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DROPPING OUT OF UNIVERSITY OF SALERNO: A SURVIVAL APPROACH

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Contents

Abstract

The aim of this paper is to analyse and model the interval of time between the first enrolment at University and the first occurrence of non-enrolment, so that the event of interest is the dropping out of University. The interest is focused on computing the probability of surviving at the University and analysing which personal, familiar and social characteristics may influence the non-completion of students' academic carrier, using Survival Analysis techniques. The dataset analysed is collected from the Central Administrative Office of the University of Salerno, and includes all full-time students enrolled at the 2002-2003 academic year, followed for five years, until the 2006-2007 academic year. Those students can either complete their study and receive their degree or leave the university, that is the event of our interest. The estimation of the probability of surviving in University is made by the Kaplan-Meier estimator. Then, to test if there is a significant difference among the survival curves, Log-rank test is considered. Since it does not allow more than one explanatory variable to be taken into account, Cox Proportional Hazards model is used to analyse the interrelations between the covariates, and explored the influence of covariates on failure times. This study shows that there is a steep decline for students in Political Science and in Educational Studies, at the first year. Moreover, female students, students who attended "Licei" and those who completed their high school study with the highest mark (i.e. 110) have the highest probability of surviving at the University, i.e. the highest rate of taking the degree. In all these cases, it can be noted that there is a Faculty effect. These differences, tested by log-rank test, are significant. Finally, Cox PH model for each Faculty confirms previous results.

Keywords

Dropout, Kaplan-Meier Estimator, Log-rank Test, Cox Proportional Hazards Model.

1 Introduction

University dropout is an important topic in many countries, since the high rates of dropouts mean waste of public money, a lower proportion of graduated people and consequently lower employment opportunities in highly qualified position.

There are two possible definitions of university dropouts. The first definition refers to college students leaving a college in which they are registrered, while the second one associates dropout with those who never receive a college degree (Spady, 1970). In this paper, dropout is defined as a student who registered for a degree programme, but does not complete it. The first definion cannot be used since the exact date in which the students leave the university, is unknown.

In literature several factors are associated with student dropout in higher education institutions (Astin, 1964; Bayer, 1964; Spady, 1970; Tinto, 1975). Those factors can be divided into two categories: factors associated with attributes or characteristics of the individual student, and those associated with the institutional environment.

Since there are so many different alternative factors which can affect the non-completion of study, it is crucial to study and analyse which ones are relevant to explain the non-completion event in institutions of higher education (Johnes, 1990; Checchi *et al.*, 1999; Arulampalam *et al.*, 2005).

For this purpose, two models are usually used: *Student Integration Model* (Tinto, 1975) and *Student Attrition Model* (Bean, 1980, 1982).

The first focuses on the importance of students' academic and institutional commitments, derived by interrelations that take place within the institution, namely a matching between students' motivations and academic ability and academic and social characteristics.

The second model, instead, emphasizes the importance of the intention to remain enrolled or to depart from college. According to this model, factors external to the institution are those which influence student attitudes and enrolment decisions.

Though both models analyse the departure from the university in competing framework, Cabrera *et al.* (1993) points out that it is possible to overlap the two models, developing an integrated model that yields a different view of the persistence process. They highlight how not only social, personal and academic factors, but also psycological and sociological elements influence the student decision of leaving the University.

In these models, the timing of the different ways in which students can exit higher education (stopout, dropout, transfer, academic dismissal, graduation) is ignored. In order to take into account the timing of departure process, Event-history models are considered (DesJardin *et al.*, 1999, 2006; Ishitani, 2003; Kalamatianou and McClean, 2003; Johnson, 2006).

Event-history modeling is a longitudinal analytic technique that is particularly well suited to study the temporal nature of student academic careers. This technique allows to evaluate transitions from one state to the next, i.e. from being enrolled or not, and to incorporate variables that capture the changing circumstances faced by students, as they proceed through their academic careers. It is important to study student academic careers using longitudinal data and temporal analytic techniques, because other techniques, like cross-sectional models, do not include temporal information and therefore they cannot be used to explain how changes in independent variables affect changes in the object of interest. In fact, cross-sectional designs are only concerned with how levels of explanatory variables explain an outcome at a specific point in time. Moreover, by using cross-sectional data and static methods to study temporal processes, it is difficult to establish the direction of casuality. Thus, if the purpose of the analysis is to explain change, longitudinal techniques, like event-history modeling, are preferred to static, cross-sectional designs.

The aim of this paper is to analyse and model the interval of time between the first enrolment at the University and the first occurrence of non-enrolment, so that the event of interest is the dropping out of the University. The interest is focused on analysing which personal, familiar and social characteristics may influence the non-completion of students' academic carrier at the University of Salerno by using Survival Analysis techniques.

The paper proceeds as follows. Section 2 describes the background and the existing works on university dropout process, discussing on one hand which models are used in literature for analysing the dropout process, and on the other hand, which factors may influence the students' decision of leaving the university. Section 3 introduces the models used in this paper, to analyse the probability of dropping out of university. In particular, Survival Analysis techniques are discussed, considering three statistical tools: the Kaplan-Meier Estimator, for estimating the survival probability, the Log-Rank Test, for comparing two or more survival curves, according to some covariates, and the Cox Proportional Hazards Model, for identifying which elements might influence the decision of dropping out of the university. Then, a description of student level data, used for estimating the probability of surviving at the university, is given in Section 4, and the results of the analyses are reported and discussed in Section 5. Some concluding remarks close the paper.

2 Background and existing works on university dropout event

There are many studies that investigate the determinants of university dropout event, using student level data. The general idea is that personal, familiar and institutional characteristics may influence the decision of leaving university without completing the program of study.

In the past, two theoretical models have been developed: *Student Integration Model* (Tinto, 1975) and *Student Attrition Model* (Bean, 1980, 1982).

The assumption of the first model is that the completion of University study depends on interaction between students and learning environment. In other words, the way in which motivation and academic ability of students iteract with the academic and social characteristics of universities, influences the chance of completing the program. Thus, students who do not interact with other undergraduates on campus or have negative experiences, might decide to leave the university.

The assumption of second model is that student non-completion is similar to a turnover in work organizations and the behavior intentions are important predictors of persistence behavior. The central point of this model is that students come to university with certain attitudes and expectations that are confirmed or disproved through campus experiences. Undergraduates either confirm the initial expectations or form new impressions, depending on the interactions with their peer. Student intentions of leaving are found to be predictive of actual leaving behavior. This model is expanded to take into account student background characteristics that are related to integration. Therefore, organizational, personal and environmental variables influence the attitudes, the intents and the decision of leaving or continuing study.

Even though these models examine the departure from college as a longitudinal process, in which students' decision to continue studying is influenced by the quality of interactions between precollege characteristics and institutional environments, they consider the departure process in a competing framework. However, it might be interesting to merge these models, developing an integrated model, through the structural equation modeling (Pascarella and Chapman, 1983; Braxton, Duster and Pascarella, 1988; Cabrera, Nora and Castaneda, 1993). In this way, students' dropout behavior is described, pointing out that academic and social factors influence the decision of non-completion of study, but in this model time timing of dropout is not considered.

The role of time in dropout studies is analysed, using the Event-History model (DesJardin *et al.*, 1999, 2006; Ishitani, 2003; Kalamatianou and McClean, 2003; Johnson, 2006), in order to focus on the time periods when students are at risk of leaving the institution, identifying which characteristics affect the probability of dropping out. This technique is particularly interesting for analysing the departure process, because the assessment of the transition from one state to another, i.e. from enrolled to not enrolled, and the identification of the factors (personal, academic, familiar) which influence the students' decision of leaving, are attainable.

Among the several determinants that might influence the chance of study non-completion, dropout risk is associated with the topic studied at university and pre-college academic qualification. In other words, the probability of dropping out of university is higher among students with relatively poor levels of prior qualifications (Johnes, 1990; Light ans Strayer, 2000; Smith and Naylor, 2001; Arulampalam *et al.*, 2005). The likelihood of withdrawing tends to be higher among students in the science disciplines, such as mathematics, engineering and technology and physical science (Johnes and McNabb, 2004).

Completion rates may also vary across gender and age. In particular, males and more mature students are more likely to drop out compared to females or youger students, respectively (Bean and Metzner, 1983; Arulampalam *et al.*, 2004).

In addition to individual characteristics, several institution-specific factors are also found to affect university completion, such as the gender composition of faculty and institutional quality, measured by the results of subject-specific Teaching Quality Assessment (TQA). In detail, students attending universities characterised by high standards of quality in teaching have a lower probability of dropping out relative to those studying at universities that do not achieve the same standards (Robst *et al.*, 1998; Johnes and McNabb, 2004).

Furthermore, working when attending school reduces educational attainment. One explanation suggested is related to the fact that students who work have less time for doing other activities, including studying (Eckstein and Wolpin, 1999).

Parental income, education and socio-economic status are generally important determinants of individual education choices and of the probability of graduation. Empirical evidence on income and occupational mobility suggests that university graduates mainly come from higher educated families (Eckstein and Wolpin, 1999; Checchi *et al.*, 1999; Cingano and Cipollone, 2003; Checchi and Flabbi, 2006).

Finally, a reduction in higher education standards goes in the direction of increasing the number of students in tertiary education and also, by reducing dropout, the graduation rates (Di Pietro and Cutillo, 2006; Bratti *et al.*, 2007).

Some studies have concentrated on the hypothesis that the Italian University Reform, according to the Law 509/99, might have reduced both students' workloads and grading standards in exams. Di Pietro and Cutillo

(2006), focusing on impact of the Italian University Reform on dropout rates, use a decomposition methodology to assess whether changes in the probability of dropping out are determined by changes in students' observable characteristics or by changes in students' behaviour. Their findings suggest that since students' characteristics worsen after the reform, i.e. they tend to achieve poorer academic outcomes, which in turn result in higher dropout rates, the reduction in dropout rates could be explained by a change in student behaviour, such as higher motivation to complete a study program, better focused and more labour market oriented curricula, increased possibilities to combine study and work.

Bratti *et al.* (2006) look into the hypothesis that the fast increase in the number of students is accompanied by a reduction in the higher education and investigates the consequences on drop out and graduation rates. They illustrate a case study on the Marche Polytechnic University, reporting a significant reduction in course workloads and an increase in student performance after the reform, which are shown to have significantly reduced the likelihood of student dropping out.

3 *The student level data of the University of Salerno*

The dataset is collected by the Central Administrative Office of the University of Salerno, and includes all full-time students enrolled at the University in the 2002-2003 academic year. They have been followed for five years, until the 2006-2007 academic year. Those students can have two status: they complete their study, taking the degree or they leave the university, that is the event of our interest.

In this paper, an individual is assumed to have successfully completed his/her study, if he/she takes the degree by the end of third year. Dropout is, therefore, defined as withdrawal from his/her degree programme.

The duration of time is five years (the regular duration of study, i.e. 3 years, plus two additional years). At the end of the fifth year, it is assumed to be a forced termination: a successful completion or dropout. Moreover, since there is no available any information about the following academic year (2007/2008), it is assumed that students who are still enrolled at the beginning of the fifth year, may continue their study in the next academic year, and they do not leave their study.

For each subject, some covariates have been registered, as shown in Table (3.1). The Law Faculty is not considered, because marks of exams are missing in the dataset.

Variable Name	Definitions
Faculty	the study programme chosen by student (Economics; Pharmaceutics; Engineering; Humanities; Languages; Educational Studies; Mathematical, Physical and Natural (MFN) Sciences; Political Science)
Year of enrolment	Last Year of study attended by student
Gender	1 if the student is Female, 0 if Otherwise
Age	Age at the time of enrolment, divided into four classes (18-19; 20-21; 22-23; >24)
School Attended	High School attended by student before enrolling (Classical, Scientific, Technical, Professional, Langagues, Training, Professional, Others)
High school final mark	Mark of the final exam of High School, divided into classes (60-69; 70-79; 80-89; 90-99; 100)
Income	Family Income level (range: from 1 if the level is low, to 9 if the level is high)
Average mark of exams	Mean of exams' marks of student, divided into classes (18-21; 22-24; 25-27; 28-30)

Table 3.1: *Description of the characteristics registered for the students.*

The population analysed consists of 5823 full-time students, enrolled in 2002-2003 academic year at the University of Salerno. The Table (3.2) shows the distribution of population, by Faculty and Gender. It can be noted that female students choose to study Educational Studies (96%), Languages (82%), Pharmaceutics (70%) and Humanities (68%), while the other Faculties have typically a male setting.

Faculty	Female	Male	Total
Economics	507 (0.48)	551 (0.52)	1058 (0.18)
Pharmaceutics	308 (0.70)	132 (0.30)	440 (0.08)
Engineering	129 (0.20)	532 (0.80)	661 (0.11)
Humanities	962 (0.68)	458 (0.32)	1420 (0.24)
Languages	358 (0.82)	80 (0.18)	438 (0.08)
Educational Studies	569 (0.91)	55 (0.09)	624 (0.11)
MFN Sciences	197 (0.24)	621 (0.76)	818 (0.14)
Political Science	136 (0.37)	228 (0.63)	364 (0.06)
Total	3166 (0.54)	2657 (0.46)	5823

Table 3.2: *Distribution of male and female, for Faculty in which they are enrolled. (The percentage values are given in parentheses.)*

Though in Italy, the normal age of entry into the University is 18-19 years, the average age at time of the enrolment at the University of Salerno is 20-21 for all Faculties, with the exception of Political Science, for which students are older (23 years, in average). Moreover, most of the Faculties have a lower percentage of students with more than 24 years, whereas these rates are rather higher for Political Science (20%) and Educational Studies (14%) (Table (3.3)).

Faculty	18-19	20-21	22-23	>24
Economics	649 (0.61)	295 (0.28)	39 (0.04)	75 (0.07)
Pharmaceutics	292 (0.66)	101 (0.23)	11 (0.03)	36 (0.08)
Engineering	498 (0.75)	119 (0.18)	14 (0.02)	30 (0.05)
Humanities	804 (0.57)	409 (0.28)	67 (0.05)	140 (0.10)
Languages	283 (0.65)	114 (0.26)	19 (0.04)	22 (0.05)
Educational Studies	317 (0.51)	174 (0.28)	43 (0.07)	90 (0.14)
MFN Sciences	495 (0.61)	228 (0.28)	38 (0.05)	57 (0.07)
Political Science	155 (0.43)	111 (0.31)	22 (0.06)	76 (0.20)
Total	3493 (0.60)	1551 (0.27)	253 (0.04)	526 (0.09)

Table 3.3: *Distribution of students, for Faculty and Age at time the enrolment. (Percentage values are given in parentheses.)*

The distribution of population, distinguishing among types of high school is shown in Table (3.4). In Italian High School System, there are several types of high schools, which can be divided into three different categories: "Licei", i.e. classical, scientific and linguistic high schools, "Technical", technical and professional schools, and "Others", including other types of high schools, and schools not specified by the students.

Students who attended "Licei" prefer to enrol in Pharmaceutics (70%), Humanities (67%), Languages (63%), Educational Studies (65%) and Engineering (57%), whereas students who attended Technical High school decide to enroll in Economics (66%), MFN Sciences (60%) and Political Science (55%). Even though it seems strange that MFN Sciences is chosen by the individuals who attended Technical high schools, a possible explanation is related to the nature of the Faculty. In fact, this Faculty has several study programmes, including also informatics, subject studied in technical high schools.

The distribution of final grades for high school graduates is displayed in Table (3.5). In each Faculty the percentage of students who completed their high school study with the maximum mark is quite low, except the case of Engineering students whose percentage of top students is highest (25%). Moreover, most high school students graduate with low grades, i.e. between

60 and 79.

Faculty	Licei	Technical	Others
Economics	354 (0.335)	699 (0.662)	3 (0.003)
Pharmaceutics	307 (0.698)	106 (0.241)	27 (0.061)
Engineering	377 (0.573)	280 (0.426)	1 (0.001)
Humanities	948 (0.668)	374 (0.262)	100 (0.070)
Languages	274 (0.634)	151 (0.350)	7 (0.016)
Educational Studies	404 (0.647)	148 (0.237)	72 (0.116)
MFN Sciences	315 (0.386)	489 (0.598)	13 (0.016)
Political Science	149 (0.413)	200 (0.554)	12 (0.033)
Total	3128 (0.54)	2444 (0.42)	235 (0.04)

Table 3.4: *Distribution of students, for Faculty and High School. (Percentage values are given in parentheses.)*

Faculty	60-69	70-79	80-89	90-99	100
Economics	269 (0.26)	241 (0.23)	227 (0.22)	169 (0.16)	150 (0.14)
Pharmaceutics	100 (0.23)	115 (0.26)	79 (0.18)	67 (0.15)	77 (0.18)
Engineering	116 (0.18)	130 (0.20)	117 (0.18)	134 (0.20)	161 (0.25)
Humanities	402 (0.28)	339 (0.24)	320 (0.23)	207 (0.15)	150 (0.11)
Languages	89 (0.21)	97 (0.23)	114 (0.27)	83 (0.19)	46 (0.11)
Educational Studies	222 (0.36)	195 (0.31)	129 (0.21)	52 (0.08)	26 (0.04)
MFN Sciences	252 (0.31)	215 (0.26)	151 (0.18)	113 (0.14)	86 (0.11)
Political Science	135 (0.37)	106 (0.29)	62 (0.17)	38 (0.11)	20 (0.06)
Total	1585 (0.27)	1438 (0.25)	1199 (0.21)	863 (0.15)	716 (0.12)

Table 3.5: *Distribution of students, for Faculty and high school final grades. (Percentage values are given in parentheses.)*

Some information on the dropout rate are reported in Tables (3.6)-(3.7). Students with a higher probability of dropping out, are those who enrolled at Political Science (59%) and Educational Studies (57%), whereas Engineering students have the highest rate of graduation. In fact, only 33% of students in Engineering leave the Faculty without completing the course of study. Moreover, male undergraduate in Political Science and female students in Educational Studies have the highest rates of leaving the University.

Looking at Table (3.8), it can be noted how the number of people enrolled at the University decreased over time, and at the end of the first year, about 26% of students leave the University, percentage that decrease across the years. This means that pretty high number of students decide not to continue the study during the first year.

Faculty	No Dropout	Dropout
Economics	601 (0.57)	457 (0.43)
Pharmaceutics	278 (0.63)	162 (0.37)
Engineering	444 (0.67)	217 (0.33)
Humanities	771 (0.54)	649 (0.46)
Languages	278 (0.63)	160 (0.37)
Educational Studies	270 (0.43)	354 (0.57)
MFN Sciences	473 (0.58)	345 (0.42)
Political Science	149 (0.41)	215 (0.59)
Total	3264 (0.56)	2559 (0.44)

Table 3.6: *Completing and dropping out rates for Faculty. (Percentage values are given in parentheses.)*

Faculty	Female No Dropout	Female Dropout	Male No Dropout	Male Dropout
Economics	335 (0.32)	172 (0.16)	266 (0.25)	285 (0.27)
Pharmaceutics	205 (0.47)	154 (0.24)	75 (0.17)	55 (0.13)
Engineering	101 (0.15)	28 (0.04)	343 (0.52)	189 (0.29)
Humanities	548 (0.39)	414 (0.29)	224 (0.16)	235 (0.17)
Languages	242 (0.55)	115 (0.26)	36 (0.08)	44 (0.10)
Educational Studies	256 (0.41)	312 (0.50)	15 (0.02)	41 (0.07)
MFN Sciences	137 (0.17)	60 (0.07)	336 (0.41)	285 (0.35)
Political Science	71 (0.20)	65 (0.18)	78 (0.21)	150 (0.41)
Total	1895 (0.33)	1271 (0.22)	1373 (0.24)	1284 (0.22)

Table 3.7: *Distribution of male and female, who complete or leave the university, for Faculty. (Percentage values are given in parentheses.)*

Year	Number of students	Year	Number of Dropouts
2002	5823		
2003	4297	At the end of First Year	1526 (0.26)
2004	3696	At the end of Second Year	601 (0.14)
2005	3433	At the end of Third Year	262 (0.071)
2006	3264	At the end of Fourth Year	169 (0.049)

Table 3.8: *Number of students enrolled and the Number of Dropouts across the Years. (Percentage values are given in parentheses.)*

In dropout studies, data collection must end at some arbitrarily-defined period without some of subjects having experienced the event of taking the degree. In other words, a student, at the end of the study programme may either receive the degree or leave the university. Thus, there are two different time points: the *time of origin*, i.e. the time at which an original event, such as enrolment at the university, occurs, and the *time of failure*, i.e. the time at which the final event, such as dropping out at the university, takes place. In this ways, it is dealt with censored observations, i.e. observations with incomplete information about event of interest.

To study the relationship between the occurrence of events and selected predictors, Survival Analysis techniques, which incorporate both censored and uncensored observations, have been used. Moreover, it is possible to study time-varying predictors, those whose values change from one year to the next during the observation period, and to allow the effects of these variables to vary over time, modeling dynamic processes.

One of the aim of survival analysis is to estimate the survival probability function by *Kaplan-Meier (KM) estimator* (1958), which is usually derived as a non-parametric maximum likelihood estimate of the survivor function.

Assume that T_i ($i = 1, \dots, n$) is an arbitrary non-negative random variable, corresponding to *duration of studies* of the ith individual, having a cumulative distribution function given by:

$$F(t) = P(T \leq t) = \int_0^t f(u)du, \tag{4.1}$$

where $f(u)$ is the probability density function.

Assume that the T_i ($i = 1, \dots, n$) are i.i.d. with survivor function $S(t)$, that is the probability of an individual surviving beyond time t, given by:

$$S(t) = P(T \geq t) = 1 - F(t) = \int_t^\infty f(u)du \tag{4.2}$$

It is a monotone decreasing continuous function with $S(0) = 1$ and $S(\infty) = \lim_{t \to \infty} S(t) = 0$.

The T_i ($i = 1, \ldots, n$) are also characterized by failure rate given by *cumulative hazard function* $\Lambda(t)$, to be estimated, and it is given by:

$$\Lambda(t) = \int_0^t \lambda(u)du = log(S(t)) \tag{4.3}$$

so that:

$$S(t) = \exp[-\Lambda(t)] = \exp[-\int_0^t \lambda(u)du] \tag{4.4}$$

where $\lambda(u)$ is the *Hazard function* is the probability that an individual dies at time t, i.e. dropping out, conditional on having survived to that time, and it is given by:

$$\lambda(t) \quad = \quad -\frac{f(t)}{S(t)} \tag{4.5}$$

Let C_i ($i = 1, \ldots, n$) be the *censoring time*, i.e. the time between the time of enrolment and the moment of dropping out of the University for the *ith* individual, and let

$$Z_i = \min(T_i, C_i), \tag{4.6}$$

and

$$\delta_i = I[T_i \leq C_i], \tag{4.7}$$

where δ_i is an indicator function, equal to 1 if the student does not complete his study, and zero, otherwise.

Assume that (Z_i, δ_i) is observed.

An important assumption of the Kaplan-Meier method is that the probability of a censored observation is independent of the actual survival time. In other words, the reason for which one individual is censored, is unrelated to the reason of dropping out, and the individuals whose survival times are censored, are a sample having the same distribution.

Assuming that T_i and C_i ($i = 1, \ldots, n$) are independent, consider the indicator function that the individual i is still under observation at time t, i.e. the individual i is still enrolled at the university at time t:

$$Y_i(t) = I[T_i \geq t] \tag{4.8}$$

where $I[.]$ is an indicator function.

Let

$$N_i(t) = I[T_i \leq t, \delta_i = 1] \tag{4.9}$$

be the number of observed failures for individual i, i.e. the number of observed students who leave the university, where $\delta_i = I[T_i \leq C_i]$.

Let:

$$\bar{Y}(t) = \sum_i^n Y_i(t) = \sum_i^n I[Y_i \geq t] \tag{4.10}$$

be the number of subjects at risk for failure at time t, i.e. the number of students who are at risk for dropping out, and let:

$$\bar{N}(t) = \sum_i^n N_i(t) = \sum_i^n I[N_i \leq t, \delta_i = 1] \tag{4.11}$$

be the total number of individual failures up to and including t, i.e. the total number of dropouts up to and including t.

Consider a partition of the interval $[0, t]$, such that $0 = t_1 < t_2 < \cdots < t_m = t$; and assume that $\bar{N}_k$ is the number of dropouts in $[t_{k-1}, t_k]$, and $\bar{Y}_k$ is the number of students at risk at time t_k^0, so that for small Δt:

$$\begin{aligned} \Lambda(t + \Delta t) - \Lambda(t) &\approx \lambda(t)\Delta t \\ &\approx P[t \leq T < t + \Delta t | T \geq t]. \end{aligned} \tag{4.12}$$

This might be estimated by $\frac{[\bar{N}(t+\Delta t) - \bar{N}(t)]}{\bar{Y}(t)}$.

If the sum of these quantities over subintervals $[0, t_k)$ is considered and if the subintervals get small enough that they contain at most one event times, an estimator of $\Lambda(t)$ is:

$$\widehat{\Lambda}(t) = \int_0^t \frac{d\bar{N}(s)}{\bar{Y}(s)} \tag{4.13}$$

called *Nelson-Aalen estimator*.

Recalling the relations between survival function and the hazard, the estimator of survival curve is obtained:

$$\widehat{S}(t) = \exp[-\widehat{\Lambda}(t)] \;=\; \prod_{k:t_i \le t} \exp\left[-\frac{\Delta N(t_i)}{\bar{Y}(t_i)}\right]$$
$$\approx \prod_{k:t_i \le t} \exp\left[1 - \frac{\Delta N(t_i)}{\bar{Y}(t_i)}\right] \tag{4.14}$$

that is the *Kaplan-Meier estimator*, where $\Delta\bar{N}(t) = \bar{N}(t) - \bar{N}(t-)$.

The asymptotic variance of Kaplan-Meier estimator is equal to:

$$\sigma^2(t) = S^2(t) \int_0^t \frac{dF(s)}{[1 - F(s)]^2 - (1 - G(s))} \tag{4.15}$$

where $G(t) = P[C_i \le t]$, and it is estimated by:

$$\hat{\sigma}^2(t) = \hat{S}^2(t) \int_0^t \frac{nd\bar{N}(s)}{(\bar{Y}(s))^2} \tag{4.16}$$

For more details, see Fleming and Harrigton (1991).

Another aim of Survival Analysis is to compare the survival curves of two or more groups, that usually is made by the *Log-rank test* (Mantel, 1966; Cox, 1972; Peto and Peto, 1972). It is used to test the null hypothesis that there is no difference between the population survival curves (i.e. the probability of an event occurring at any time point is the same for each population). This test does not allow more than one explanatory variable to be taken into account and gives equal weight to early and late failures.

Assume $t_1^0 \le, \ldots, \le t_L^0$ are the ordered observed distinct failure times, i.e. duration of the studies, in the sample formed by combining two groups. Let N_{ij} and Y_{ij} ($i = 1, \ldots, n; j = 1, 2$) be the number of observed failures, i.e. the number of the observed dropouts and the number at risk, i.e. the number of students who are at risk of non-completing the study, in sample j at time t_i^0, respectively. Let N_i and Y_i be the corresponding values in the combined groups. The data at t_i^0 are summarized in Table (4.1):

Given Y_{ij}, the N_{ij} have a binomial distribution with number of trial Y_{ij} and, under the hypothesis of a common failure rate λ in the two groups,

Failure	1 Sample	2 Sample	Total
Yes	N_{i1}	N_{i2}	N_i
NO	$Y_{i1} - N_{i1}$	$Y_{i2} - N_{i2}$	$Y_i - N_i$
Total	Y_{i1}	Y_{i2}	Y_i

Table 4.1: *Number of cases failing and not failing at t_i^0 from those at risk, by sample*

approximate event probability $\lambda(t_i^0)\Delta t$. Fisher's exact test for equal binomial parameters in this setting is based on conditioning further on Y_i and on using the resulting conditional hypergeometric distribution for Y_{i1}. This distribution will have conditional mean ϵ_{i1} and variance υ_{i1} given by:

$$\epsilon_{i1} = N_i \frac{Y_{i1}}{Y_i} \tag{4.17}$$

and

$$\upsilon_{i1} = N_i \frac{Y_{i1} Y_{i2}}{Y_i^2} \frac{Y_i - N_i}{Y_i - 1} \tag{4.18}$$

Considering the vector of observed death times minus conditionally expected number of failures across observed failure times, and if the assumpption is that these differences are independent, the statistic is:

$$Q = \sum_{i=1}^{L} (N_{i1} - \epsilon_{i1}). \tag{4.19}$$

It can be shown that under H_0, it is approximately a standard normal distribution:

$$Q \approx N(0, V), \tag{4.20}$$

where $V = \sum_{i=1}^{L} \upsilon_{i1}$. So under H_0:

$$T = \frac{Q^2}{V} \approx \chi^2_{(1)}. \tag{4.21}$$

If two or more survival curves are significantly different, it is possible to assess the factors that may play a role in survival probability. The *Cox Proportional Hazards (PH) Model* (Cox, 1972) is useful to identify the risk factors and their risk contributions, selecting efficiently a subset of significant variables, upon which the hazard function depends. In other words, it explores the association of covariates with failure times and survival distributions, and it studies the effect of a primary covariate, while adjusting for other variables.

A key characteristic of the Cox model is that the hazard ratio does not depend on time, so that it is nonparametric with respect to time, but parametric with respect to covariates. Any distributional assumption about the baseline hazard is not made, assuming that it is common among all individuals.

Consider (Z_i, δ_i, x_i) ($i = 1, \ldots, n$), where Z_i is given by (4.6); δ_i is given by (4.7), and x_i are the covariates, i.e. Gender, Age at Matriculation, Type and Mark of High School, Familiar Income, Mark of Exams.

Assume that covariates do not vary with time, and that $S(t|x)$ is the conditional survival function $P(T > t|x)$. Thus the conditional hazard function is given by

$$\lambda(t|x) \quad = \quad \lim_{\Delta t \to \infty} \frac{1}{\Delta t} P[t \leq T \leq t + \Delta t | T \geq t, x] \tag{4.22}$$

If *T* is the failure time variable i.e. *duration of studies*, a partition on *T* is defined so that $0 = t_0 \leq t_1 \leq \cdots \leq t_m < \infty$, and consider a new variable $T^* = t_i$ if $t_i \leq T < t_{i+1}$ ($i = 0, 1, \ldots$).

In this case, the conditional hazard function on the discrete distribution of T^* is given by:

$$\lambda^*(t_i|x) = P[T^* = t_i | T^* \geq t_i, x] \qquad i = 0, 1, \ldots \tag{4.23}$$

and in terms of original distribution of T:

$$\lambda^*(t_i|x) = 1 - \exp\left[- \int_{t_i}^{t_{i+1}} \lambda(u|x) dx \right] \tag{4.24}$$

Assuming that a model with arbitrary covariate x has, for each t_i, conditional odds of failing in an interval $[t_i, t_{i+1}]$ proportional to the model with covariate $x = 0$, then for each t_i

$$\frac{\lambda^*(t_i|x)}{1-\lambda^*(t_i|x)} = \frac{\lambda_0^*(t_i)}{1-\lambda_0^*(t_i)} g(x) \tag{4.25}$$

for some function g, where $\lambda_0^*(t_i) = \lambda^*(t_i|x=0)$.

Now, if the proportionality does not depend on the partition chosen, then it results that:

$$\frac{1-\exp\left[-\int_t^{t+\Delta t}\lambda(u|x)du\right]}{\exp\left[-\int_t^{t+\Delta t}\lambda(u|x)du\right]} = \frac{1-\exp\left[-\int_t^{t+\Delta t}\lambda_0(u)du\right]}{\exp\left[-\int_t^{t+\Delta t}\lambda_0(u)du\right]} \cdot g(x) \tag{4.26}$$

In order to ensure that $q \leq 0$, $g(x) = \exp(\beta x)$ is considered. If $\Delta \to 0$, it results:

$$\lambda(t|x) = \lambda_0(t) \cdot \exp(\beta^{'} x) \tag{4.27}$$

where $\lambda_o(t)$ is the *Baseline hazard rate*, β is the regression parameter vector, estimated by maximizing a partial likelihood, without regard to the baseline hazard $\lambda_0(t)$.

Inference procedures for the PH model and the multiplicative intensity model requires computation methods for finding estimates of the regression coefficients and the baseline hazard function, and at least approximate sapling distributions of those estimators.

Assume that the covariates do not vary with time, the failure distribution is continuous and there are no ties among the observed failure times.

Consider again the independent triples (Z_i, δ_i, x_i), $i = 1, \ldots, n$. Z_i has a density in our case θ is β and ϕ is $\lambda_0(t)$. We want to make inference on θ, with ϕ a nuisance parameter. Z_i are transformed into $(V_1, W_1, \ldots, V_N, W_N)$.

Suppose to observe L failures at times $0 = t_0^0 < t_1^0 < \cdots < t_L^0 < t_{L+1}^0 = \infty$. The covariates associated with L failures are $X_1, \ldots, X_L$. Now suppose that n_i items are censored at or after t_i^0 but before t_{i+1}^0, at times $t_{i1}^0, \ldots, t_{i+m_i}^0$. The covariates associated with the m_i censored items are $(X_{(i,1)}, \ldots, X_{(i,m_i)})$. Consider a condition on $\{X_i : i = 1, \ldots, n\}$.

For $i = 0, \ldots, L$, it results: $V_{i+1} = \{t^0_{i+1}, t^0_{ij}, (i,j) : j+1, \ldots, m_i\}$ and $W_{i+1} = \{(i+1)\}$. In the nested sequence (P_i, Q_i), P_i contains the times of all censoring up to time t^0_{i-1} and the times of all failures through times t^0_{i-1}. Instead, Q_i specifies t^0_i and the times of all censoring at or after t^0_{i-1} and up to t^0_i.

Inference for β could be based on the information in P_{i+1} given Q_i, that is, on the partial likelihood:

$$\prod_{i=1}^{L} P[W_i = (i)|Q_i] \tag{4.28}$$

To obtain an expression for $P[W_i = (i)|Q_i]$, it is considered that the assumption of independent censoring implies that the probabilities that the item with label (i) fails at $t^0_i = t_i$, given the risk set $R_i \equiv \{j : X_j \leq t^0_i\}$ and given that one failure occurs at t_i, is:

$$\begin{aligned} P[W_i = (i)|Q_i] &= \\ &= \frac{d\Lambda(t_i|x_{(i)}) \prod_{j \notin R_i - (i)} \{1 - d\Lambda(t_i|x_j)\}}{\sum_{l \in R_i} \left[d\Lambda(t_i|x_l) \prod_{j \in R_i - l} \{1 - d\Lambda(t_i|x_j)\} \right]} \\ &= \frac{\lambda(t_i|x_{(i)})}{\sum_{l \in R_i} \lambda(t_i|x_l)} \\ &= \frac{\exp(\beta' x_{(i)})}{\sum_{l \in R_i} \lambda(t_i|x_l)} \end{aligned} \tag{4.29}$$

Thus, using (4.28), the partial likelihood is given by:

$$L(\beta) = \prod_{i=1}^{L} \frac{\exp(\beta' x_{(i)})}{\sum_{l \in R_i} \exp(\beta' x_l)} \tag{4.30}$$

The log Partial likelihood is given by:

$$\log L(\beta) = \sum_{i=1}^{L} \left\{ \beta' x_i - log \sum_{j \in R_k} \exp(\beta' x_{(j)}) \right\} \tag{4.31}$$

The efficient score for $U(\beta) = \frac{\partial \log L(\beta)}{\partial \beta}$ is:

$$U(\beta) = \sum_{k=1}^{L} \left\{ x_k - \frac{\sum_{j \in R_k} x_j \exp(\beta' x_j)}{\sum_{j \in R_k \exp(\beta' x_j)}} \right\} \tag{4.32}$$

Maximum partial likelihood estimates β are found using the p simultaneous equations $U(\beta) = 0$, where p is the number of covariates.

In order to make inferences on β based on Partial Likelihood, the functional form for $\lambda_0(t)$ does not be specified . It can be proved that:

$$\hat{\beta} \sim N(\beta, I(\beta)^{-1}) \tag{4.33}$$

where $I(\beta)^{-1}$ is the Information matrix, and can be derived using the standard methods.

5 Analysis of the dropout rates at the University of Salerno

In this section, survival analysis techniques are used to estimate the dropout probability. First of all, the survival function is estimated by the Kaplan-Meier estimator. In Figure (5.1), eight different lines indicate the survivor probabilities for the students who studied in one of the Faculties of the University of Salerno. It can be noted how the dynamics of departure differs by the Faculty. A steep decline is observed for the students in Political Science and in Educational Studies, at the first year. The lower survival rate for these two Faculties continue throughout the observation period. Moreover, at the end of the second year, the survival probability also decrease for the Humanities. This means that the decision of leaving the university is taken by the students enrolled at the Humanities during the second year, and not during the first year, as for students in the Political Science and Educational Studies.

The KM estimator for males and females is shown in Figure (5.2). It can be noted how male students have lower survival rates than female. This means that males do not complete their study, and therefore leave the University faster than females. This is true also if you look at survival functions of male and female, distinguishing by Faculty (Figures (5.3)-(5.6)). It is confirmed that the students in Political Science and in Educational Studies, in particular males, have lower survival rate than those in other Faculties. Moreover, the rate of dropping out for male undergraduates in Pharmaceutics and MFN Sciences is particularly evident at the end of the second year, while male students in Languages, Educational Studies and Political Science leave the university during the first year. Therefore, Faculty attended has an effect on probability of surviving at University.

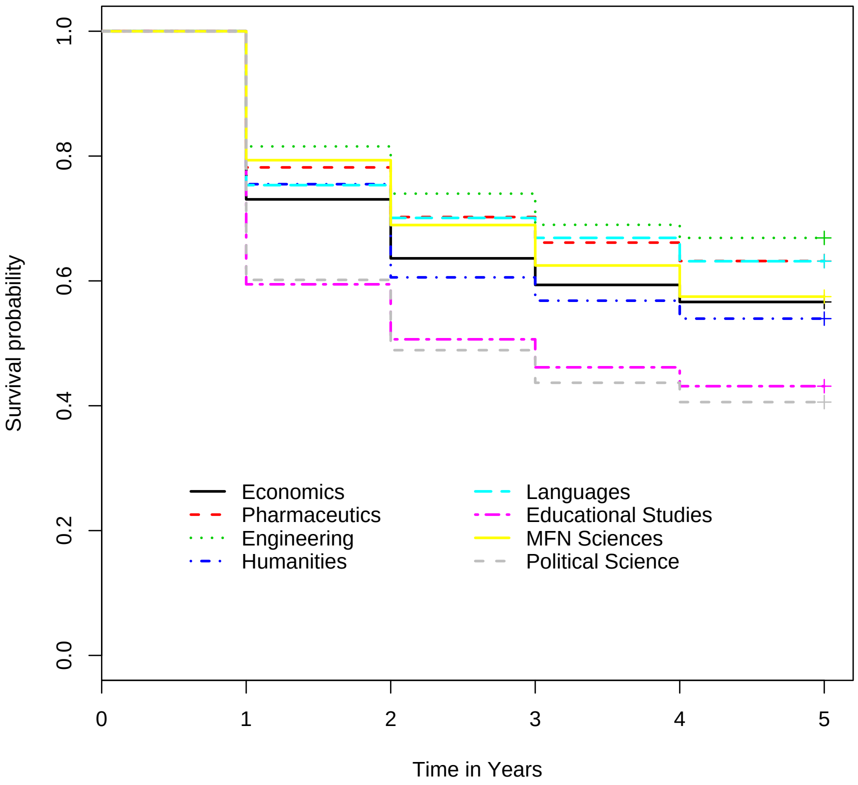

Figure 5.1: *Survival functions for Faculties.*

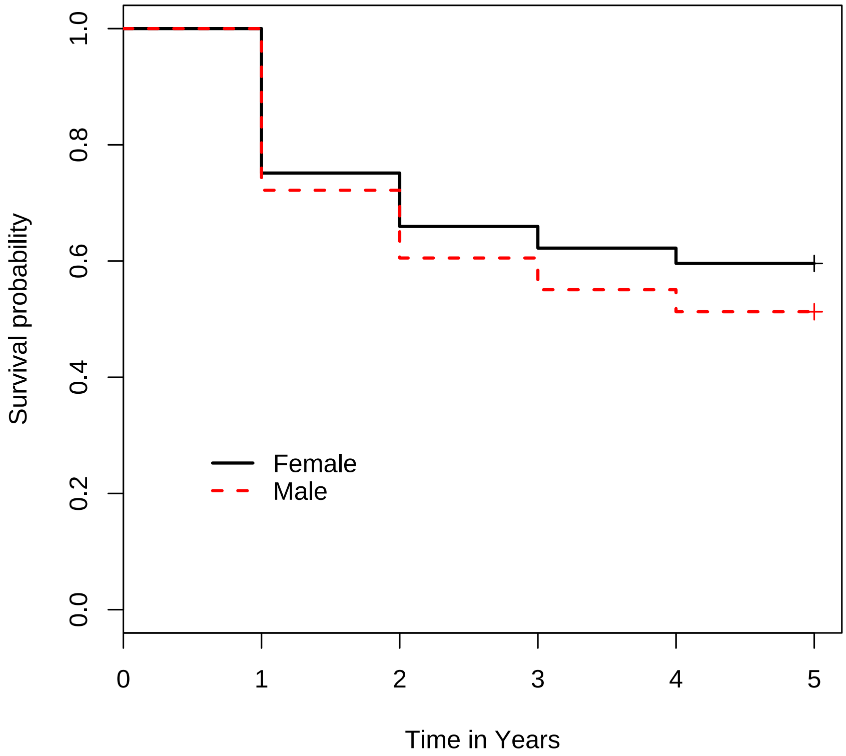

Figure 5.2: *Survival functions for males and females, for data considered entirely.*

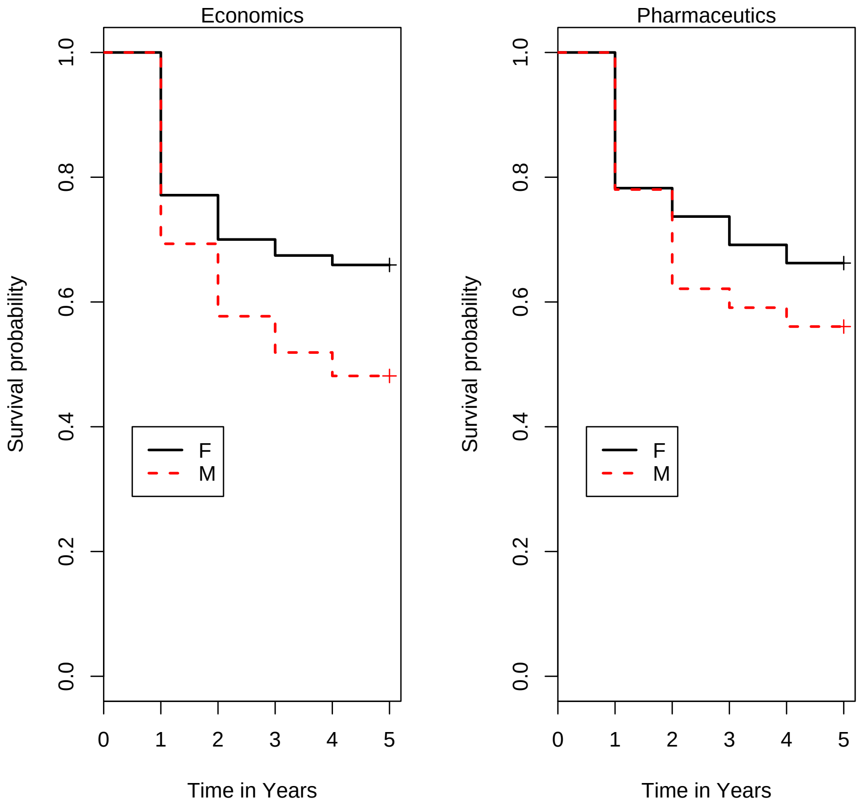

Figure 5.3: *Survival functions for male and female, by Faculty (Economics, Pharmaceutics).*

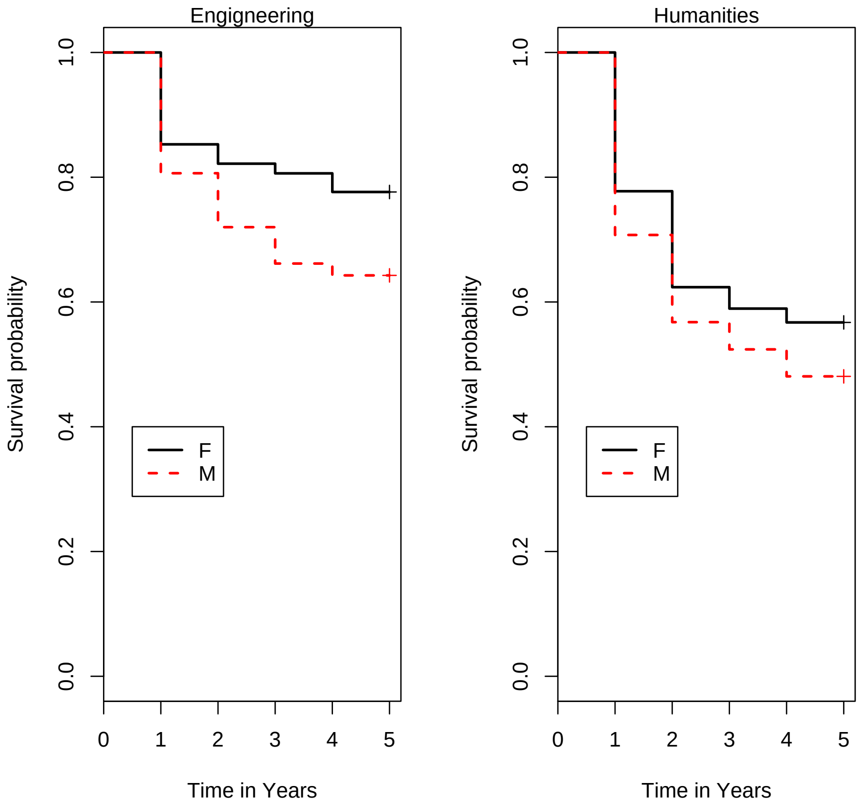

Figure 5.4: *Survival functions for male and female, by Faculty (Engineering, Humanities).*

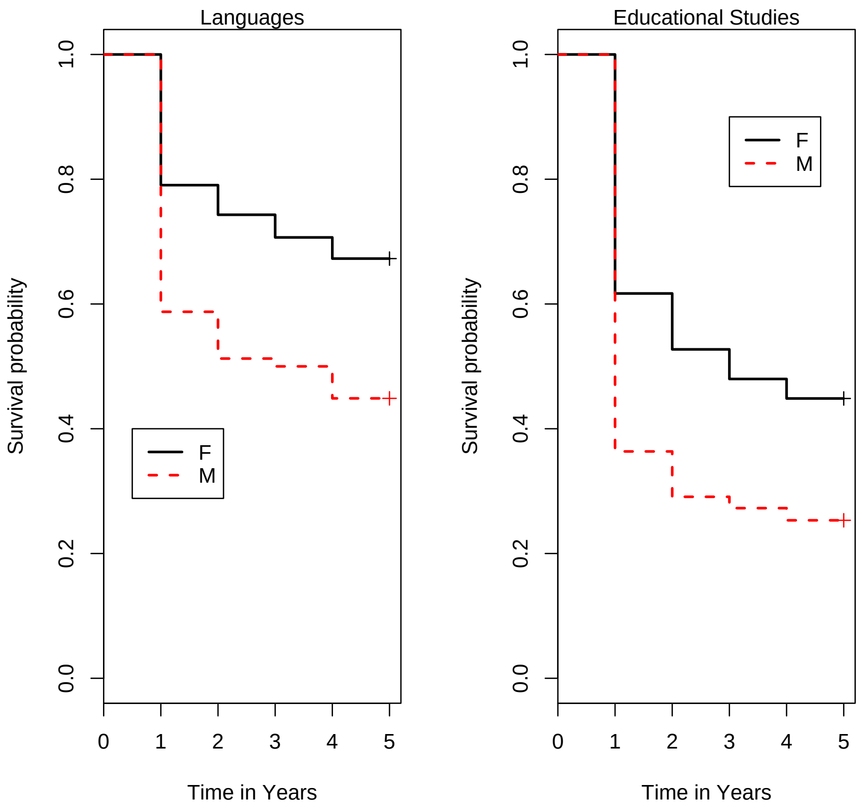

Figure 5.5: *Survival functions for male and female, by Faculty (Languages, Educational Studies).*

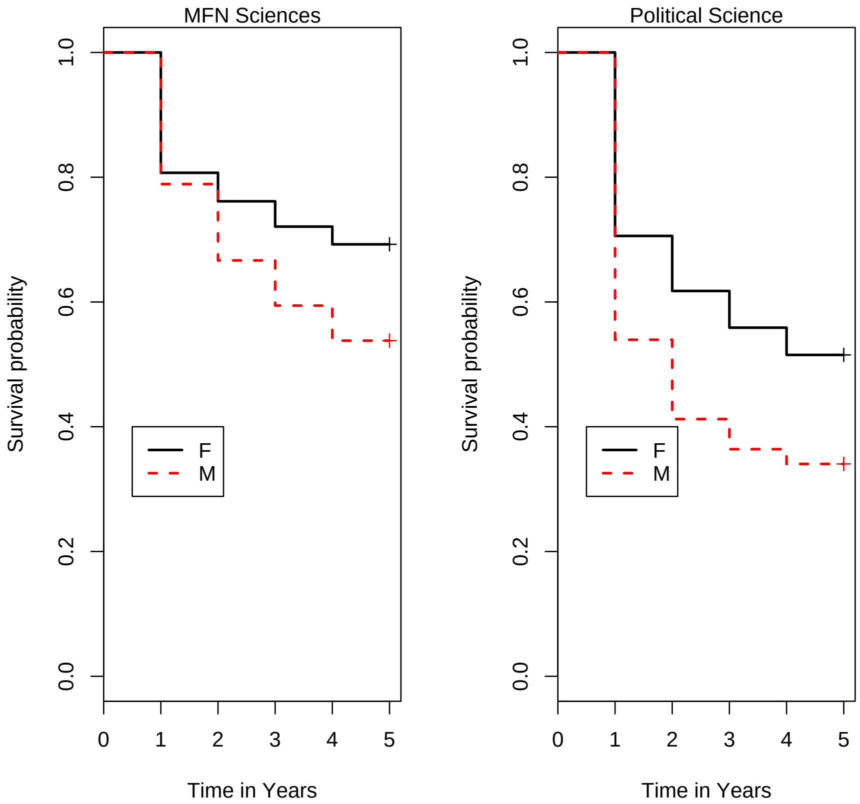

Figure 5.6: *Survival functions for male and female, by Faculty (MFN Sciences and Political Science).*

In Figures (5.7)-(5.10), the four lines correspond to the different groups of students according to the age at the time of enrolment at the University. It can be noted how the students who are more than 24 years old, have a survival rate that is lower than those who are 19 years old. Therefore, students who enrol at the University immediately after completing their high school study, have a greater probability of taking the degree than those who decide to study at the University after having completed the high school study by many years. Moreover, it can be noted that there is also a Faculty effect. This means that the probability of surviving after the first year, for older students in Economics and Engineering is lower than that for older students in other Faculties.

The students who attend the "Licei" have the higher probability of surviving at the University, i.e. the higher rate of taking the degree. This results depends on the nature of the high school. Technical high schools provide a specialised qualification, so that students may find a job, also without taking the degree, whereas those who studied at the "Licei" have to continue their study, enrolling at the University, since the "Licei" provide a general qualification (Figures (5.11)-(5.14)). Also in this case, a Faculty effect is noted.

Finally, students who complete their high school study with the maximum mark (i.e. 110), have the higher probability of completing their study, whereas those who have lower marks, between 60 and 79, have the lower probability of surviving, i.e. the lower rate of taking the degree and therefore the higher chance of leaving the University (Figures (5.15)-(5.18)). Moreover, it can be noted how the probability of dropping out of the university for students with lower marks changes by Faculty attendend.

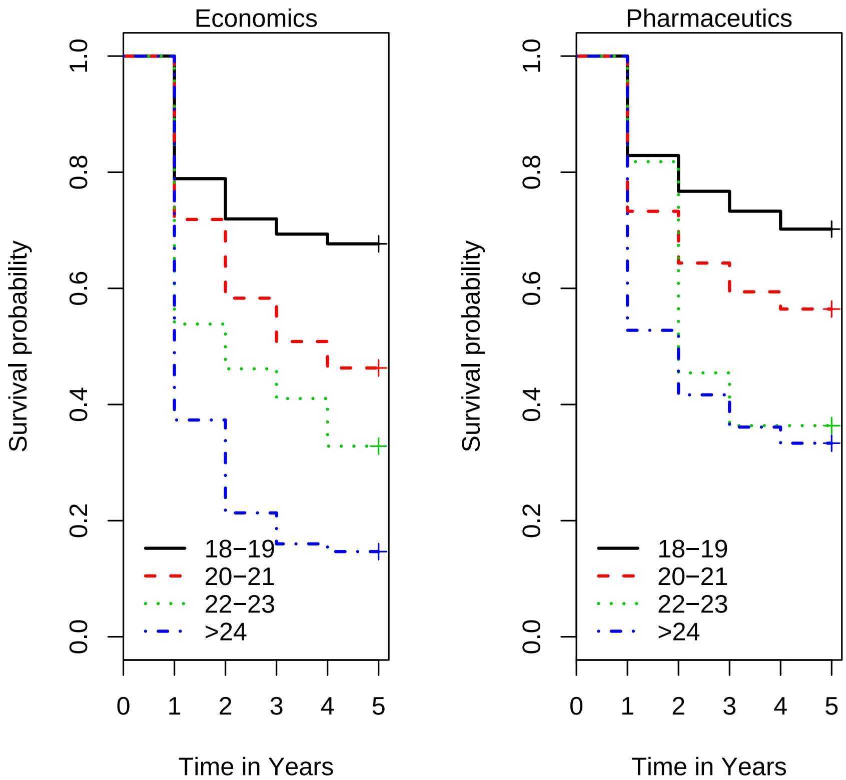

Figure 5.7: *Survival functions for students in Economics and Pharmaceutics, with different levels of age at the time of the enrolment.*

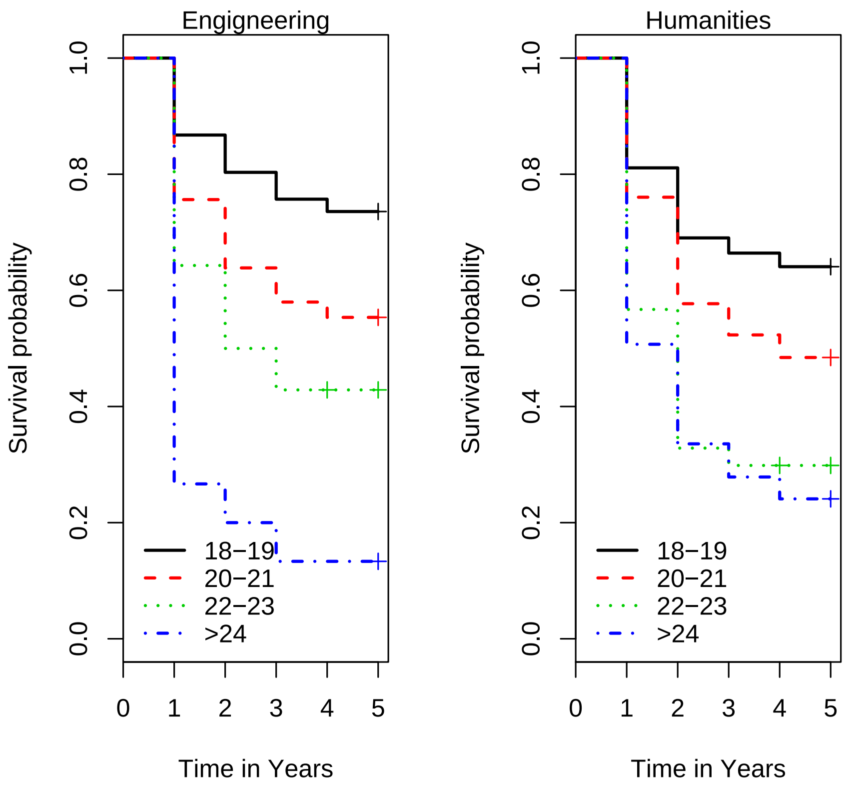

Figure 5.8: *Survival functions for students in Engineering and Humanities, with different levels of age at the time of the enrolment.*

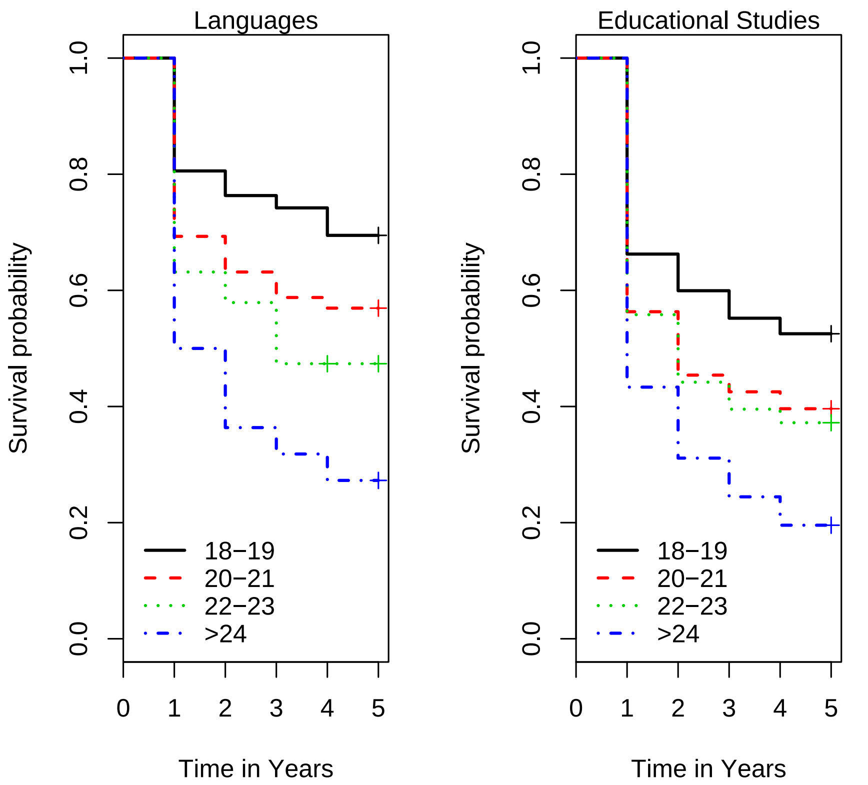

Figure 5.9: *Survival functions for students in Languages and Educational Studies, with different levels of age at the time of the enrolment.*

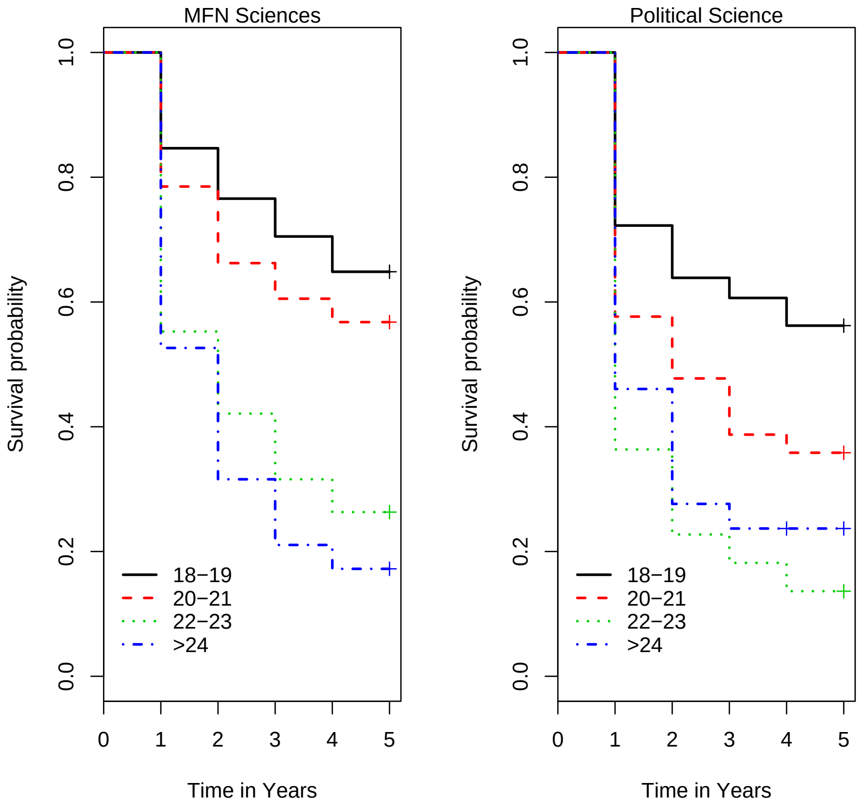

Figure 5.10: *Survival functions for students in MFN Sciences and Political Science, with different levels of age at the time of the enrolment.*

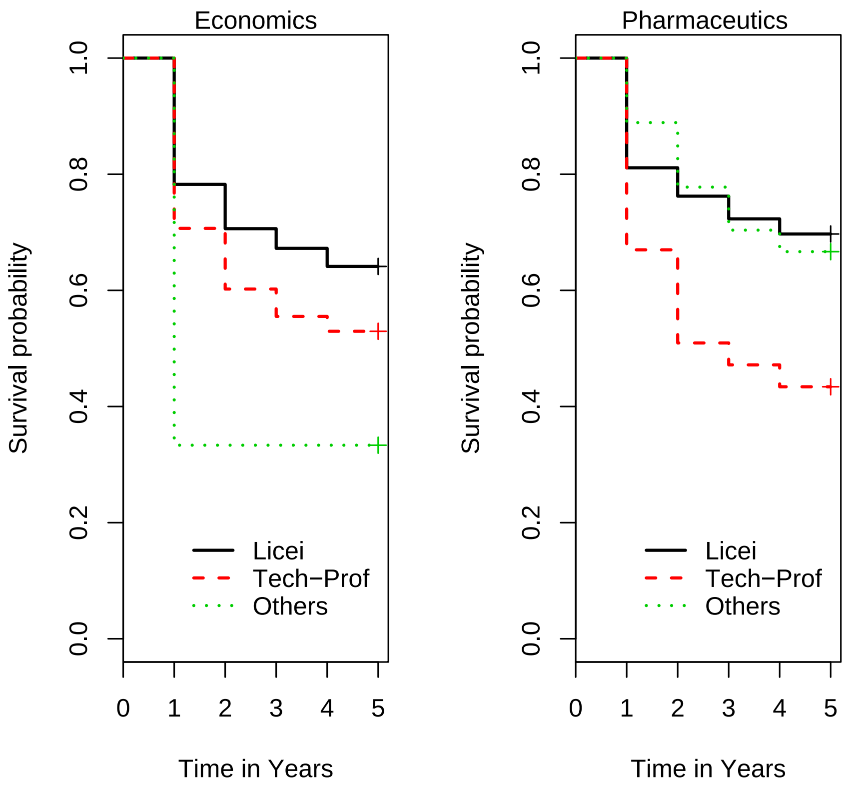

Figure 5.11: *Survival functions of students in Economics and Pharmaceutics, according to type of High Schools.*

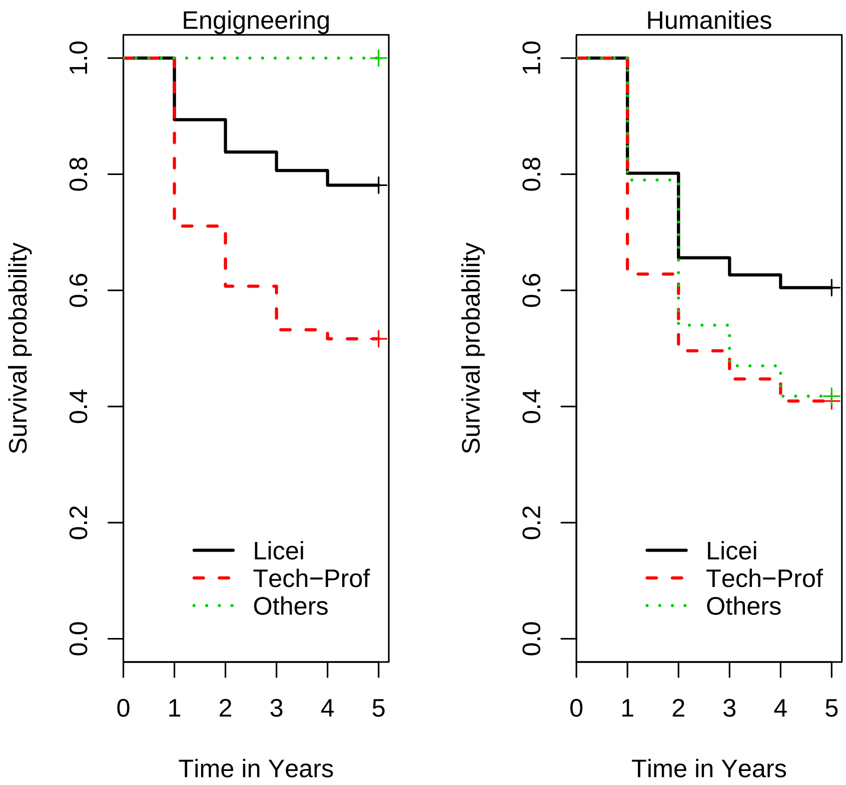

Figure 5.12: *Survival functions of students in Engineering and Humanities, according to type of High Schools.*

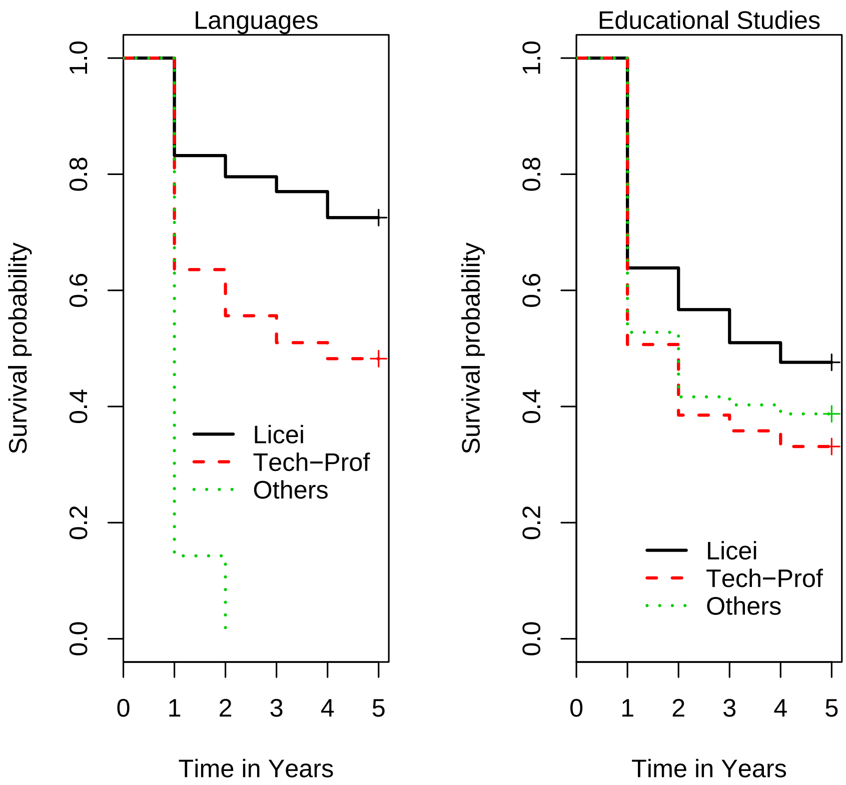

Figure 5.13: *Survival functions of students in Languages and Educational Studies, according to type of High Schools.*

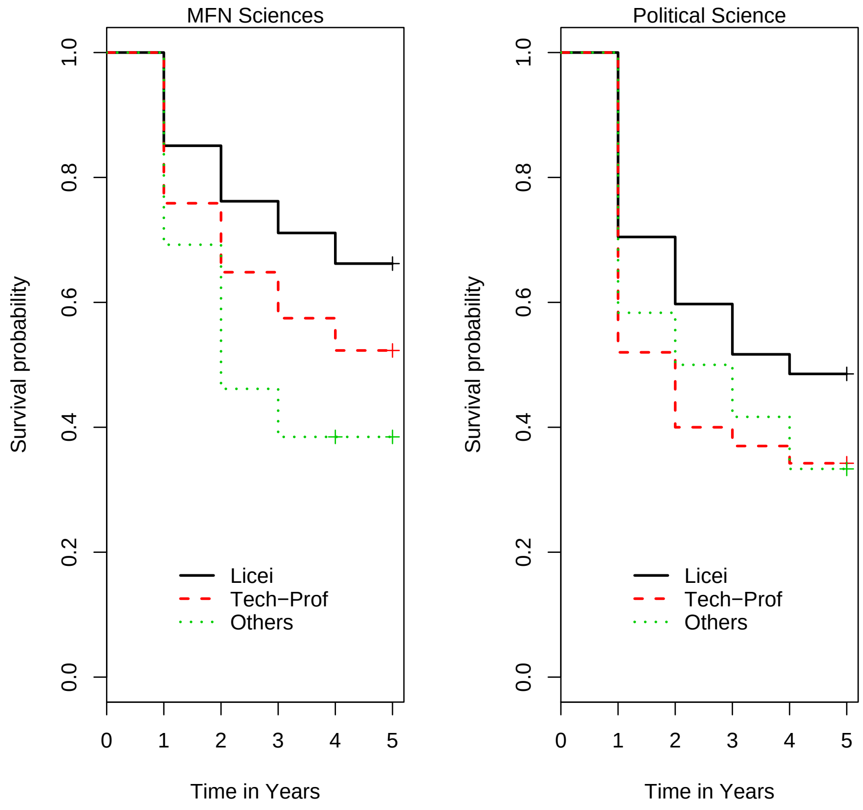

Figure 5.14: *Survival functions of students in MFN Sciences and Political Science, according to type of High Schools.*

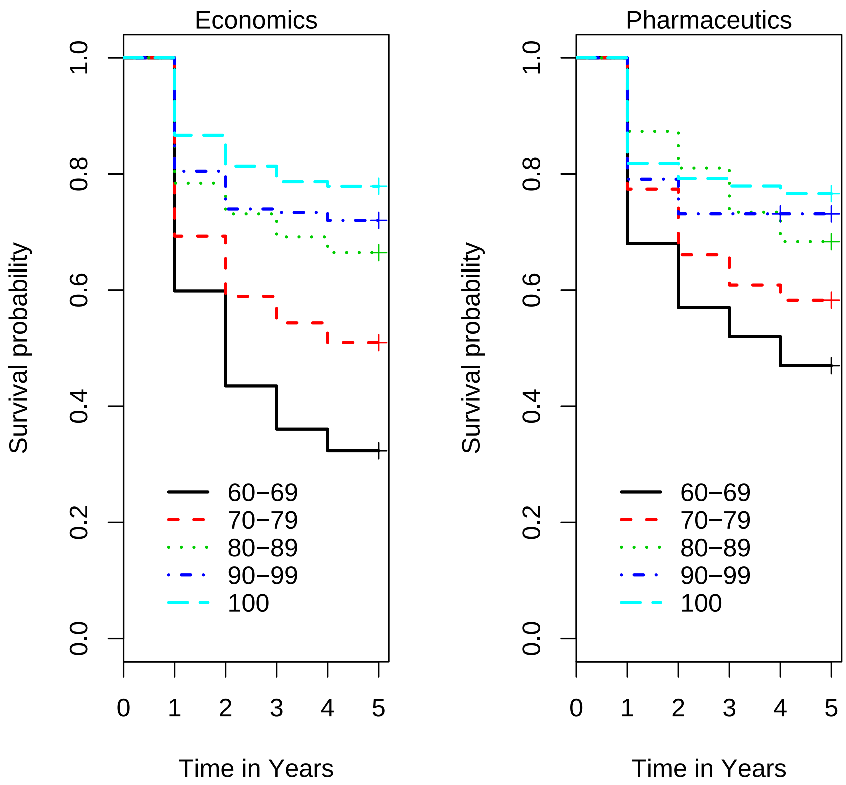

Figure 5.15: *Survival functions of students in Economics and Pharmaceutics, according to mark got at the end of High School time.*

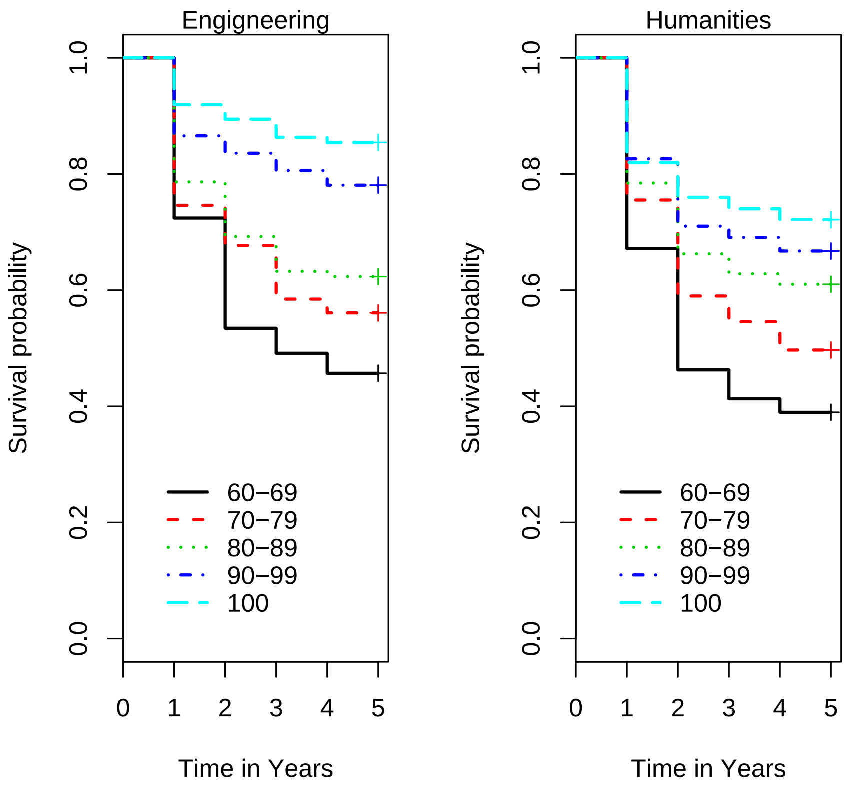

Figure 5.16: *Survival functions of students in Engineering and Humanities, according to mark got at the end of High School time.*

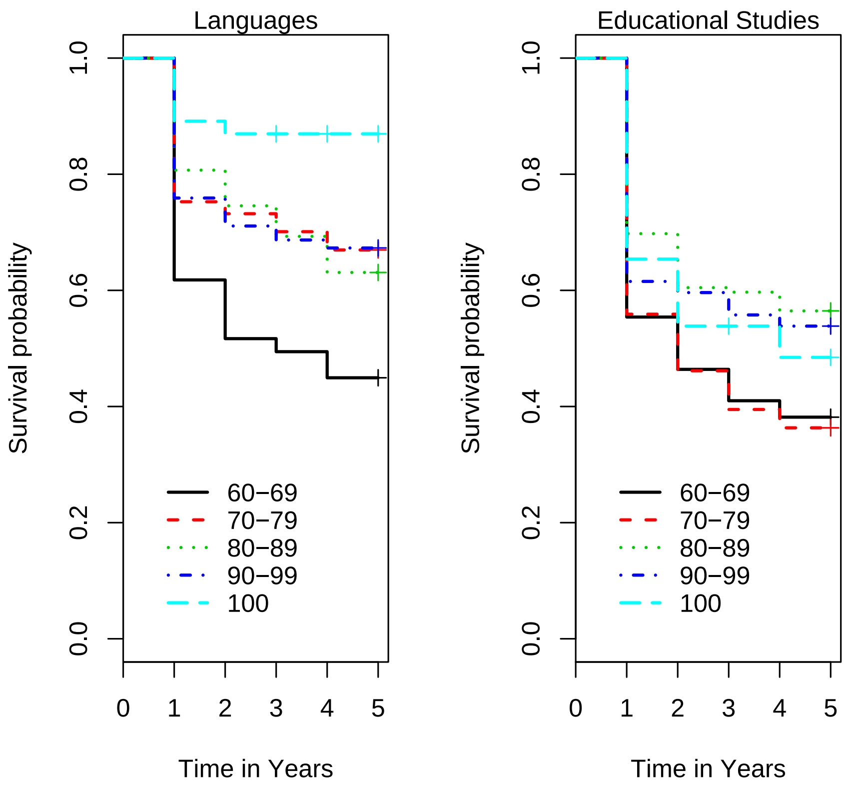

Figure 5.17: *Survival functions of students in Languages and Educational Studies, according to mark got at the end of High School time.*

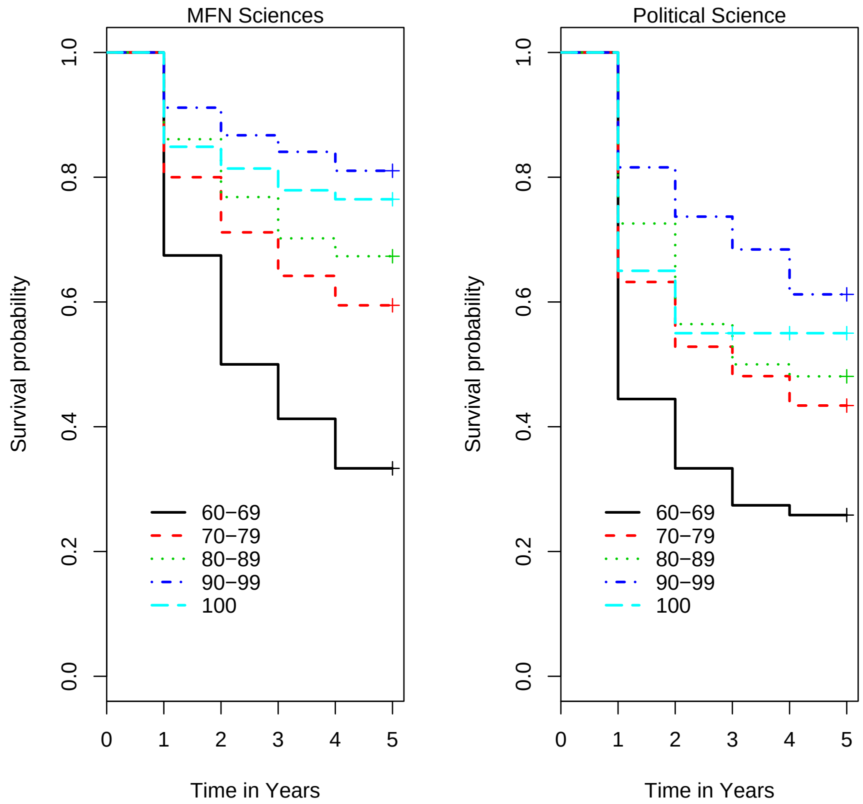

Figure 5.18: *Survival functions of students in MFN Sciences and Political Science, according to mark got at the end of High School time.*

To be sure that there is a significant difference among the survival curves, as emerged in the previous Figures, the equality of the survivor functions is tested by the Log-rank test, where the null hypothesis is that the survival curves are equal. The Table (5.1) shows the values of p-value for each log-rank tests, by to Gender, Age at the time of the enrolment, Type of High School, and the high school final grades. It can be noted how the null hypothesis is always rejected, choosing a significance level equal to 0.05. Thus, it is confirmed that there is a significant difference in survival curves, between Males and Females, according to the Age of student at the moment of entry at the Univeristy, the Type of High School attended by the students, and the final mark received at the high school.

Faculty	Gender	Age	High School	High School Mark
Economics	<0.001	0	<0.001	0
Pharmaceutics	0.048	<0.001	<0.001	<0.001
Engineering	0.004	0	<0.001	<0.001
Humanities	0.002	0	<0.001	<0.001
Languages	<0.001	<0.001	<0.001	<0.001
Educational Science	<0.001	<0.001	<0.001	<0.001
MFN Sciences	<0.001	0	<0.001	0
Political Science	<0.001	<0.001	<0.001	<0.001
Total	<0.001	0	0	0

Table 5.1: *P-values of Log-rank tests for testing the difference in survival curves according to some covariates.*

A limitation of using the log-rank test is that it does not allow more than one explanatory variable to be taken into account. In fact, it may be interesting to analyse the interrelations between the covariates, and explored the influence of covariates on failure times. Studying the effect of a primary covariate, while adjusting for other variables, allow to select efficiently a subset of significant variables, upon which the hazard function depends. For this purpose, a Cox Proportional Hazards model is used.

To select the most significant covariates, the likelihood ratio test is used to test two nested models.

The most significant variables for the Cox PH model, for each Faculty and when the data are anlysed entirely are shown in Table (5.2)-(5.10). A positive estimated coefficient indicates an increased hazard and hence a shorter expected survival time. Consequently, a negative estimated coefficient denotes a decreased hazard, and therefore a greater expected survival time. It is confirmed that there is a significant difference of the survival curves among Faculties, between males and Females, according to the Age at the time of the enrolment, the type and mark of high school, according to the family level income and the average mark of exams taken at the University.

The difference between males and females is validated for Pharmaceutics, Engineering, Humanities, MFN Sciences, and Political Science. In particular the estimated coefficient is positive and it means that male students have an increased hazard and therefore a shorter expected survival time than females. In other words, males students may leave the university more quickly than females.

The age at the moment of the enrolment is significant for all faculties, and it has a positive coefficients. Therefore, the probability that the older students do not complete their study is higher than that of female group. Looking at the high school final grades and the mark of exams, it can be noted how the student with higher marks, have a decreased hazard and hence a longer expected survival time than those with lower marks. Thus, their chance to take the degree is higher than that of other group.

Fixing the other covariates, the hazard ratio between males and females is equal to 1.37. This means that, with other covariates fixed, males students are 1.37 time more likely than females students to have shorter survival rate. Now a male student in Political Science is 1.33 time more likely than a male student in Economics to have shorter survival rate. Then a older male student is 5.90 time more likely than a youger male student to have shorter survival rate.

	coef	se(coef)	se2	Chisq	p
Facolty	0.0412	1.042	0.0117	3.52	<0.001
Gender	0.3170	1.373	0.1287	2.46	0.014
Age	0.5915	1.807	0.0976	6.06	<0.001
High School Mark	-0.2048	0.815	0.0270	-7.58	<0.001
Income	0.0971	1.102	0.0163	5.97	<0.001
Mark of Exams	-0.2168	0.805	0.0329	-6.60	<0.001
High School	-0.0547	0.947	0.0144	-3.79	<0.001
Gender:Age	-0.1475	0.863	0.0612	-2.41	0.016

Table 5.2: *Cox Proportional Hazards Model, considering the data entirely.*

	coef	se(coef)	se2	Chisq	p
Age	0.509	1.66	0.0807	6.31	<0.001
High School Mark	-0.174	0.84	0.0718	-2.42	0.015
Income	0.132	1.14	0.0405	3.26	<0.001
Mark of Exams	-0.635	0.53	0.1259	-5.05	<0.001

Table 5.3: *Cox Proportional Hazards Model, for Economics.*

	coef	se(coef)	se2	Chisq	p
Gender	1.477	4.378	0.5381	2.74	<0.001
Age	1.572	4.818	0.3746	4.20	<0.001
High School Mark	-0.299	0.742	0.1044	-2.86	<0.001
Income	0.105	1.110	0.0607	1.72	0.081
Mark of Exams	-0.286	0.751	0.1332	-2.15	0.032
Gender:Age	-0.889	0.411	0.2851	-3.12	<0.001

Table 5.4: *Cox Proportional Hazards Model, for Pharmaceutics.*

	coef	se(coef)	se2	Chisq	p
Gender	0.7711	2.162	0.5460	1.41	0.016
Age	1.8336	6.257	0.5627	3.26	<0.001
Income	0.0918	1.096	0.0462	1.99	0.047
Mark of Exams	-0.9499	0.387	0.1257	-7.55	<0.001
Gender:Age	-0.6414	0.527	0.2993	-2.14	0.032

Table 5.5: *Cox Proportional Hazards Model, for Engineering.*

	coef	se(coef)	se2	Chisq	p
Gender	0.3108	1.365	0.1420	2.19	0.029
Age	0.3604	1.434	0.0705	5.11	<0.001
High School Mark	-0.1677	0.846	0.0594	-2.82	<0.001
Income	0.0791	1.082	0.0352	2.25	0.025
Mark of Exams	-0.1704	0.843	0.0686	-2.49	0.013

Table 5.6: *Cox Proportional Hazards Model, for Humanities.*

	coef	se(coef)	se2	Chisq	p
Age	0.315	1.370	0.1469	2.144	0.032
High School Mark	0.025	1.025	0.1117	0.224	0.042
Income	0.207	1.230	0.0609	3.402	<0.001
Mark of Exams	-0.935	0.393	0.1666	-5.612	<0.001

Table 5.7: *Cox Proportional Hazards Model, for Languages.*

	coef	se(coef)	se2	Chisq	p
Age	0.308	1.360	0.0824	3.73	<0.001
Income	0.108	1.114	0.0486	2.23	0.026
Mark of Exams	-0.486	0.615	0.1092	-4.45	<0.001

Table 5.8: *Cox Proportional Hazards Model, for Educational Studies.*

	coef	se(coef)	se2	Chisq	p
Gender	-0.9720	0.378	0.6601	-1.47	0.042
Age	0.3412	1.407	0.0826	4.13	<0.001
Mark of High school	0.4170	1.517	0.2944	1.42	0.016
Income	0.0734	1.076	0.0404	1.82	0.029
Mark of Exams	-1.9933	0.136	0.4883	-4.08	<0.001
High School	-0.1030	0.902	0.0344	-3.00	<0.001
Gender:High School Mark	-0.3966	0.673	0.1617	-2.45	0.014
Gender:Mark of Exams	0.9510	2.588	0.2602	3.66	<0.001

Table 5.9: *Cox Proportional Hazards Model, for MFN Sciences.*

	coef	se(coef)	se2	Chisq	p
Gender	1.057	2.878	0.5075	2.08	0.0370
Age	0.961	2.615	0.3219	2.99	0.0028
Income	0.135	1.144	0.0592	2.28	0.0230
Mark of Exams	-0.454	0.635	0.1469	-3.09	0.0020
Gender:Age	-0.426	0.653	0.1931	-2.21	0.0270

Table 5.10: *Cox Proportional Hazards Model, for Political Science.*

Two important issues in Cox PH model are related to testing the proportional hazard assumption, i.e. if the proportional hazard assumption holds on, and to verifying the influence of some observations on estimating the model. The p-values of test for verifying the existence of the proportional hazard assumption are shown in Table (5.11)-(5.13). It can be noted how in some models, mark of exams and family income level seems to be not proportional. In other words, for these two covariates, the proportional hypothesis does not hold on. This might depend on the presence of linear trend in the hazards. In other words, some covariates could be time-varying, and it is important to check if they change over time. In these models, this control cannot be made, since the factors are not continuous.

	Full Data	Economics	Pharmaceutics
Faculty	0.48		
Gender	0.15		0.20
Age	0.07	0.18	0.21
High School Mark	0.65	0.45	0.64
Income	<0.05	<0.05	0.96
Mark of Exams	<0.05	<0.05	
High School	0.23		
Gender:Age	0.05		0.30

Table 5.11: *P-values of the test on proportional hazard assumption, for model with all data, for Economics, Pharmaceutics.*

Another issue in Cox PH model is related to the influence of single observation on estimating the models. Therefore if a particular subject affects the estimated coefficients, it would be eliminated from the data, and the model should be estimated again. To evaluate the influence of individuals on the estimated β coefficients, the *dfbetas* values are used. In particular, *dfbetas* is approximately the change in the coefficients scaled by their standard error. Comparing the magnitudes of the largest dfbeta values to the estimated coefficients, there are no subject's influence on the estimated coefficient.

	Engineering	Humanities	Languages
Gender	0.58	0.62	
Age	0.93	0.16	0.14
High School Mark		0.43	0.81
Income	0.71	<0.01	0.08
Mark of Exams	0.31	0.06	<0.05
High School			
Gender:Age	0.66		

Table 5.12: *P-values of the test on proportional hazard assumption, for Engineering, Humanities, Languages.*

	Educational Studies	MFN Sciences	Political Science
Gender		0.92	0.46
Age	0.21	0.13	0.57
High School Mark		0.37	
Income	0.59	0.11	0.99
Mark of Exams	0.81	0.60	0.09
High School		0.44	
Gender:Age			0.89
Gender:Mark of High School		0.67	
Gender:Mark of Exams		0.77	

Table 5.13: *P-values of the test on proportional hazard assumption, for Educational Studies, MFN Sciences and Political Science.*

6 Concluding remarks

The aim of this paper was to analyse and model the interval of time between the first enrolment at University and the first occurrence of non-enrolment, so that the event of interest is the dropping out of University. The data consists of the full-time students enrolled at the University of Salerno at the 2002-2003 academic year, and they are analysed by Survival Analysis models.

This study has shown that there is a steep decline for the students in Political Science and in Educational Studies, at the first year. Moreover, male students have lower survival rates than female students, i.e. they leave the University earlier than female group. Moreover, students who enrol at the University immediately after completing their high school study, have greater probability of taking the degree than those who decide to study at the University after having completed the high school study by many years. Students who attended "Licei" have the highest probability of surviving at the University, i.e. the highest rate of taking the degree. Students who complete their high school study with the highest mark (i.e. 110), have the highest probability of completing their study. In all these cases, it can be noted that there is a Faculty effect. These differences are confirmed by Log-rank test and Cox Proportional Hazards Model.

The study confirms most of the substantive findings of earlier research illustrated in Section 2, where it has been underlined how gender and age influence the probability of completing the study, how income and precollege qualification affect the decision of dropping out of the University.

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