion, there is insufficient public information on study programs' quality in Portugal (OECD, 2006). Therefore, we look at admission conditions and evaluate its information content regarding programs' quality. Special attention is devoted to the compulsory exams required by each study.

Although HEIs' quality is not directly observable, several performance indicators have been proposed to evaluate features that go from access and participation to research and to labour market outcomes. Several studies have analyzed the relationship between HEIs' quality and wage returns, concluding that institutional quality matters for graduates' performance in labor markets (see Black and Smith, 2004, Dale and Krueger, 2002, and Brewer et al., 1999). For example, Smith et al. (2000) discuss a performance indicator for higher education institutions based on graduate employment outcomes. In fact, economists find labour market outcomes a natural way of evaluating student performance. This follows from the standard human capital model, which sees education as an investment: students bear the costs of attending school if they expect that these are outweighed by future returns.

In this paper, using data for the Portuguese public higher education system, at the program/institution level, we infer programs' quality through the admission conditions. We do that by evaluating the impact of admission conditions, namely *numeri clausi* and the compulsory exams required by each study, in particular the Math exam, on programs' employability. The study benefits from the data on graduates employability per study program and institution, released in the beginning of 2008 by the Ministry of Science Technology and Higher Education.

Foreshadowing the conclusions, it seems that making the Math exam compulsory is associated with higher quality study programs, as that admission condition appears to be linked with higher employability. This result suggests that high school students should look at admission conditions as quality indicators when applying to higher education programs. According to human capital theory we would expect study programs requiring a Math exam to be among the most demanded by candidates to higher education. Paradoxically, Cardoso et al. (2008) found that those programs face lower demand. This indicates the existence of a market failure that may call for a State intervention.

The paper unfolds as follows. Section 2 discusses the admission conditions in the context of the Portuguese higher education system. Section 3 describes the data and the empirical analysis is presented in Section 4. Section 5 concludes the study.

2 Admission policies and information in the Portuguese higher education system

The Portuguese higher education system is a binary system with universities and polytechnics as the main education providers. Access to the public higher education system is regulated by the Ministry of Science, Technology and Higher Education (MCTES, *Ministério da Ciência, Tecnologia e Ensino Superior*) through *numeri clausi* and admission

policies, settled every school year. Each study program has to define a compulsory examination in one or two subjects, and the weight given to both secondary school grades and exam(s), within the limits established by the Ministry itself. Currently, access to public higher education works through a national competition based on students' revealed preferences (each candidate ranks up to six institution/program pairs) and GPA, which is a weighted average of their marks in upper secondary education and in national examinations. Such competition takes place in two phases. In the first phase all places are available. Places not filled in that phase are available for a second round.

The focus of the present analysis is the Portuguese public higher education system, where important changes have been taking place. Namely, the number of candidates has declined due to demographic changes and large investments in higher education occurred in the 90s, which have resulted in large imbalances between demand and supply in the Portuguese higher education system. Excess supply is represented in Figure 1, which depicts the number of places available in the public higher education system and the number of places filled in the first phase of the application process. These imbalances, quantified in Portela et al. (2008), exacerbated the competition for candidates between institutions, enhancing strategies of differentiation. Such strategies appear in a context in which "public information on course content, program goals, quality and opportunities and graduate employment is inadequate or unavailable" (OECD, 2006: 27). Although a new accreditation agency, which will be in charge of study programs evaluation, was created in 2007, so far the approval of new study programs has been a bureaucratic procedure, as they do not depend on an evaluation or accreditation process.

Among differentiation strategies, the definition of admission conditions has had a major role as they affect the number of study program's potential candidates (OECD, 2006). Namely, national exams play a crucial role in defining the pool of candidates, as some subjects have low success rates. For example, exams on Mathematics, Physics and Chemistry are known to place tougher requirements on the applicants. In the Math exam, in 2006,

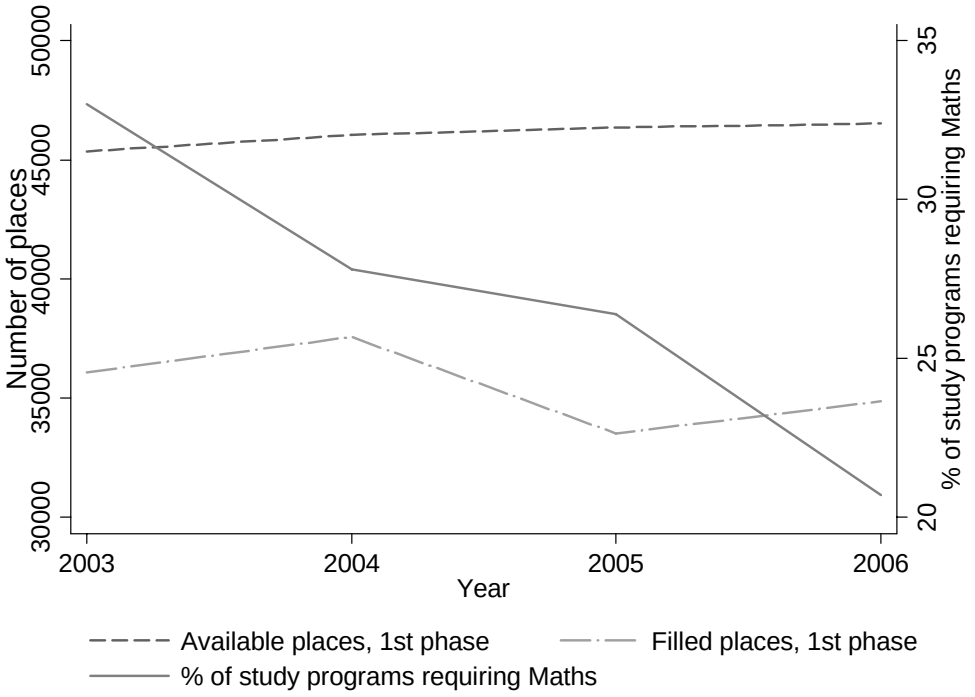

Figure 1: Excess supply and percentage of study programs requiring Maths

only 26% of the students obtained a passing grade (27% in 2005, and 31% in 2004 and 2003). In Physics the share of students passing the exam was 30%, 47%, 37%, and 22%, respectively in 2006, 2005, 2004, and 2003, whereas in Chemistry, the shares were 35%, 52%, 41% and 53%.

As admission policies may have a decisive role in defining the number of candidates and students' enrolment in higher education, which is the most important factor in the Government funding formula, HEIs may have differentiated strategies when defining admission conditions. On the one hand, given the very high failure rate, if study programs want to target a larger pool of candidates, they should drop the Math exam as an admission condition. This seems to have been the strategy of a large number of study programs. From Figure 1 we observe that the percentage of study programs requiring the Math exam has been decreasing steadily, from 33%, in 2003/2004, to 20.7%, in 2006/2007 (in 2007/2008 that percentage decrease further to 13.4%). On the other hand, institutions may opt to set

more stringent admission conditions to target specific segments of the student population, namely including one or two of those exams as pre-requisites and defining a minimum admission grade above the passing grade. The field of Economics provides a good example of such differentiation: some study programs made the Math examination optional, to target a larger pool of candidates, whereas University Nova of Lisbon set a higher minimum of 12.5/20 in the average application grade as a pre-requisite for application.

In this paper, we use that data on the number of graduated unemployed per study program to analyse the information content of admission conditions on programs' quality. In other words, we test whether admission conditions reflect study programs' quality and could, therefore, work as a guide in students' choices when applying to HEIs. Given the restriction that the Math exam imposes on the pool of potential candidates, we focus our analysis on that admission condition.

3 The data

This study focusses on the Portuguese public funded HEIs, which comprises 14 universities and 26 polytechnics, accounting approximately for 70% of the Higher Education students. The present analysis uses data for the academic year of 2006/2007. A pair study program/institution is taken as the unit of analysis. The data set used for the empirical analysis comprises 974 pairs institution/program, representing 40 Higher Education institutions.[1]

The study program size, proxied by *numerus clausus*, the exams required to apply to a specific study program and the distinction between universities and polytechnics are among the variables available.[2] We also have information on the average of the GPA at entrance

[1] In 2006/2007, public funded HEIs offered 576 study programs, corresponding to 991 pairs institution/program, and 46580 vacancies. Seventeen pairs were dropped from the analysis due to non-availability of information on relevant variables.

[2] The student-teacher ratio is usually taken as a quality measure. As in the Portuguese context that ratio is centrally imposed, we opt for using the program size, proxied by the numerurs clausus. This way

of registered applicants in a given institution and program, which works as an indicator of selectivity, which allow us to control for the quality of students (Sá et al., 2007). Smith et al. (2000), for example, find out that the educational background is relevant for the probability of being unemployed or inactive for the UK university graduates. Additionally, we have used the classification of the programs in 10 fields of study adopted by the MCTES in 2006: Agriculture, Architecture, Natural Sciences, Law and Social Sciences, Economics and Business, Sports and Arts, Education, Humanities, Health, and Technologies.

Furthermore, in February 2008, the Portuguese Ministry of Science, Technology and Higher Education has released information on the number of unemployed workers registered in the Government Employment Agencies per study program and institution (GPEARI/MCTES, 2008). That data covers all the pairs of programs and institutions in both the public and private sector. This information allows for the construction of employability indicators, a proxy for graduates' unemployment per program/institution pair. We calculate the ratio of the number of workers registered as of December 2007 in the Government Employment Centers to the number of graduates per program and institution in the period 1996 to 2006, which we call unemployment propensity per program/institution.

The summary statistics for the variables used in the empirical analysis are reported in Table 1. The average propensity to unemployment is 6.7%, while the average GPA of registered applicants is 137.6 (out of 200), with a standard deviation of approximately 14.5. The average size of study programs is around 47 places, with a standard deviation of approximately 39 places. About 20% of the pairs institution/program require a Math exam, while only 2% require an exam in physics. For Chemistry, Biology and Portuguese the figures are 5%, 11% and 7%, respectively. The most representative field of study in terms of number of pairs institution/program is Technologies with 22%, followed by Law and Social Sciences with more than 16%. The least represented field is Sports and Arts with a little bit more than 3% of all study programs. Almost half of the study programs

we do control for the existence of economies of scale.

are in polytechnic institutions.

Table 1: Summary statistics

Variable	Mean	Standard deviation
Unemployment propensity	0.067	(0.121)
Grade Point Average (GPA) of registered applicants	137.59	(14.47)
Study program size	47.24	(38.97)
Maths	0.202	
Physics	0.020	
Chemistry	0.052	
Biology	0.115	
Portuguese	0.072	
Agriculture	0.056	
Architecture	0.072	
Natural Sciences	0.078	
Law and Social Sciences	0.161	
Economics and Business	0.109	
Sports and Arts	0.031	
Education	0.074	
Humanities	0.083	
Health	0.115	
Technologies	0.221	
Polytechnic	0.498	

Notes: The sample under analysis corresponds to 974 observations and 40 institutions. Unemployment propensity is bounded between 0 and 1. Minimum and maximum values for the Grade Point Average are 109 and 185.10, respectively, whereas 5 and 550 are the minimum and maximum study programme sizes, respecively. All the remaining variables are dummy variables.

4 Empirical analysis

The graduates' unemployment propensity indicator and information on admission conditions are used in our empirical analysis, which aims at estimating the impact of admission conditions on graduates' employability. As argued above, this will allow us to associate admission conditions and study programs' quality. The dependent variable in the empir-

ical model, the propensity for unemployment of a pair institution/program, is a fractional response variable, which suggests the use of fractional models.

Take the model specification as

$$E\left(PUNEMP|\boldsymbol{x}\right) = \beta_0 + \beta_1 AGPA + \beta_2 SIZE + \beta_3 Polytec + \boldsymbol{\gamma}_1\boldsymbol{E} + \boldsymbol{\gamma}_2\boldsymbol{I} + \boldsymbol{\gamma}_3\boldsymbol{F} \quad (1)$$

where $PUNEMP$ is the propensity for unemployment of graduated students; $AGPA$ is the average of the GPA of registered applicants; $SIZE$ is the *numerus clausus,* which we take for the study program size; $Polytec$ is a dummy variable taking the value 1 for polytechnic institutions; $\boldsymbol{E}$ is a vector of dummy variables for entrance exams required by each institution/program pair, which includes the exams of Math, Physics, Chemistry, Biology and Portuguese; $\boldsymbol{I}$ is a vector of dummy variables for each of the 40 institutions under analysis; and finally $\boldsymbol{F}$ is another vector of dummy variables for the 10 fields of study.

To start with, the model in equation (1) is estimated by OLS (see the results in the first column of Table 2). However, the estimation of equation (1) by OLS has some problems, and then should be taken just as a benchmark. First, OLS does not guarantee that the predicted values are in the unit interval. Second, the model does not pass some specification tests. We performed a RESET test based on the regression of $\hat{u}_i$ on $\boldsymbol{x}_i$, $\hat{y}_i^2$, $\hat{y}_i^3$, where $\hat{u}_i$ are the OLS residuals, and $\hat{y}_i^2$, $\hat{y}_i^3$, are polynomials of the OLS fitted values, and $\boldsymbol{x}_i$ defines the set of regressors. A statistic $NR^2 \sim \chi_2^2$ of 19.7, with a $p - value$ of 0.0001, is obtained and leads to the rejection of the null hypothesis under which equation (1) is true. The robust RESET test statistic is about 11.3, with a $p - value$ of 0.0035, which confirms the previous result.

Table 2: Results for unemployment propensity

	OLS	QMLE	
Variable	Estimates	Estimates	Marginal Effects
AGPA of registered applicants	-0.0009***	-0.0146***	-0.0008***
	(0.0003)	(0.0054)	(0.0003)
Study program size	-0.0002**	-0.0031*	-0.0002*
	(0.0001)	(0.0018)	(0.0001)
Maths	-0.0335**	-0.5702**	-0.0253***
	(0.0150)	(0.2345)	(0.0091)
Physics	-0.0051	-0.2056	-0.0097
	(0.0112)	(0.2356)	(0.0102)
Chemistry	-0.0094	-0.2441	-0.0114
	(0.0162)	(0.3734)	(0.0157)
Biology	0.0261	0.4781	0.0290
	(0.0213)	(0.3797)	(0.0270)
Portuguese	0.0445*	0.5712**	0.0366*
	(0.0239)	(0.2632)	(0.0205)
Observations	974	974	
SSR	13.0003	12.7419	
SER	0.1191	0.1819	
R^2	0.0939	0.1119	
RESET	19.7189	6.4742	
	[0.0001]	[0.0393]	
Robust RESET	11.3168	0.6697	
	[0.0035]	[0.7155]	

Notes: Significance levels: $*$: 10% $**$: 5% $***$: 1%. Robust standard errors in parentheses; $p-values$ in square brakets. The dependent variable is unemployment propensity. AGPA stands for the average of the Grade Point Average. The QMLE regression is estimated by Generalized Linear Model, with family binomial and link logit. It includes a set of dummies for institutions, polytechnic institution, and fields of study (Agriculture, Architecture, Natural Sciences, Law and Social Sciences, Economics and Business, Sports and Arts, Education, Health and Technologies). SSR stands for Sum of Squared Residuals and SER is the standard error of the regression.

We opt for an alternative solution discussed by Papke and Wooldridge (1996).[3] Take the assumption

$$E\left(y_i|\boldsymbol{x}_i\right) = G\left(\boldsymbol{x}_i\beta\right), \tag{2}$$

valid for all i, and $0 < G\left(z\right) < 1$ for all $z \in \mathbb{R}$. Usually $G\left(.\right)$ is a cumulative distribution,

[3]Papke and Wooldridge (1996) also discuss other alternatives: (i) model the log-odds ratio as a linear function; (ii) use of the beta distribution to model the fractional variable y. The latter, however, is not robust to a distributional failure.

with the two most common distributions being the logistic distribution and the standard normal cumulative distribution function. Papke and Wooldridge (1996) propose a quasi-likelihood method for estimating the β. The authors use in particular the Bernoulli log-likelihood, which provides consistent estimates of β, as long as the assumption stated by equation (2) is valid.

When we take a fractional dependent variable, as is the case of the present analysis, the use of a quasi-maximum likelihood estimator (QMLE) and the logistic function follows as natural choices from the above arguments. The model is then defined as

$$E\left(PUNEMP|\boldsymbol{x}\right) = G\left(\alpha_0 + \alpha_1 AGPA + \alpha_2 SIZE + \alpha_3 Polytec + \boldsymbol{\tau}_1\boldsymbol{E} + \boldsymbol{\tau}_2\boldsymbol{I} + \boldsymbol{\tau}_3\boldsymbol{F}\right) \tag{3}$$

where $G\left(.\right)$ is the logistic distribution. The results for the estimation of equation (3) are provided in the second column of Table 2; the third column presents its marginal effects.

The robust RESET test is 0.6697 with a $p-value$ of 0.3818 (the statistic and $p-value$ for the non-robust test are 6.4742 and 0.0409, respectively), which indicates no misspecification problem in equation (3). Furthermore, the sum of squared residuals (SSR) is lower than the obtained when the model is estimated by OLS (12.7 compared with 13.0), and the R^2 of the second model is higher (0.1119 against 0.0939). The standard errors of the regressions (SER) are not directly comparable. In face of the evidence gathered, estimates presented in the second column of Table 2 are the ones we look at in detail.

The marginal effects associated with the estimation of equation (3) are similar to the ones obtained for the OLS estimation. From that set of results, it appears that a better pool of registered candidates, measured by their average grade, is, as expected, associated with a lower unemployment propensity for graduates. Also, larger programs, those offering more places each year, have, on average, a lower unemployment propensity. This might capture the prestige, or implantation in the market, of a specific study program. Higher average GPA is associated with lower unemployment propensity, while bigger study programs are

related with lower unemployment propensity, *ceteris paribus*.

The most conspicuous result in Table 2 concerns the exams required to apply to a study program. Study programs that require a Portuguese exam seem to be associated with a higher propensity for unemployment, in about 3.7 percentage points. Exams on Physics, Chemistry and Biology are not independently relevant in the explanation of our dependent variable. Requiring the Math exam impacts negatively on the propensity for unemployment in about 2.5 percentage points. This result is statistically and economically significant, and it goes in the same direction of previous research for other countries. For example, Smith et al. (2000) find out that an A-level in Mathematics appears to reduce the probability of becoming unemployed or inactive after graduation, in the UK, whereas James et al. (1989) found that the number of semesters of math in high school are a good investment when it comes to the earnings of higher education graduates.

Several mechanisms could operate to generate the results that requiring the Math exam is linked to higher employability. On the one end, the Maths exam may be working as a filter to attract the best students, who are expected to have better performance in the labor market. We attempt to control for it, by including the average GPA. On the other hand, a better pool of students enables the program/institution to provide better and more demanding trainnig, which in turn will result in better labour market outcomes. That is, the requirement of a Math exam seems to work as an indicator of higher employability, and, therefore, as an indicator of study program's quality. These results suggest that competition for students, and the differentiation strategies that followed through changes in admission conditions as described in Section 2, resulted in higher quality programs keeping the Math exam as a compulsory exam, while several programs have made the Math exam optional.

According to the human capital theory and given these results, we should expect candidates to HEIs to prefer study programs that require the Math exam as it seems to be an indicator of the program's quality and therefore to guarantee better employment

prospects. In fact, choosing a study program that includes the Math exam as an admission condition seems to work as an unemployment insurance. Following the predictions of the human capital theory we should observe a higher demand for those study programs.

Paradoxically, previous results on the Portuguese higher education system, presented in Cardoso et al. (2008), indicate that having a Math exam as an admission requirement reduces demand for a study program by about 42%, when looking at the number of students who place a specific study program as their first choice. That is, although we concluded that degrees that include Math as a pre-requisite have a higher employability they do not seem to attract more students. These paradoxical results may be the consequence of an information failure; i.e., applicants to higher education may not have enough information when choosing their study programs. Furthermore, although the longer-term benefits of studying Math seem to be large enough, students and their families may not be able to take it into account earlier in their education. Given the existing funding scheme, which depends mainly on the number of registered students, HEIs do not have an incentive to solve this information problem, as their strategies focus on short run demand (Figure 1 corroborates this hypothesis as it shows a clear decrease in the share of study programs requiring a Math exam). There is therefore room for a governmental intervention in order to help families to incorporate the market signals in their decision-making processes and invest in studying math.

5 Conclusion

In a context of excess capacity and increasing competition for candidates to higher education, adjustment in admission conditions has been part of HEIs differentiation strategies. Among changes in admission conditions, the steady decrease in the number of study programs requiring the Math exam stands out. In this paper we use a graduates' employability indicator and estimate a fractional model to infer about the relation between selection

conditions and study program quality.

Apart from other controls, the type of national exams defined as a pre-requisite and the mean GPA are accounted for. We find that larger study programs tend to have higher employability. As expected, higher average GPA at entrance appears to result in a lower propensity to become unemployed. Compulsory admission exams, the focus of our analysis, seem to have a significant impact on graduates' employability. Namely, we do detect a link between requiring the Math exam and employability. Therefore, requiring a Math exam as an admission condition may be seen as an indicator of study program quality. In a context of increasing competition for students it seems that study programs that kept the Math exam as a compulsory admission condition are associated with higher quality. This means that when choosing between study programs in the same field and institution, with the same size and with a pool of registered applicants of similar human capital stock, requiring the Math exam should be a criterion to take into account as it may signal program quality, and consequently its employability.

In fact, undergraduates' labour market performance works as a market test to study programs' quality, indicating future returns of students investment in higher education. Our estimates suggest that study programs that make the Math exam compulsory are associated with higher employability. Therefore, students are expected to prefer study programs requiring a Math exam as it seems to be a good indicator of study programs quality. However, previous estimates suggest that degrees that require the Math exam face lower demand when compared to other studies (Cardoso et al. 2008).

These results suggest that candidates to higher education do not have enough information when choosing study programs. In particular, poor and less educated families may be ill informed to evaluate the kind of market signals identified above. If the paradox we identified in this paper has its roots in an information failure, a natural policy prescription would be for the Government to publicise study programs' employability and highlight the relevance of studying Math for primary and secondary school students. The publication of

the number of unemployed graduates per program/institution, used in this paper, is a first step in filling that gap. The study of Math in primary and secondary schools should be understood as a merit good, which students should be compelled to consume.[4] A solution to this problem could be to make the discipline of Math compulsory in high school. These results may also provide a rationale for the Government to set standards for school scores in Math national exams, as well as to provide the necessary means to reach them. This is an issue that deserves further research in the future and the attention of policymakers.

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[4] An argument for the Government intervention is that individuals may not always act in their own best interests. This view of the need for Government intervention is referred to as paternalism (see, for example, Stiglitz, 2000).

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