Portuguese Women in Science and Technology (ST): Some Gender Features Behind MSc. and PhD. Achievement

Chagas Lopes, Margarida

ISEG (SCHOOL OF ECONOMICS AND MANAGEMENT, TECHNICAL UNIVERSITY OF LISBON, SOCIUS - RESEARCH CENTRE IN ECONOMIC AND ORGANIZATIONAL SOCIOLOGY

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Author: Chagas Lopes, Margarida

(Assistant Professor at ISEG – Institute of Economics and Business Administration of the Technical University of Lisbon)

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Abstract

Most research based upon institutional data has been dealing with the situation of Portuguese women in Science and Technology as if it would be a homogeneous set. Quite the opposite, whilst women in science are performing increasingly better than men since the early school ages, indeed a Portuguese idiosyncrasy comparing to other PISA countries, they are still underrepresented in most technological fields. Among other determinants this feature ascribes most Portuguese graduate women to occupations where career prospects are quite uncertain and worse than men's in the same qualification levels. Either by career requirements or in reason of one's seeking to improve knowledge and apply to a better job, post-graduation undergoing appears therefore as an obvious way out strategy. Nevertheless, even high skilled Portuguese women in scientific occupations face generally weaker opportunities and have to take more time than men to achieve a post-graduation. A Project in the behalf of Portuguese Foundation for Science and Technology provided us longitudinal data on PhD. and MSc. trajectories within four Portuguese universities. By investigating such a data on the basis of a Hazard-Survival Model and Cox Regression Analysis we could identify some of the main gender determinants behind obstacles and time to achieve MSc.

Key Words: Gender and Science; Obstacles to post-graduation achievement; Hazard Survival Models; Portugal.

JEL Classification: **I23**

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1.- Introduction

This research area has for long been given a meaningful concern and effort by most Portuguese researchers on Gender Studies. The resulting outcomes have as well been deeply marked by the diversity of disciplinary domains approaching that research field. Therefore, we can identify some of the main contributes coming from Linguistics, Anthropology, History, Sociology, Economics, …, and we will briefly review some important results in a further Section[1].

Nevertheless, the operational support research relied on cross-sectional data most of times. This is a natural feature because of both the scarcity of alternative data and the technical difficulties in dealing with panel or longitudinal information.

But inequality is by nature a dynamic process… Therefore, considering gender differences in educational chances, post-graduation strategies and inherent results in terms of occupational condition and work status will strongly advise the use of time sensitive data. Furthermore this kind of analysis will deeply benefit from the possibility of recovering individual trajectories from an as early as possible stage. Actually, some recent research on school failure and on child work in Portugal allows us to reinforce this statement[2].

[1] We will almost exclusively rely on research deriving from Economics and Sociology. For a further reading on gender studies in Portugal under a broader scientific point of view see APEM (2001, 2002) and Machado (coord., 2006).
[2] Chagas Lopes & Medeiros (2004); Chagas Lopes & Goulart (2005).

This paper will rely mostly on Economics of Education's and Human Resources Economics' contributes to explore and analyse longitudinal data on a sample of Portuguese MSc. and PhD. women (and men) who graduate in four Portuguese public universities.

In the light of the approaches and outcomes the reviewed bibliography displays we believe it would be worthwhile trying to find some possible answers for questions like the ones:

- How severe would remain the gender gap behind study track selection and performance (e.g., between the Scientific-Technological field *versus* the other areas) by the age of 15, when most boys and girls must choose among further studying subjects?
- Will this eventual gender differences still propagate nowadays in as much as graduation areas are concerned?
- And, especially, in which concerns pos-graduation studies: will we face similar or alternatively gender differentiated motivations, strategies and opportunities in which concerns undergoing MSc. and PhD? How long does it take to get a Master / a PhD. for women and men, all other things remaining constant?

We shall try to shed some light on these issues along this paper.

We will start in Section 2 with a general characterization of the Portuguese situation. A brief theoretical discussion will be made in Section 3. Data description and statistical analysis make the object of Sections 4

and 5. Finally, in Section 6 we will review the main outcomes and suggest further eventual research lines.

2. General Overview and Characterization

For organisation purposes we will break down the analysis of the situation concerning Portuguese women in Science and Technology into the following items:

- school trajectories: assessing gender differences relative to scientific and technological performance, perceptions and motivations when completing (present) compulsory education, e.g., at 15 years age and when proceeding into secondary education;
- tertiary education and post-graduation: perceiving the main differences between women and men graduate and post-graduate in scientific and technological fields, in which concerns namely concentration by fields of study and main reasons behind undergoing into MSc. and/or PhD;
- articulation between school and work trajectories: will labour market insertion conditions affect differently women' and men' decisions and opportunities to follow post-graduation studies? How far will the occupational status obtained as a result of a MSc. and/or a PhD. differ between male and female populations?

School trajectories and performance levels in compulsory education have for long time been presented as one of the major reasons behind

different school track choosing between girls and boys, not only in Portugal but in general. Nevertheless the outcomes from PISA 2003[3] revealed quite unexpected results: despite the huge weakness both girls and boys went on exhibiting relatively to Mathematics (in all the four criteria considered), Reading Literacy and Scientific Culture and Knowledge[4], gender differences in all the above domains were perceived not to be statistically meaningful in Portugal. This feature should be emphasized **as a national idiosyncrasy**: actually, boys almost systematically perform far better than girls in Mathematics (a result which is still holding for countries such as Greece, Slovakia, Italy, Denmark, Czech Republic, Ireland, for instance) and although in a small scale in Scientific Culture, but in Portugal those gaps seem to be narrowing, in line with the general, albeit modest, upgrading trend.

Also, some statistical indicators developed by the Portuguese Ministry for Education are showing that scientific tracks are attracting each year an increasing proportion of the 11th. degree pupils: some 62%, against 16,9% for Humanities and 12,8% for Socio-Economics, in 2004/2005[5]. But when we consider Secondary Vocational Education we still perceive an important gender bias arising in which concerns some studying fields, such as Environment and Natural Resources, Electronics and Mechanics, Civil Engineering, Metalwork Engineering, Chemical Engineering, Informatics: the feminisation rate among pupils in these six fields taken altogether roughly approached 32%, in 2001, according to the same source. This result will not be further developed in this paper as it concerns a population different from the one whose trajectories we intend to analyse. But it is

[3] OECD (2004).
[4] Meaning the ability to apply scientific knowledge and skills to ”real life situations” and not specifically curricula assessment (OECD, 2004, op. cit).
[5] GIASE (2004-2005).

worthwhile to stress that a strong gender bias is yet at stake for the youngsters who begin by now a vocational trajectory leading to further intermediary technical occupations, a feature which should not be irrelevant both for education and labour market policy making.

As our main concern deals with women and men in higher education and post-graduation degrees, let us consider now some of the most recent data relative to gender distribution among graduation areas. According to the National Statistical Institute (INE) very high feminisation rates can be observed, in 2004, among students in Mathematics and Statistics (67,1%), Environment Protection (75,0%), Life Sciences (59,4%), Physics (58,4%) and Veterinary Sciences (58,9%); at the same time, the corresponding rates for the Engineer fields roughly reached some 33%, as an average[6]. Which means that another specificity of the Portuguese situation appears now clearly: **Portuguese women's behave quite differently between scientific and engineer/technological fields**[7], their participation in science being still increasing while in technology an apparent psychological threshold seeming to be difficult to overcome.

Relatively to post-graduation studies we must emphasize the growing participation of women as well: the global feminisation rate came to around 67,4% in 2002, with 56% being the share of women among the whole PhD. achievers in that same year[8]: a meaningful break between MSc's and PhD's undergoing chances seeming likewise to be evident for women.

[6] INE (2006).
[7] The formal association between Engineer and Technology fields is here proposed for sake of simplification. Actually, a more sophisticated research wouldn´t allow for this assimilation but the diversity of Higher Education classifications all over the EU, waiting for a complete harmonisation procedure as yet, makes the distinction quite harmful. For an adequate consideration of this question see, for instance, Ackers, L. *et alii* (2004).
[8] EUROSTAT (2005).

Most Portuguese post-graduation students depend on a fellowship or a place in the labour market because both direct and opportunity costs are high and increase with age. The Portuguese Science and Technology Foundation's (STF) fellowship database is statistically meaningful and sheds light into some relevant features: between 1999 and 2002 the STF fellowship feminisation rate raised from 41,5% to 49,8%. But when we restrain data to consider only PhD's taken abroad we can see that the share of women diminishes drastically to some 38,9%. The same database also reveals that an important percentage of the fellowship-holders do not conclude PhD. before the fellowship time elapse: among these ones, we find some 46% and 42% among female and male candidates, respectively. These indicators are particularly meaningful of some of **the existing differences in studying opportunities and restrictions between women and men applying to post-graduation studies**, a feature we are particularly concerned with.

Therefore, it is important to consider now the information on the articulations existing between work and further schooling trajectories. We have observed previously the important and raising share of Portuguese women in most of the graduation scientific fields: should there be a corresponding participation rate of these scientist women in the alike labour market occupations? And, if so, will this correspondence be in line with the post-graduation strategies they decide to take in a later stage? Will we find behind those further studying trajectories identical or alternatively quite different determinants when confronting women' and men' life patterns?

Women graduate and post-graduate in S&T mostly develop their occupational activity in three different work fields: Higher Education (HE),

as teaching and researching staff; firms and other economic organisations (BES), either in manufacturing or in services; Government departments (GOV), especially in public agencies and laboratories where they work mostly as researchers. Will Portuguese S&T women follow this same general pattern?

A first insight on data relative to 2002 HE personnel reveals that women are under-represented as teachers and researchers[9] even in the tertiary education areas where they largely outnumber men as graduates: this situation is particularly striking in "Sciences", a domain which comprises Mathematics, Statistics, Physics, some of the Environment Studies fields…, where the feminisation rate for the teaching staff was by then equal to 44,4% (INE, 2006, op. cit.). Less surprisingly, the feminisation rate among teachers in the "Engineering fields" roughly approached some 22% in that same year, yet lying below the corresponding female graduation rate.

Certainly we are aware of the impact played by the co-existence between two different female teaching generations, the youngest becoming by and large more prone to scientific domains than the precedent one. A very interesting research line in this light stresses the fact that Portuguese graduate women were becoming visible and statistically meaningful long before most of their European colleagues. When trying to seek the main reasons behind that outcome, several features use to be mentioned: belonging to a social elite who tried to compensate family income loss throughout the investment in their children "human capital", along the second half of the 19th. century; aiming at an intergenerational upward

[9] The Portuguese Act on Higher Education Teaching Staff actually establishes the double commitment of teaching and researching for HE assistants and professors.

social mobility via the youngsters' graduation, a strategy still perceivable in most Portuguese families. But in either situation and despite the openness provided to women by the huge scientific progress along the "golden decades", their further studying options, decisions and opportunities would remain as a strongly gendered endeavour, responsible for the high level of gender occupational concentration [10].

From our point of view, things are changing nowadays, namely in which concerns female performance and orientation towards scientific domains (much more than relatively to the technical ones…), as we have been discussing. Notwithstanding, HE seems to remain a very gendered space. Actually, a great deal of research has been developed in Portugal on such issues like women' upward mobility inside HE (Amâncio & Ávila, 1995, op. cit), gender bias concerning association and networking opportunities in HE careers (Reis 2001; Perista & Silva 2004; Thurn *et alii* 2004; Amâncio 2005), family and career articulation, hierarchical determinants, career precariousness, field of work reputation (Perista & Silva 2004, op. cit), among other.

But in spite of all these restrictions, HE remains as the main occupational area both for women and men developing R&D in Portugal. Actually, the small share R&D personnel represents among Portuguese global employment (0,86% in 2003) is mostly allocated to research activities: some 79,3%, from which 45% are women, according to data for 2004 provided by the European Commission (EC 2006). According to the same source, more than one half of the R&D personnel worked in HE, against less than 0,20% in BES and less than 1/6 in Government occupations. This happens mainly on account of the very limited financial

[10] See, namely, Amâncio & Ávila (1995) and Amâncio (2005).

amount devoted to R&D by most Portuguese economic activities, the largest share of this effort coming from large size firms operating in Lisbon Metropolitan Area.

Disaggregating by gender the above outcomes we actually observe that in 2004 some 56,4% of the Portuguese women in Science and Technology were employed as Human Resources in Science and Technology in Education (HRSTE), against only some 32,3% in economic occupations (HRSTO) (EC 2006, op. cit). This result has for long been under scrutiny as well. Some sociologists argue that the main reasons behind this feature have to do with the abovementioned small investment made by Portuguese firms in R&D, in line with the resilience from traditional and even archaic culture and organisation models inside firms, less open and "friendly" to female scientists. At the same time, and despite the lower payment status, Government occupations would be more attractable for women because of the higher chances provided to reconcile family and work activities (Ferreira 1995).

Notwithstanding, this line of argumentation seems to us to provide only a partial explanation, for several reasons. Firstly, Government expenditure share in R&D lies even below the corresponding effort made by the business sector (EC 2006, op. cit). But the main disagreement reason has to do with the distinction we have been making between Science **and** Technology, as it comes more and more clear that either strategies and occupational status strongly differ between these two areas for Portuguese women. Therefore, we adhere much more to the argumentation provided by Falcão Casaca: women are still quite apart from the qualification areas which firms value the most (Falcão Casaca 2005); and we dare say that those areas have to do mainly with Technology. On the contrary, scientific

qualifications, in which women are performing better and better, are specially required both by HES and Government departments and laboratories. According to data from the E.C. report we are considering the break down by industry of the feminisation rate of the Portuguese HRST, in 2004, is particularly elucidative: it raises from about 30% in manufactures to 54,46% in the tertiary; besides, the feminisation rate of the Knowledge Intensive Services (KIS), in which HES and GOV departments and laboratories are comprised, reaches 58,61% (EC 2006, op. cit).

These last results are much in line with approaches and outcomes brought by some previous research. Taking into consideration the discussion developed by Castells and Faulkner, among other authors, Falcão Casaca confronts diverse approaches on nowadays relationship between women and scientific and technological progress. In line with Faulkner, Falcão Casaca supports the socio-constructivist approach and criticises both the techno-optimistic and the techno-pessimistic perspectives. Likewise, in line with the larger opportunities most authors forecasted that post-industrial society would bring for women in a less hierarchical and more relational technologic and scientific framework, rather traditional views and stereotyped perceptions are still at work: this is the case for the prevailing association between masculinity and technological (much more than scientific, we believe…) skills (Falcão Casaca 2005, op. cit).

A feature to which we should partially attribute the gender bias we go on observing when Portuguese adolescents must choose among further studying fields, despite the close performance scores both sexes are revealing nowadays in Mathematics and Scientific Knowledge. A bias which arises even more acutely among technological vocational tracks, as

we have already discussed. And most certainly a stigma still embedded in most organisations as well, be them a part of the BES or most HE institutions and departments. In these occupations are there as well problems concerning vertical mobility which we will not develop.

We shall turn now into the core purpose of this paper, which is twofold:

- Given the obvious mismatch between the high and increasing scientific performance Portuguese women are exhibiting and the occupational status and general labour market conditions most of them actually face, will it be that undergoing post-graduation studies, to begin with a Master, would play the role of a compensatory strategy, eventually the only one able to promote upward mobility or even the means to apply to a better job, as some previous research seemed to show us (Chagas Lopes coord. 1999; Chagas Lopes & Leão Fernandes 2000, 2003);
- In spite of all the observed closing performances and in some scientific fields even women' higher achievement, will MSc. and PhD. be more difficult to obtain and more time consuming for women than for men?

Besides the above questions, most other issues would deserve a thorough investigation: gender differences in occupational outcomes and status after the achievement of a same post-graduation degree, for instance, would no doubt stand among the most important ones. It will not be possible nevertheless to consider with enough detail other features than the two above mentioned.

3. Theoretical Background

Human Resources Economics and Economics of Education have for long been criticising the mainstream approach for which human capital theories should be considered as *the* adequate theoretical framework behind demand for education and further studying strategies[11].

Actually, most hypotheses and results proposed by such theories are no longer adhering to nowadays study and work life cycles. Among those unrealistic traits it would be enough to select a few: the one under which more education would necessarily imply more and better work opportunities; the well known Mincer conceptualisation of the "overtaking year" (Mincer 1974) according to which transitions between education and labour market would take place instantaneously and automatically; yet the assumption under which no further education and training would be sought after the insertion into the labour market; also - and perhaps the most limitative assumption – the one which states complete homogeneity among individuals towards education.

Besides the still very high attractiveness these theories - together with most other "mainstream economics" approaches - exert upon a great number of education and labour researchers, we believe that statements like the above ones should more than ever be subject to critical scrutiny. Otherwise Economics will risk fail playing its role as a social science, because of the almost absolute lack of adherence of a great deal of assumptions to the effective research subject.

[11] By "further studying" specialised bibliography means the individual demand for education after compulsory education having been finished. For this paper purposes we will use this terminology to refer to post-graduation trajectories.

The homogeneity assumption has been perhaps the most criticised one, in which concerns both equality towards education and also further labour market opportunities. Nevertheless, inequality can only be assessed in its broader and diverse dimensions as a dynamic and time dependent outcome, a feature which imposes the use of longitudinal or panel data able to depict life cycle trajectories for individuals under consideration.

In the framework of some research projects developed under the behalf of STF, we have been able to work with such kind of data and arrive to results which suggest that in Portugal the homogeneity assumption is far from being realistic in domains such as school failure and achievement, labour market insertion and further mobility trajectories[12]. As we are here particularly concerned with Portuguese scientists' and researchers' post-graduation patterns, for whom secondary education and graduation patterns have already been characterised from a gender perspective, we will no longer develop this issue by now and postpone for a next Section those specific professional occupations' analysis.

The hypothesis under which more education would necessarily imply more and better work opportunities and statuses has been successfully proved along times as a general macroeconomic outcome. Another quite different and much times opposite result arises nevertheless with the transposition of that outcome into each individual's life cycle, despite the obstinacy with which the orthodox theory insists in trying to prove that assumption.

Actually, instead of the soft, well adjusted and automatic transition between school and work, real life insertion processes are more and more

[12] Chagas Lopes (coord., 2001); Chagas Lopes (coord., 2004); Chagas Lopes, Medeiros & Pinto (2005).

subject to uncertainty, time consumption, trial and error efforts, bad job-matching results, most of times. Mariana Alves' PhD. dissertation offers us a reference framework in this light either because of the theoretical approach developed and the partial coincidence with the occupations under analysis and the approach to the gender biases involved in the insertion strategies (Alves 2004). From this author's work we obtain a thorough discussion of the above traits relatively to the insertion processes of graduates by the Faculty of Sciences and Technology.

The argument which states that education and/or training would be completed before entering the labour market has to be eradicated for good, as well: how would it be possible otherwise to go on sustaining the need for lifelong learning (LLL) as most education and research organisations agree? Complying with LLL obviously prevents – or it should…- researchers to go on relying on some of the other conventional assumptions as, for instance, those which support the computation of the rates of return to education as if work trajectories should be continuous, without any unemployment or inactivity breaks and neutral towards skills upgrading and downgrading procedures[13].

In this paper we will try therefore to investigate the main gender differences behind Portuguese scientist labour market insertion conditions: will it be the case that job-matching, working conditions and more generally motivations and strategies towards post-graduation would be substantially different for men and women scientists? Will it be that taking a MSc./a PhD. will work for Portuguese scientist women as a compensatory strategy for the worse working conditions and as a vehicle

[13] Alternatively, we have been developing research on the relationship between work and skills improvement or obsolescence on the basis of Weiss (1986).

towards vertical mobility which otherwise would become much more difficult?

And if so, time needed to take such degrees will be as well gender dependent? How far will such features such as family status, husband's/wife's profession and occupational status, own satisfaction with work conditions, mobility chances, learning opportunities and alike …affect both decision and time to take post-graduations, for women and for men?

The theoretical model follows the Hazard Analysis, with the usual formalisation[14]:

$$h\,(t \mid x) = h_0\,(t)\, e^{x'\beta}\,,$$

where **x** is a vector of known individual characteristics, β a vector of unknown parameters and h_0 (t) is a baseline hazard function for an individual with x=0.

Let **T** represent the individual life time, with $\mathbf{T \geq 0}$ continuous, f (t) the probability density function (pdf) and F(t) the distribution function, such as

$$F(t) = Pr\,[T \leq t] = \int_0^t f(x)\,dx$$

Therefore, the survivor function, S(t), comes

$$S(t) = Pr\,[T \geq t] = \int_t^\infty f(x)\,dx$$

[14] See, for instance, Lawless (1982) and Kachigan (1986).

with S(t) decreasing monotonous continuous.

As $h(t \mid x) = h_0(t)\, e^{x' \beta} = f(t) / S(t)$, it represents the instantaneous probability of an event occurring in time **t** given it lasted until **t.**

So, if we are considering the amount of time needed for a given individual to take a MSc. – the probability that a MSc. will take more than two years, for instance[15] - it comes straightforward that such amount will depend on the individual's initial conditions, $\mathbf{h_0}$ (e.g., own previous qualification, graduation area, university in which graduation has been achieved…), own individual characteristics, **x** (such as gender, age, birth place…) and a set of parameters, **β,** associated to the variables whose joint influence we wish to estimate: for example, family situation, number of children, situation towards employment, occupational characteristics and opportunities foreseen when post-graduation decision has been taken, among others.

4. Data and Preliminary Results

To study post-graduation trajectories we mostly rely upon TELOS II project database, which comprises data on 145 MSc. and PhD. (118 and 27, respectively) diploma achieved in 1995/96 and 2000/2001 in four Portuguese public universities: University of Aveiro, Lisboa University – Faculty of Psychology and Education, the New University of Lisbon – Faculty of Sciences and Technology and Lisbon Technical University – Institute for Economics and Business Administration (ISEG). This sample

[15] We should notice that in previous periods, including the first one considered in our survey, administrative arrangements concerning time to achieve MSc. and PhD. were not so strict as they are nowadays. Besides, most individuals and post-graduation institutions not always comply with legal time intervals assigned to the degrees completing, exceptional regimen being frequently allowed. Moreover, individuals outside academic career are often free from observing too strict time intervals.

corresponds to about 33% of the universe, e.g., the whole number of MSc. and PhD. obtained in those institutions in the above years[16]. The feminisation rate of the sample is 52,4 % and the distribution by graduation and post-graduation field is the following:

Scientific Domains	Graduation	MSc.	PhD.
Educational Sciences	0,7	12,2	13,5
Foreign Languages and Literature	4,9	2,9	0,0
Mother Language and Literature	4,2	2,9	0,0
Economics	16,7	12,9	18,9
Business Management	6,3	8,6	5,4
Biology/ Biochemistry	5,6	3,6	2,7
Chemistry	11,1	3,6	10,8
Electronics and Automation	6,9	7,2	8,1

Source: UIED**,** *Projecto Telos,* 2005

Longitudinal life cycle data has been obtained for TELOS II project throughout a survey directly addressed to MSc. and PhD. graduates. The corresponding questionnaire's main sections concerned:

- individual characteristics, such as date and place of birth, sex, qualification level, husband's/wife's, father's and mother's qualification level, professional occupation and situation towards labour market;

[16] UIED (2005).

- indicators on own previous trajectory, such as field of study during secondary education, graduation field and higher graduation institution, situation towards work during graduation, reasons and motivation for having undergone post-graduation studies;
- characterisation of the employment and/or unemployment situation(s) prior to and at the time when the decision concerning post-graduation had been taken;
- indicators on work and family characteristics (e.g. kind of occupation, activity sector, contractual situation… and living or not in a couple/in common with parents, number of children and other dependents if so…) during post-graduation time intervals;
- degree of satisfaction and self fulfilment with either MSc's, PhD's, or both, curricula, pedagogical methodologies, contribution to skills and knowledge improvement;
- satisfaction degree relatively to the work and career situation as a consequence and/or after the post-graduation having been achieved.

Contingency Analysis between graduation area and sex reveals an extremely high association between both variables, with a Qui-square significance level equal to 0 and a contingency coefficient higher than 55%; actually, we found no women graduate in Electronics and Automation, whenever no man did graduate in Educational Sciences in our sample... Nevertheless, we must be cautious and make no generalizations to the Portuguese situation because of data restrictions we have been referring.

As to the main reasons behind MSc, acquiring more knowledge, progressing in studying, improving one's job performance and being able to undergo an academic career seem to be the most important arguments imposing on women' decision. The professional occupation held in a first moment appears to deeply explain as well the reasons why women intend to undergo a MSc. especially for nurses and university teachers. Quite meaningfully, actually, those first labour market occupations were mostly obtained throughout a national or public contest in the case of women: some 48% of them got their first occupation thereby against some 23% for men in alike situations: the latter would perhaps have benefited from a more rich "social capital"...

Decision to take a MSc. also seems to be quite contingent on time women spend in the first employment: tenure is meaningfully lower for women and getting a MSc. appears to work also as a major or even the unique way to achieve job stability, eventually in line with upward mobility.

Contingency Analysis provided particularly robust results for associations with the variable "time to complete MSc". Actually, this time interval appears to be quite gender influenced for the population under analysis, **women being some 12% more frequent than men in taking three or more years to complete MSc**. Seeking for some possible reasons behind the women' larger time spells, we notice two especially contingent features: "husband's/wife's school level" and "husband's/wife's professional occupation", with Qui-square significance levels equal to 0,040 and 0,068. Family situation (e.g. children age and number) was the next variable but we did not consider its influence because its significance

level (0,107) lied over the statistically acceptable maximum threshold (0,100).

Outcomes concerning PhD. must be considered with particular caution given the small number of individuals with this degree in our sample (32, being 19 men and 13 women)[17]. Nevertheless, reasons behind PhD. seem to be quite different from MSc.' both for women and for men, as one could expect. "Facing no employment alternatives" and "Employer institution's decision/initiative/arrangement…" appear to be the main reasons for women to undergo this further degree. We cannot find now any statistically meaningful association with husband's either school level or professional occupation, neither seems "time to get PhD." be statistically associated with anyone of the proposed variables. Of course we must realise that PhD. is still mostly undergone by individuals seeking an academic career, a feature which explains differences in strategy when compared to MSc. By the above reasons, no Cox Regression adjustment will be tried for PhD's in the next Section.

Nevertheless, **some PhD's outcomes appear to be quite gender influenced**. Actually, some 79% among male PhD's expressed to be "Much Satisfied" with post-doctoral academic career situation, against roughly 31% for their female counterparts[18]. An identical result occurs with the "Ability to enhance scientific culture" once PhD. completed. But most gender differences concerning PhD. have to do with leading obstacles and course's curriculum and arrangements: "Lack of support by family" is the

[17] Actually, only 27 among this 32 had already completed PhD. by the time of the survey; notwithstanding, for some analytical purposes we considered the whole 32 trajectories whenever they appeared to be meaningful telling on gender differences.

[18] Outcomes coincident with the above one have already been obtained by other author's results. See for instance Gonzalez et al (2001), Perista & Silva (2004, op. cit.), Amâncio e Ávila (1995, op. cit), Amâncio (2005, op. cit).

obvious deterring feature, referred by cc. 1/3 of the surveyed women (no man appointed this obstacle…); time schedule, teaching/learning methodology's and curriculum's adequacy towards occupational and own requirements are also much more emphasized by women than by men as some of the leading difficulties in achieving a PhD.

5. How long does it take to complete a MSc.?

In order to further understanding conditions under which gender affects post-graduation undergoing, we will try now a more robust analysis on time required for women and men to complete a MSc.

As previously referred most individuals in our survey were graduate in scientific fields, only some 7% (6,9%) of them having got a degree in a more pro-technological field, e.g. Electronics and Automation. The characterisation we previously made of the Portuguese situation clearly reveals how women are better and better performing in scientific fields, closing the gap towards men since compulsory education. Also we observed the growing role women have being playing in most scientific graduation and post-graduation fields, such as Mathematics, Physics, Biology, Chemistry…And we noticed as well their higher concentration compared to men's in occupations such as the ones in HE and GOV fields, some highly qualified jobs where notwithstanding labour conditions and status are severely marked by precariousness and instability.

Therefore it seems quite probable that undergoing post-graduation studies, to begin with MSc., will mean for most scientist women the only way to overcome instability, try to secure a professional career or even

keep one's job, namely when in academic trajectories. But against which price? Despite other both direct and opportunity costs, e.g. time to family, time to themselves... which we will not deal with in this paper, one major inequity issue arrives to women intending to undergo a MSc., according to the Contingency Analysis we have developed: they will take longer than men and have to face family's lack of support most of times. We will try to confirm now this time pattern and associate restrictions throughout a Cox Regression applied to the Hazard Model we developed in Section 3, a more robust statistical tool than Contingency Analysis we carried for initial exploratory purposes.

Once again, we must emphasize that sample dimension strictly prevents us from generalizing to the whole Portuguese context anyone of the eventual outcomes. Nevertheless we esteem most results we obtained throughout the Cox Regression (CR) adjustment to be quite interesting and expect they will stimulate further research on these features on the basis of more robust and desirably nationally representative data.

We adjusted CR for the 108 individuals (47 males and 61 females) who had completed MSc. by the time of the survey. From among all the adjustments we essayed and for which Qui-square test proved to be statistically acceptable we have chosen the best one to illustrate the relationships at stake. The corresponding Survival Table is the following (see also Appendix for general computation):

SURVIVAL TABLE

		Survival Rate	Cumulative Hazard
MALE	0 ----------	------n.s.m.------	------0,037------
	1 ----------	------0,963------	------0,037------
	2 ----------	------0,573------	------0,558------
	3 ----------	------0,262------	------1,339------
	4 ----------	------0,000------	------…..------
FEMALE	0 ----------	------0,922------	------n.s.m.------
	1 ----------	------0,891------	------0,115------
	2 ----------	------0,666------	------0,406------
	3 ----------	------0,159------	------1,836------
	4 ----------	------0,000------	------.....------

Legend: n.s.m. – not statistically meaningful.

Time intervals: 0 – lower than 1 year

1 – lower than 2 years

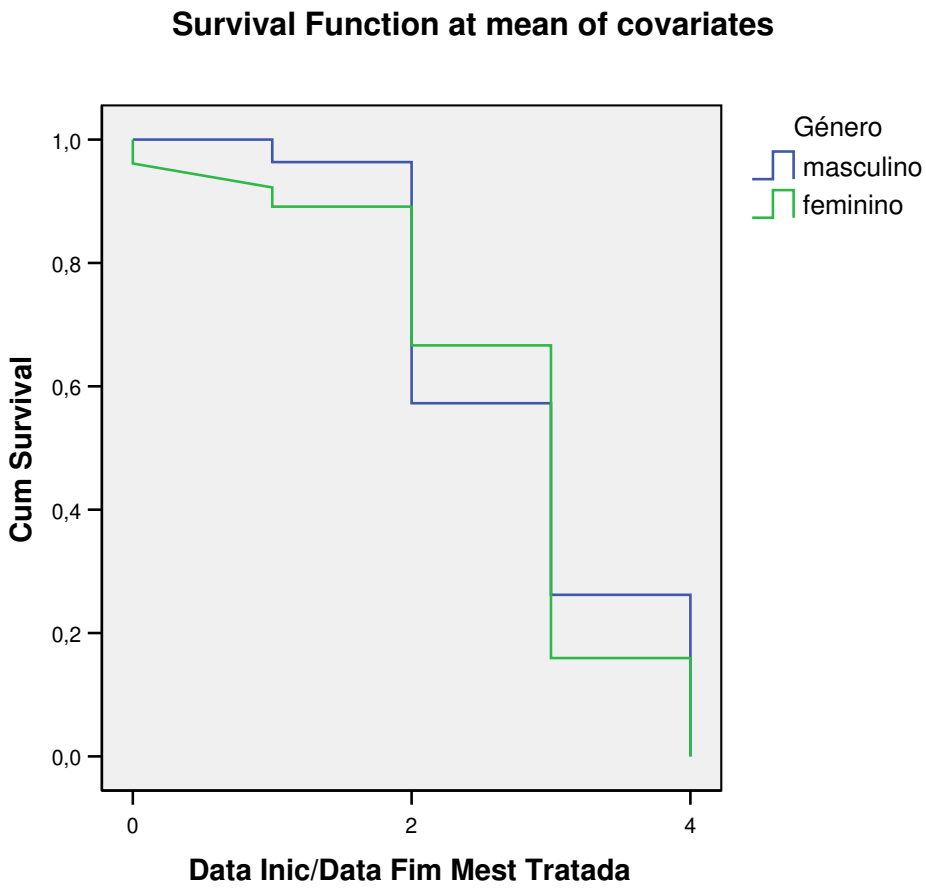
2 – between 2 and 3 years

3 – between 3 and 4 years

4 – 4 years or more

From the Cumulative Hazard column we conclude that no MSc. among the ones in our sample has taken 4 years or more; nevertheless, time length always exceeded interval 2 for both men and women but more frequently for the latter: actually, the cumulative frequencies of MSc. concluded within the three initial years (falling until interval 2 inc.) was 55,8% for men and only 40,6% for women, an outcome which suggests that

more women than men needed more than 3 years to complete MSc., (moved into interval 3). Notwithstanding, time length distribution in which concerns time needed for women to complete a Master seems to be bi-modal: we should notice indeed that more women (3,7%) than men (1,15%) also achieved the degree in the smallest time interval (1)[19], taking less than two years to get their MSc.



Will it be the case that those so high efficient women falling in the left wing of the time distribution will be less family and/or work dependent that the others who had to take three and more years to complete the

[19] Actually, a not statistically meaningful number of individuals (n.s.m.) in the sample (2 female MSc.) has been ranked into interval 0, equivalent to a time length lower than one year. But we won't consider this result unless further checking will allow for it.

Master? This outcome convokes a deeper researching on a statistical feature which cannot be approached on the basis of such a limited database and we just emphasize it in order to stimulate further research on this apparent bi-modal distribution.

In the CR adjustment we used sex as the stratification variable, thereby directly allowing to compare features conditioning both women' and men' time needed to complete MSc. As to the "explaining" variables, e.g. the ones which coefficient values overcame the statistical tests and were more close - or less deviated from…- to the correspondent expected values[20], we obtained the following ones, arranged in decreasing order: "(Perceived) lack of basic required knowledge/qualification", "Job closing/employer's difficulties", "Need to keep a job during Master preparation", "Having no career expectation", "Lack of support by the family" and "Wishing to acquire further knowledge". This apparently miscellaneous become more clear when we remember variable classification we presented in Section 4: thereby, some individual and initial conditions and motivation factors (perceived previous qualification and knowledge level; desire to improve qualifications), included in $\mathbf{h}_0$ and **x**, together with other determinants such as situation towards labour market (actual or probable unemployment, absence of upward mobility chances), income restrictions which impose the need to combine a paid job with Master completion[21] and family demandings, as well, these latter features ascribed to **β** parameters of the Hazard/Survival Function, were all meaningfully associated with gender differences in time needed to get a Master.

[20] Although no one of them could significantly approach the corresponding Exp (value) as a consequence of the small number of observations.
[21] Furthermore when the fellowship policy suffers from the restrictions Portuguese researchers are so well aware…

Nevertheless, we cannot find now any meaningful influence exerted by conjugal variables, like husband's/wife's school level and occupation as in Contingency Analysis; but in the present joint influence (and not one by one) variables model it will probably be the case that mate variables' influence will impart throughout some other related effects, such as the household income and family characteristics, an issue which we believe would deserve further investigation as well.

Therefore, we may apparently deduce the following main results: no single issue would be robust enough to explain gender differences in time to get a Master, **a set of diverse aetiology reasons** needed to be searched instead; **most features concern dynamics**, either under the form of previous school achievement and knowledge acquiring or in what concerns further work and career perceived opportunities, thereby confirming the absolute need for longitudinal data as a research basis; finally, despite labour market status, income restrictions and family care playing the well known and quite expectable role in differentiating women' and men' decisions to undergo post-graduations and especially a Master degree , the apparently most determinant feature has to do with **own evaluation on previous qualification standard** in line with the desire to improve ones further knowledge. This is an outcome which further research should inevitably reconsider and deepen, in our opinion. Besides, given its specificity an intrinsic nature, we believe it would only be adequately approached throughout an interdisciplinary research involving scientific expertise in domains such as Economics, Sociology, Education Sciences, and Psychology.

6. Conclusions and suggestions for further developments

A thorough scrutiny on the present situation of Portuguese women in Science and Technology displays a quite heterogeneous picture: actually, while they are revealing higher and probably still increasing performance scores in scientific domains in general and most particularly in Mathematics (a feature we described as a national idiosyncrasy), Physics and Life Sciences, most technology areas on the opposite side are still attracting less women than men.

This feature bears in several consequences, the first one being the need for researchers to disaggregate between Science and Technology, instead of carrying on a joint analysis of those two fields, when investigating on women' and men' education and occupational situations[22]. Another important issue deals with decision making as actually we still perceive a severe gender bias in which concerns Portuguese youngest generations' choice among further education tracks, especially in which has to do with secondary vocational education. Despite other less favourable more general outcomes, individuals' further work opportunities are quite contingent on this still weaker appeal exerted by much technology fields, a feature especially evident for women in business sectors, as several Portuguese authors have been presenting.

Likewise, despite their scientific performance, women are overrepresented in jobs and occupations where instability, lack of career

[22] Actually, this should be the only way to avoid some frequent misleading conclusions mostly allowed by institutional data itself, as namely data provided by EUROSTAT (New Chronos) which aggregates "Science, Mathematics and Computing" employment values.

opportunities and bad work conditions dominate, as in GOV departments and HE institutions.

Institutional data also reveals the large differences existing between women' and men' post-graduation opportunities, even in scientific fields where women are equally or even overrepresented in graduation. Therefore, aiming at a Master or a Doctorate in order to overcome labour instability, comply with employment and career requirements or even improve one's further skills and knowledge – this latter issue appearing to be most meaningful for female Portuguese scientists according to our survey – becomes more difficult for women than for men and more time consuming.

As the existing institutional data precludes dynamic analyses, in this research we rely on results obtained throughout a specially addressed survey which allows for longitudinal data on about one hundred and half MSc. and PhD. trajectories, obtained in four Portuguese universities.

In the light of the latter and according to Contingency Analysis we have developed we observed that indeed more 12% women than men had to take three or more years to achieve a Master. As to PhD. and despite both women and men being mostly complied by career reasons when undergoing this degree, most women than men appointed curriculum organisation and time scheduling as some of the main obstacles, while only women referred lack of support by the family to undergo the degree. Also, whenever most men (cc. 80%) considered themselves as "much satisfied" with post-doctoral situation in academic career only less than one third of the surveyed women expressed likewise, a result which confirms other authors' outcomes.

Actually, analysing gender differences in occupational outcomes and status after the achievement of a same post-graduation degree would no doubt stand among the most important further research lines.

To get a further insight on time dependency relative to the main features and obstacles behind MSc. undergoing, we further applied a Cox Regression Analysis to contrast women' and men' situations, thereby computing some main relations described throughout a Baseline Hazard model we developed in the theoretical framework. We concluded thereby and once again that actually more women than men had to take three or more years to get a Master.

But there is evidence as well that time distribution for women should be bi-modal, a meaningful number of them, higher than men', being able to achieve in less than two years. Further research on this apparent bi-modal distribution would be most advisable and should aim at investigating the main features behind those women and their work and family condition.

When searching for the main issues behind differences in time men and women show relatively to MSc. achievement, Cox Regression revealed as well that all expectable individual, qualification, work (e.g. first employment tenure) and family reasons (throughout which mate's variables such as school level and occupation may impart as well) were meaningful.

Quite interestingly from our point of view appears to be nevertheless the main reason which systematically appeared in all the adjustments we essayed: own evaluation on previous qualification level, associated with the wish to improve one's knowledge. This feature is worthwhile of a further

research as well. In our opinion, it would be quite advisable to develop a thorough interdisciplinary research on such a result, given the important implications it would eventually bring to policy making.

APPENDIX

Block 0: Beginning Block

Omnibus Tests of Model Coefficients

-2 Log Likelihood
596,572

Omnibus Tests of Model Coefficients(a,b)

	Overall (score)			Change From Previous Step			Change From Previous Block		
kelihood	Chi-square	df	Sig.	Chi-square	df	Sig.	Chi-square	df	Sig.
589,659	7,262	17	,980	6,913	17	,985	6,913	17	,985

a Beginning Block Number 0, initial Log Likelihood function: -2 Log likelihood: 596,572
b Beginning Block Number 1. Method = Enter

Variables in the Equation(b)

	B	SE	Wald	df	Sig.	Exp(B)	95,0% CI for Exp(B)	
							Lower	Upper
profissc	,001	,001	,316	1	,574	1,001	,999	1,002
sexo	,031	,234	,017	1	,895	1,031	,653	1,630
areafor2	,000	,001	,008	1	,929	1,000	,998	1,002
profcurm	,700	,420	2,782	1	,095	2,015	,885	4,588
razcurm4	,013	,117	,013	1	,908	1,014	,806	1,274
razcurm9	,051	,111	,213	1	,645	1,052	,847	1,307
razcur12	,085	,152	,315	1	,574	1,089	,809	1,467
razcur13	-,035	,114	,095	1	,758	,965	,772	1,208
obstfor1	,208	,229	,825	1	,364	1,231	,786	1,927
obstfor3	,235	,509	,214	1	,644	1,265	,467	3,430
obstfor5			.	0(a)	.			
obstfor6			.	0(a)	.			
obstfor7	,950	,759	1,564	1	,211	2,585	,584	11,453
obstfor8	,175	,781	,050	1	,822	1,191	,258	5,504
obstfo10	,029	,319	,008	1	,928	1,029	,551	1,922
obstfo11	,026	,716	,001	1	,971	1,026	,252	4,179
obstfo12	,204	,623	,107	1	,744	1,226	,361	4,160
finobstf	,020	,150	,017	1	,896	1,020	,760	1,369
propcurs	-,041	,038	1,176	1	,278	,960	,891	1,034

a Degree of freedom reduced because of constant or linearly dependent covariates
b Constant or Linearly Dependent Covariates S = Stratum effect. obstfor5 = 0 + S ; obstfor6 = 0 + S ;

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