From high school to second level degree: a multi-state model to analyse the southern University mobility in Italy

La mobilitá universitaria dal Sud al Nord in Italia

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Outline

- Introduction
- The data
- Methodological approach
- Application to two Italian students' cohorts
- Results
- Conclusions

Research Group

- MIUR
- University of Palermo
- University of Cagliari
- University of Siena
- University of Turin

University enrolments in Italy in the last years

Since year 2008 till 2012, there has been an overall decrease in the university enrolments, with an average loss of about 4300 Bachelor (BA) freshmen per year.

After, the enrolments increased: in 2012 at the North, in 2013 at the Center, and in 2014 at the South and Islands.

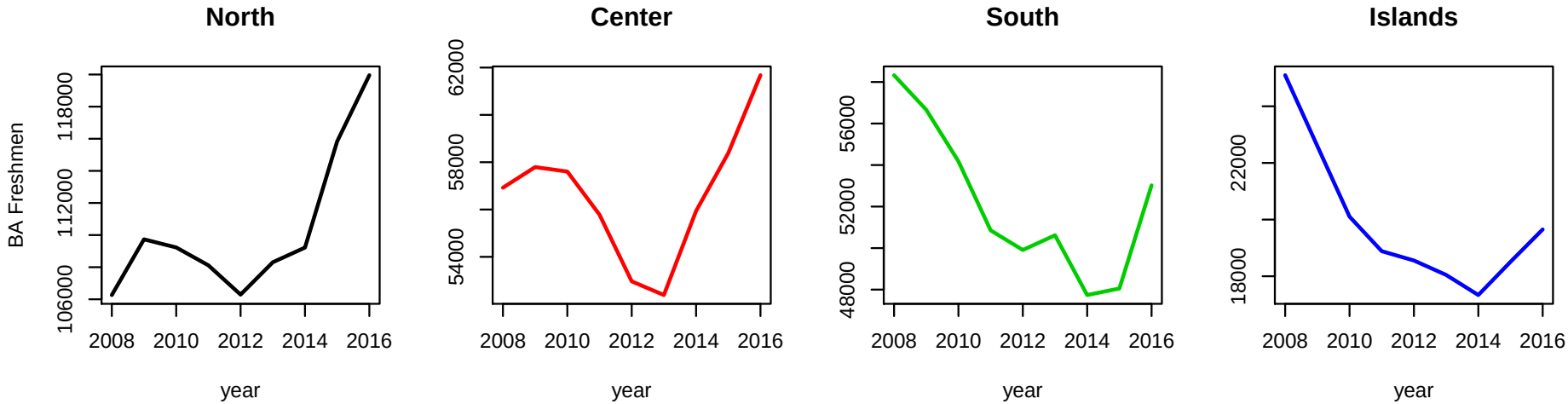

Figure 1: Time series of the Italian freshmen by macro-region.

At the same time there has been an increase in the students' mobility (SM) from South and Islands toward the Center-North

Data & Aims

The transition from high school to the second level university degree courses in terms of macro-regional mobility.

The Data

- were provided by the Italian Ministry of Education, University and Research.
- are a national level longitudinal administrative micro-data on educational careers
- two Italian freshmen cohorts enrolled at an Italian 3-year degree course in 2008/09 and 2011/12
- 242076 and 227870 3-year freshmen, respectively, with around 200 variables
- the follow up is 7 and 5 years, respectively

Aim

- to describe the spatio-temporal mobility paths in terms of students' flows
- to provide "mover" or "stayer" students' profiles at BA and MA levels
- to compare the baseline profiles for the two cohorts

The student's challenge: the 2008 cohort

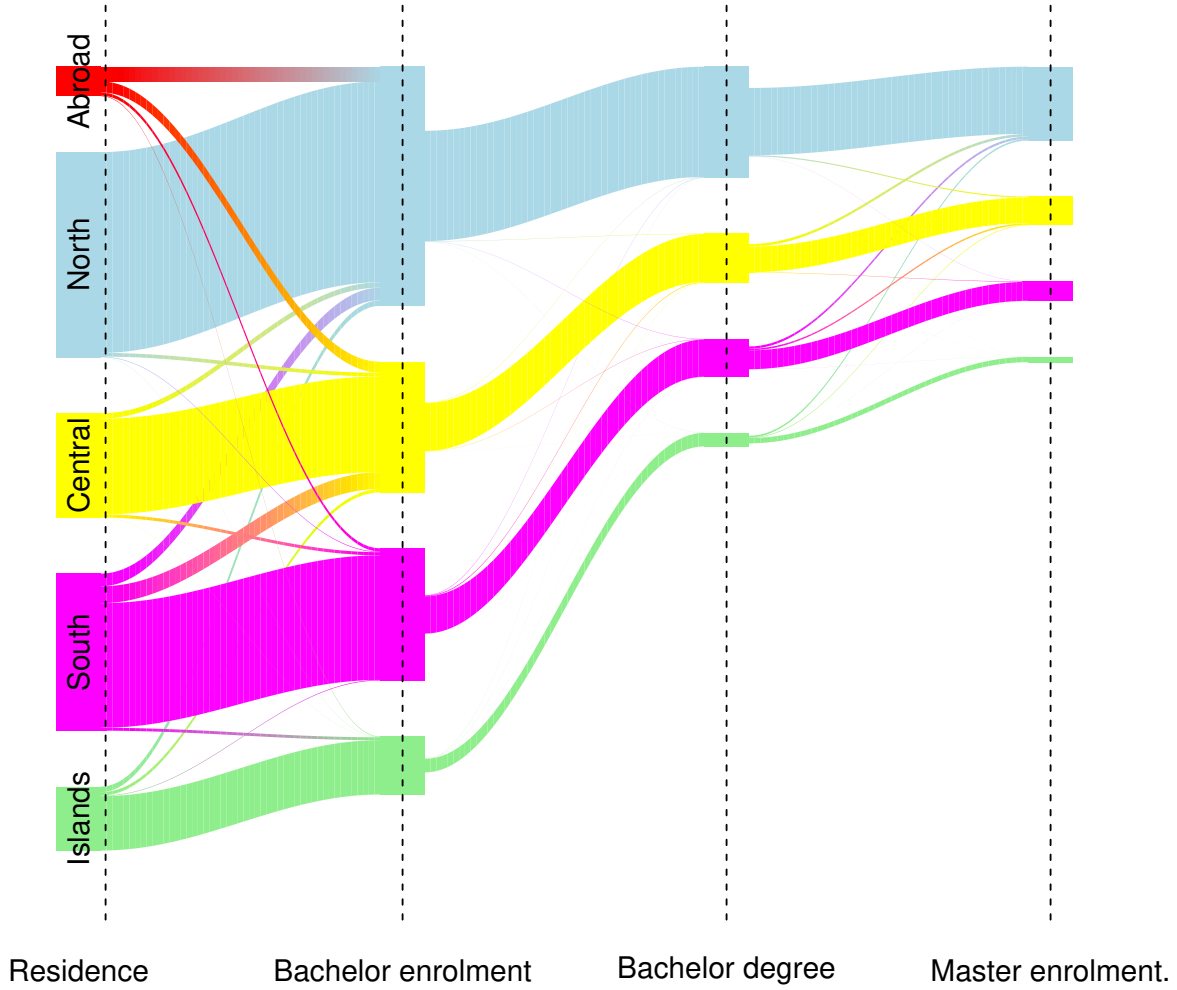

Figure 2: Sankey diagram of Italian university students' careers in terms of macro-regional mobility for the cohort 2008/09.

The student's challenge: the 2011 cohort

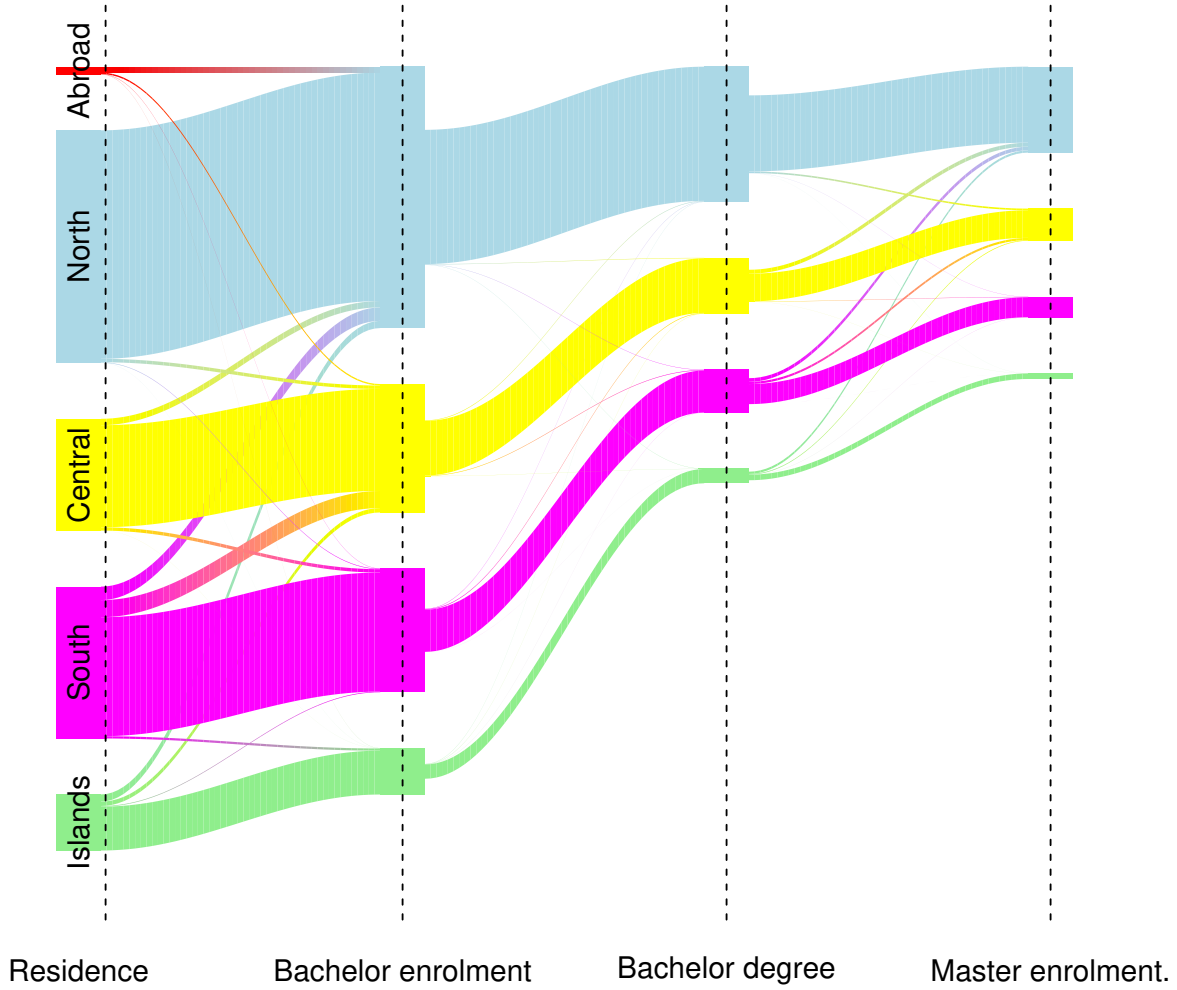

Figure 3: Sankey diagram of Italian university students' careers in terms of macro-regional mobility for the cohort 2011/12.

Table 1: The 2008 and 2011 students' cohorts' "multiple challenges" to enroll at the master degree course passing through the bachelor enrolment and degree. Percentages are calculated with respect the number of residents.

Cohort	Path	Residents	BA enrolments	BA degrees	MA enrolments
2008	Always NORTH	88711	86821	43174	25070
	%		*97,9*	*48,7*	*28,3*
	Other paths		1890	64	303
	%		*2,1*	*0,1*	*0,3*
	Always CENTER	45126	41411	15580	8122
	%		*91,8*	*34,5*	*18,0*
	Other paths		3715	84	821
	%		*8,2*	*0,2*	*1,8*
	Always SOUTH	67902	53888	15469	7822
	%		*79,4*	*22,8*	*11,5*
	Other paths		14014	388	1592
	%		*20,6*	*0,6*	*2,3*
	Always ISLANDS	27598	23503	5476	2114
	%		*85,2*	*19,8*	*7,7*
	Other paths		4095	140	911
	%		*14,8*	*0,5*	*3,3*
2011	Always NORTH	94618	92989	49750	26834
	%		*98,3*	*52,6*	*28,4*
	Other paths		1629	62	419
	%		*1,7*	*0,1*	*0,4*
	Always CENTER	45513	41536	17629	8980
	%		*91,3*	*38,7*	*19,7*
	Other paths		3977	150	1213
	%		*8,7*	*0,3*	*2,7*
	Always SOUTH	61789	48245	16616	7886
	%		*78,1*	*26,9*	*12,8*
	Other paths		13544	314	2272
	%		*21,9*	*0,5*	*3,7*
	Always ISLANDS	22820	17850	5626	2128
	%		*78,0*	*24,7*	*9,3*
	Other paths		5015	159	1122
	%		*22,0*	*0,7*	*4,9*

BA enrolment by residence

Table 2: Percentage rates of bachelor enrolments by residence macro-region and University macro-region, for the cohorts 2008 and 2011 (% row)

Cohort	Residence at	Bachelor enrolment at North %	Center %	South %	Islands %	Total %
2008	Abroad	50,09	37,07	11,11	1,73	100
	North	97,87	1,78	0,27	0,08	100
	Center	5,15	91,77	2,98	0,10	100
	South	8,06	10,75	79,36	1,83	100
	Islands	8,67	5,26	0,91	85,16	100
	Total	**42,71**	**23,32**	**23,60**	**10,36**	**100**
2011	Abroad	76,58	18,98	2,91	1,53	100
	North	98,28	1,47	0,23	0,02	100
	Center	5,70	91,26	3,00	0,04	100
	South	8,87	11,26	78,41	1,45	100
	Islands	12,83	7,81	1,14	78,22	100
	Total	**46,69**	**22,93**	**22,11**	**8,27**	**100**

BA graduation within 5 years

Table 3: Percentage rates of BA graduation by macro-region of residence (by row) and of graduation for the cohorts 2008/09 and 2011/12

Cohort		North	Centre	South	Islands	Total
2008/09	**Abroad**	32.1	29.1	21.5	15.4	**29.5**
	North	49.8	43.2	24.2	21.1	**49.6**
	Centre	51.3	37.8	24.4	19.6	**38.1**
	South	48.7	42.6	29.0	27.1	**32.0**
	Islands	46.6	42.6	25.0	23.5	**26.5**
	Total	**48.6**	**38.0**	**28.7**	**23.6**	**38.8**
2011/12	**Abroad**	32.0	24.6	18.7	33.3	**30.2**
	North	53.6	46.8	31.0	43.5	**53.4**
	Centre	66.2	42.7	32.9	44.4	**43.7**
	South	56.2	49.4	34.9	30.8	**38.3**
	Islands	54.5	46.1	53.5	32.1	**36.3**
	Total	**53.5**	**43.6**	**34.9**	**32.1**	**45.4**

- Movers' BA rates are higher than the Northern stayers
- Moving from South and Islands is very convenient

MA enrolment within 6 years

Table 4: Percentage rates of master degree enrolments, by BA macro-region and MA enrolment macro-region, for the cohorts 2008/09 and 2011/12

Cohort	Bachelor at	Master enrolment at North %	Centre %	South %	Islands %	Total enrolled %	Not enrolled %	Total BAs %
2008	North	57,9	1,0	0,1	0,0	**59,0**	**41,0**	**100**
	Centre	5,3	51,6	0,7	0,1	**57,7**	**42,3**	**100**
	South	6,1	4,1	50,0	0,1	**60,3**	**39,7**	**100**
	Islands	12,3	4,2	0,3	38,5	**55,3**	**44,7**	**100**
	Total	33,9	13,3	9,0	2,5	**58,7**	**41,3**	**100**
2011	North	54,3	1,2	0,1	0,0	**55,6**	**44,4**	**100**
	Centre	7,1	49,4	0,5	0,1	**57,2**	**42,8**	**100**
	South	8,5	5,1	46,5	0,0	**60,1**	**39,9**	**100**
	Islands	15,2	4,6	0,5	37,5	**57,8**	**42,2**	**100**
	Total	**33,8**	**12,7**	**8,1**	**2,2**	**56,8**	**43,2**	**100**

The highest continuation rate to the MASTER is in the South

MA enrolment within 6 years by region

Table 5: Origin-destination regions for MA enrolments. Cohort 2011/12.

	Abr	Bas	Cal	Cam	Emi	Fri	Laz	Lig	Lom	Mar	Pie	Pug	Sar	Sic	Tos	Tre	Umb	Ven	Total	permanence rate	migration rate
Abruzzo	1280			27	122	2	131	4	63	53	46	17			43	5	9	51	**1853**	**0,691**	**0,309**
basilicata	5	88		16	16		7		11	2	14	5			4		1	2	**171**	**0,515**	**0,485**
Calabria	5		727	6	49	2	42	1	55	1	44	3		3	45	2	5	5	**995**	**0,731**	**0,269**
Campania	17		3	4376	141	11	321	6	195	18	117	5	1	11	70	19	1	50	**5362**	**0,816**	**0,184**
Emilia	7			12	4881	26	99	15	352	47	176	10	2	4	116	46	7	244	**6044**	**0,808**	**0,192**
Friuli				1	57	901	15	1	65	4	37	1			18	16	1	148	**1265**	**0,712**	**0,288**
Lazio	16		1	44	158	5	5991	6	197	15	104	7	2	5	59	16	14	52	**6692**	**0,895**	**0,105**
Liguria				1	36	7	14	944	109	2	79			3	30	7		15	**1247**	**0,757**	**0,243**
Lombardia	4		1	7	212	25	134	35	12144	10	180	10	3	1	64	48	2	190	**13070**	**0,929**	**0,071**
Marche	152	1		2	176	9	43	4	59	1111	61	10	1	2	51	17	5	57	**1761**	**0,631**	**0,369**
Piemonte	2				54	10	16	22	144	1	4153	1	2		11	6	2	24	**4448**	**0,934**	**0,066**
Puglia	33	3	1	13	169	18	92	2	143	37	133	1811			55	9	4	51	**2574**	**0,704**	**0,296**
Sardegna	1			1	63	1	22	8	41	6	52	1	536	1	31			25	**789**	**0,679**	**0,321**
Sicilia	4		14	10	226	21	102	3	222	13	215		2	1743	86	14	12	49	**2736**	**0,637**	**0,363**
Toscana	1			6	178	8	67	5	139	7	79	1	2	1	2752	10	12	54	**3322**	**0,828**	**0,172**
Trentino					64	9	7		73	1	17				14	619		113	**917**	**0,675**	**0,325**
Umbria	21			4	94	9	46		50	12	29	1		3	51	8	644	20	**992**	**0,649**	**0,351**
Veneto			1	4	221	59	46	1	185	6	80	1	1	1	40	51	1	4392	**5090**	**0,863**	**0,137**
Total	**1548**	**92**	**748**	**4530**	**6917**	**1123**	**7195**	**1059**	**14247**	**1348**	**5616**	**1884**	**552**	**1778**	**3540**	**893**	**726**	**5542**	**59338**		
attractiveness: rate	**0,173**	**0,043**	**0,028**	**0,034**	**0,294**	**0,198**	**0,167**	**0,109**	**0,148**	**0,176**	**0,261**	**0,039**	**0,029**	**0,020**	**0,223**	**0,307**	**0,113**	**0,208**			

- Trentino has the highest attractiveness rate (30,7%), Sicily has the lowest one (2%),
- Basilicata has the highest migration rate (48,5%), Piemonte has the lowest one (6,6%)

The model

Assumption: The entire process from High School (HS) to the MA enrolment since is in discrete time (t is the Academic Year)

After four years since enrolment the student can be either BA graduated or not, and if graduated, he/she can enroll at the MA.

We apply a discrete-time multi-state model.

Actually, we split it into two separate models, one for the BA graduation and the other one for the MA enrolment.

Further model assumptions/simplifications

- a multi-state model is estimated for each cohort
- students complete their BA in the university of first enrolment
- less observed macro-regional mobility paths are collapsed
- South and Islands (SI) are also collapsed for the MA enrolment
- No model selection is done, and covariates are chosen from the literature

The model

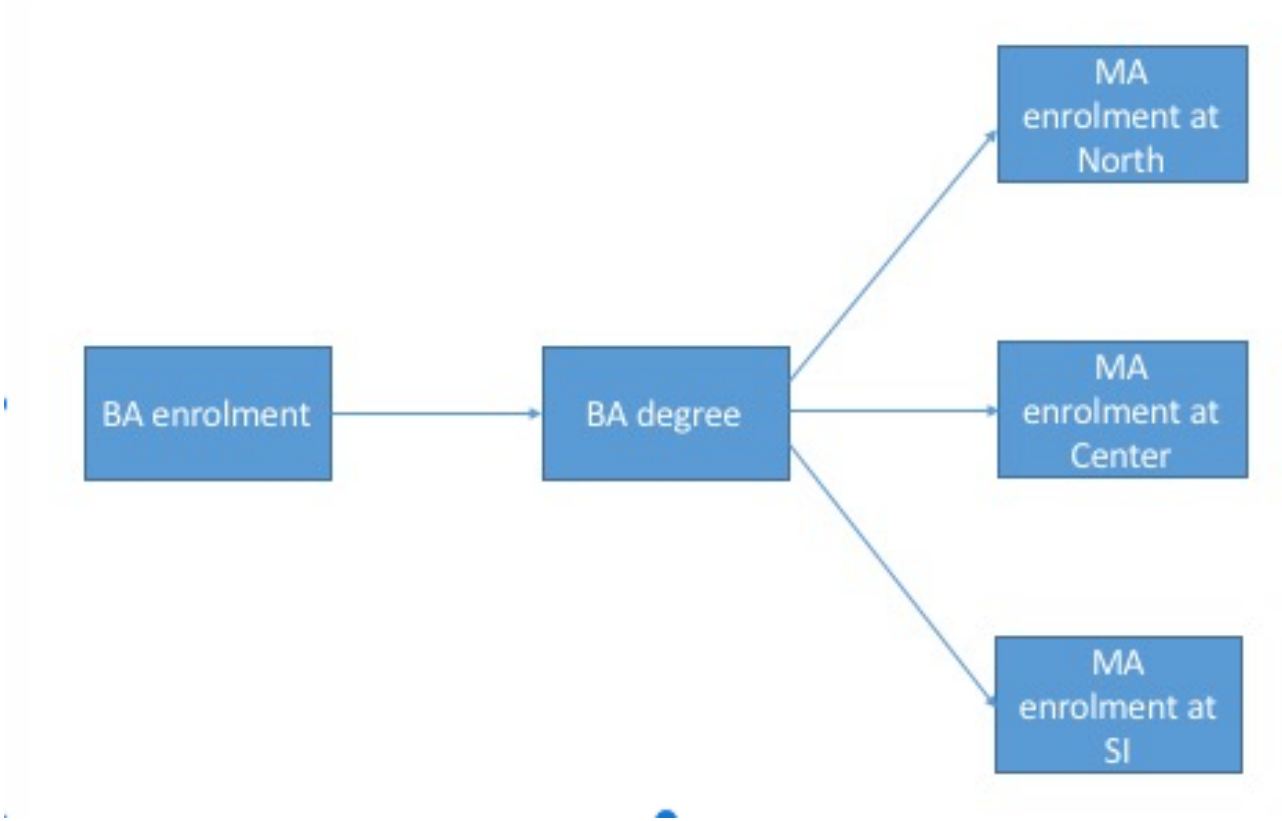

Figure 4: The multi-state model.

Model for the BA graduation

The model for the BA graduation is a discrete-time logistic regression model.

By indicating with $p(t|z)$ the probability of BA graduation at time t, conditioned to a covariate vector z, the model is

$$\log\left(\frac{p(t|Z)}{1-p(t|Z)}\right) = \alpha(t=3) + \gamma(t>3) + \beta' Z, \tag{1}$$

where

- Z is the covariate design matrix
- $\alpha(t=3)$ and $\gamma(t>3)$ are time-dependent intercepts with cutpoint equal to 3
- $\beta' Z$ is the linear predictor

Model for the MA enrolment

The model for the MA graduation is a discrete-time partially proportional odds multinomial model.

$$\log\left(\frac{p^{(j)}(t|X;Z)}{p^{(0)}(t|X;Z)}\right) = \alpha^{(j)}(t=4) + \gamma^{(j)}(t>4) + \delta^{(j)\prime}X^{(j)} + \beta' Z, \tag{2}$$

where

- $j = 1, 2, 3$, corresponding to North, Center and SI, respectively
- X and Z are covariate design matrices
- $p^{(0)}(t|X;Z)$ is the probability for the reference category, that is the probability of discontinuing university after BA at time t
- $p^{(j)}(t|X;Z)$ is the probability of MA enrolment in the j-th macro-region at time t
- $\alpha^{(j)}(t=4)$ and $\gamma^{(j)}(t>4)$ are the time-dependent non proportional-odds (NPO) intercepts with cutpoint equal to 4
- $\delta^{(j)\prime}X^{(j)}$ is the NPO linear predictor for the j-th multinomial equation
- $\beta' Z$ is the proportional-odds linear predictor.

Table 6: Description of the covariates used in the model for the BA graduation.

Variable	type	Description
BA_eTime	discrete	Time (in years) since BA enrolment
I(BA_eTime >3)	binary	1= Time since BA enrolment >3 years
Path1L	categorical	Macro-Regional (MR) Path to BA enrolment: <MR before BA enrolment> - <MR of BA enrolment>
Area1L	categorical	Area of Study at BA: Heath, Scientific, Social, Humanistic
Birth_Year	discrete	Student's year of birth
I(Birth_Year >= 1989)	binary	1= Student's year of birth >= 1989 (used for the 2008 cohort)
I(Birth_Year >= 1992)	binary	1= Student's year of birth >= 1992 (used for the 2011 cohort)
Gender_M	binary	1= male gender
HS	categorical	High School type: Classical, Scientific, Technical, Vocational, Other
HS_Grade	discrete	High School final grade ranging in 60-100
I(HS_Grade - 80)	discrete	High School final grade centered at grade 80

Table 7: Description of the covariates used in the model for the MA enrolment

Variable	type	Description
BA_Time	discrete	Time (in years) to get a Bachelor degree
I(BA_Time >3)	binary	1= Time to get a Bachelor degree >3 years
MA_eTime	discrete	Time (in years) to MA enrollment after BA
I(MA_eTime >4)	binary	1= Time to MA enrollment after BA >4 years
Path2L	categorical	Macro-Regional (MR) Path to BA degree: <MR before BA enrolment> - <MR of BA degree>
Area1L	categorical	Area of Study at BA: Heath, Scientific, Social, Humanistic
Birth_Year	discrete	Student's year of birth
I(Birth_Year >= 1989)	binary	1= Student's year of birth >= 1989 (used for the 2008 cohort)
I(Birth_Year >= 1992)	binary	1= Student's year of birth >= 1992 (used for the 2011 cohort)
Gender_M	binary	1= male gender
HS	categorical	High School type: Classical, Scientific, Technical, Vocational, Other
HS_Grade	discrete	High School final grade ranging in 60-100
I(HS_Grade - 80)	discrete	High School final grade centered at grade 80

Model for the BA graduation

Table 8: Estimates comparison from two logistic models for the BA graduation, from the 2008 and 2011 cohorts.

	2008 Cohort Estimate	2011 Cohort Estimate	Difference
(Intercept)	-0.667 ***	-0.741 ***	-0.074
I(BA_eTime > 3)TRUE	-0.019 **	0.003	0.022
Path1L_Center-Center	-0.331 ***	-0.589 ***	-0.258
Path1L_Center-Islands	-0.369	-0.749	-0.380
Path1L_Center-North	-0.039	0.138 ***	0.177
Path1L_Center-South	-0.693 ***	-0.699 ***	-0.006
Path1L_Islands-Center	-0.474 ***	-0.773 ***	-0.299
Path1L_Islands-Islands	-0.869 ***	-1.162 ***	-0.293
Path1L_Islands-North	-0.379 ***	-0.435 ***	-0.056
Path1L_Islands-South	-0.955 ***	-0.196	0.759
Path1L_North-Center	-0.081 .	-0.415 ***	-0.334
Path1L_North-Islands	-0.425 .	-0.559	-0.134
Path1L_North-South	-0.407 **	-0.486 ***	-0.079
Path1L_South-Center	-0.431 ***	-0.616 ***	-0.185
Path1L_South-Islands	-1.015 ***	-1.492 ***	-0.477
Path1L_South-North	-0.359 ***	-0.386 ***	-0.027
Path1L_South-South	-0.755 ***	-1.021 ***	-0.266
Area1L_Health	0.144 ***	0.820 ***	0.676
Area1L_Scientific	-0.296 ***	-0.714 ***	-0.418
Area1L_Humanistic	-0.062 ***	-0.145 ***	-0.083
I(Birth_Year >= 1989)TRUE	0.252 ***	0.549 ***	0.297
Gender_M	-0.174 ***	-0.12 0 ***	0.054
HS_Classical	0.123 ***	0.343 ***	0.220
HS_Scientific	0.203 ***	0.416 ***	0.213
HS_Vocational	-0.290 ***	-0.669 ***	-0.379
HS_Technical	-0.129 ***	-0.306 ***	-0.177
I(HS_Grade - 80)	0.030 ***	0.048 ***	0.018

Baseline: BA_eTime = 3, Path1L_North-North, Area1L_Social, Birth_Year < 1989, Gender_F, HS_Other, HS_Grade=80.

Model for the MA enrolment

	North			Center			South+Islands		
	2008 Estimate	2011 Estimate	Difference	2008 Estimate	2011 Estimate	Difference	2008 Estimate	2011 Estimate	Difference
(Intercept)	-1.287 ***	-0.266 ***	1.021	-5.491 ***	-4.398 ***	1.093	-8.577 ***	-7.884 ***	0.693
I(MA_eTime > 4)TRUE	-0.982 ***	-0.647 ***	0.335	-0.788 ***	-0.5 ***	0.288	-0.634 ***	-0.463 ***	0.171
Path2L_North-Center	-1.288 ***	-1.394 ***	-0.106	3.499 ***	3.51 ***	0.011	1.175	3.039 ***	1.864
Path2L_Center-Center	-2.202 ***	-1.763 ***	0.439	4.054 ***	4.297 ***	0.243	2.178 ***	2.778 ***	0.6
Path2L_Center-North	-0.229 ***	-0.203 ***	0.026	2.081 ***	1.854 ***	-0.227	-10.626	1.85 ***	12.476
Path2L_Center-South	-2.097 ***	-1.529 ***	0.568	2.207 ***	2.827 ***	0.62	7.092 ***	7.555 ***	0.463
Path2L_South-Center	-2.237 ***	-1.47 ***	0.767	3.879 ***	4.223 ***	0.344	4.768 ***	4.665 ***	-0.103
Path2L_South-North	0.159 ***	0.183 ***	0.024	1.541 ***	1.425 ***	-0.116	4.388 ***	3.956 ***	-0.432
Path2L_South-South	-2.07 ***	-1.505 ***	0.565	1.81 ***	2.063 ***	0.253	7.113 ***	7.723 ***	0.61
Path2L_Islands-Center	-1.793 ***	-1.51 ***	0.283	3.73 ***	3.969 ***	0.239	4.209 ***	4.275 ***	0.066
Path2L_Islands-Islands	-1.496 ***	-1.086 ***	0.41	1.639 ***	1.796 ***	0.157	6.855 ***	7.348 ***	0.493
Path2L_Islands-North	-0.037	0.108 *	0.145	1.054 ***	0.968 ***	-0.086	4.326 ***	3.967 ***	-0.359
Path2L_Other-Paths	-1.307 ***	-1.305 ***	0.002	2.001 ***	1.584 ***	-0.417	7.112 ***	7.114 ***	0.002
Area1L_Health	-1.776 ***	-3.232 ***	-1.456	-1.776 ***	-3.232 ***	-1.456	-1.776 ***	-3.232 ***	-1.456
Area1L_Scientific	0.012	0.377 ***	0.365	0.012	0.377 ***	0.365	0.012	0.377 ***	0.365
Area1L_Humanistic	0.118 ***	-0.297 ***	-0.415	0.118 ***	-0.297 ***	-0.415	0.118 ***	-0.297 ***	-0.415
I(Birth_Year >= 1989[a])TRUE	0.46 ***	0.542 ***	0.082	0.46 ***	0.542 ***	0.082	0.46 ***	0.542 ***	0.082
Gender_M	0.006	0.19 ***	0.184	0.006	0.19 ***	0.184	0.006	0.19 ***	0.184
HS_Classic	0.29 ***	0.649 ***	0.359	0.29 ***	0.649 ***	0.359	0.29 ***	0.649 ***	0.359
HS_Scientific	0.278 ***	0.548 ***	0.270	0.278 ***	0.548 ***	0.270	0.278 ***	0.548 ***	0.270
HS_Vocational	-0.363 ***	-0.385 ***	-0.022	-0.363 ***	-0.385 ***	-0.022	-0.363 ***	-0.385 ***	-0.022
HS_Technical	-0.144 ***	-0.062 ***	0.082	-0.144 ***	-0.062 ***	0.082	-0.144 ***	-0.062 ***	0.082
I(HS_Grade - 80)	0.011 ***	0.023 ***	0.012	0.011 ***	0.023 ***	0.012	0.011 ***	0.023 ***	0.012
I(BA_Time > 3)TRUE	-0.661 ***	-0.779 ***	-0.118	-0.661 ***	-0.779 ***	-0.118	-0.661 ***	-0.779 ***	-0.118

[a] >= 1992 for the 2011 cohort

Baseline: MA_eTime = 4, BA_eTime = 3, Path1L_North-North, Area1L_Social, Birth_Year < 1989, Gender_F, HS_Other, HS_Grade=80.

Estimated Probabilities from the BA graduation Model

Table 9: BA graduation probabilities at the third year, conditioned to the macro-regional path, from the estimated multinomial model. Cohorts 2008 and 2011

	P(BA|$t = 3$) Cohort 2008	P(BA|$t = 3$) Cohort 2011
North-Center	0.32	0.24
North-Islands	0.25	0.21
North-North	0.34	0.32
North-South	0.26	0.23
Center-Center	0.27	0.21
Center-Islands	0.26	0.18
Center-North	0.33	0.35
Center-South	0.20	0.19
South-Center	0.25	0.20
South-Islands	0.16	0.10
South-North	0.26	0.24
South-South	0.19	0.15
Islands-Center	0.24	0.18
Islands-Islands	0.18	0.13
Islands-North	0.26	0.24
Islands-South	0.16	0.28

Baseline: BA_eTime = 3, Path1L_North-North, Area1L_Social, Birth_Year < 1989, Gender_F, HS_Other, HS_Grade=80.

Estimated Probabilities from the MA enrolment Model

Table 10: MA enrolment probabilities, conditioned to the macro-regional path, from the estimated multinomial model. Cohorts 2008 and 2011

Cohort	*always stayers*	p (MA enr.)	*BA mover/MA stayer*	p (MA enr.)	*BA stayer/MA mover*	p (MA enr.)
2008	North-North-North	0.216	South-North-North	0.238	South-South-North	0.027
	Center-Center-Center	0.187	Islands-North-North	0.206	Islands-Islands-North	0.049
	South-South-SI	0.179	South-Center-Center	0.159	South-South-Center	0.020
	Islands-Islands-SI	0.142	Islands-Center-Center	0.140	Islands-Islands-Center	0.017
2011	North-North-North	0.431	South-North-North	0.462	South-South-North	0.080
	Center-Center-Center	0.443	Islands-North-North	0.448	Islands-Islands-North	0.135
	South-South-SI	0.402	South-Center-Center	0.408	South-South-Center	0.046
	Islands-Islands-SI	0.305	Islands-Center-Center	0.352	Islands-Islands-Center	0.039

Baseline: MA_eTime = 4, BA_eTime = 3, Path1L_North-North, Area1L_Social, Birth_Year < 1989, Gender_F, HS_Other, HS_Grade=80.

Conclusions

Multiple challenge from HS diploma to the MA degree enrolment

- The novelty of the paper is the analysis of the whole Italian university students flows
- we further provide probabilities of BA degree and MA enrolment for all the students' profile focusing on mobility

The analysis showed

- a North-South (till Islands) decreasing gradient in terms both of rates of BA degree and rates of MA enrolment,
- an increase of the MA student mobility from South and Islands toward North, with poorly observed opposite flows.
- the MA enrolment probability for the last cohort available (2011) is higher than the 2008 one

Future work and Data potentiality

The available data allow several types of longitudinal analysis, for example:

- students' mobility at a deeper level
- students' mobility and performance at the first and the second level university degree
- students' mobility and performance for the 5/6-year degree courses

Thanks for your attention!

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