

Scientific Productivity and Academic Promotion: A Study on Italian and French Physicists

Francesco Lissoni ^{1,2}, Jacques Mairesse ^{3,4,5,6}

Fabio Montobbio ^{1,7}, Michele Pezzoni ^{1,2,8}

(1) KITes/Cespri-Università Bocconi (Milano, IT); (2) Università di Brescia (IT);
(3) CREST-INSEE (FR); (4) Politecnico di Torino and ICER (IT); (5) Maastricht University (NL);
(6) NBER (USA); (7) Università dell'Insubria (Varese, IT); (8) Università di Bergamo (IT)

Outline

- Background motivations
- Research questions
- Scientific careers and recruitment policies
- Data: description and statistics
- Specification and Estimation
- Academics' Promotion
- Academics' Productivity
- Questions and Interim Conclusions

Background motivations

- Scientific productivity depends upon the institutional setting. Most of the available studies are based upon US data. France and Italy differ from US by:
 - Degree of autonomy of universities
 - The size and flexibility of academic job market
 - The role played by PRO's
 - Almost all academics are civil servants in France and Italy
 - Recruitment Policies
- Little is known on determinants of scientific productivity and promotion in specific institutional settings.
- Policy makers' wish to increase the effectiveness of public founding of science

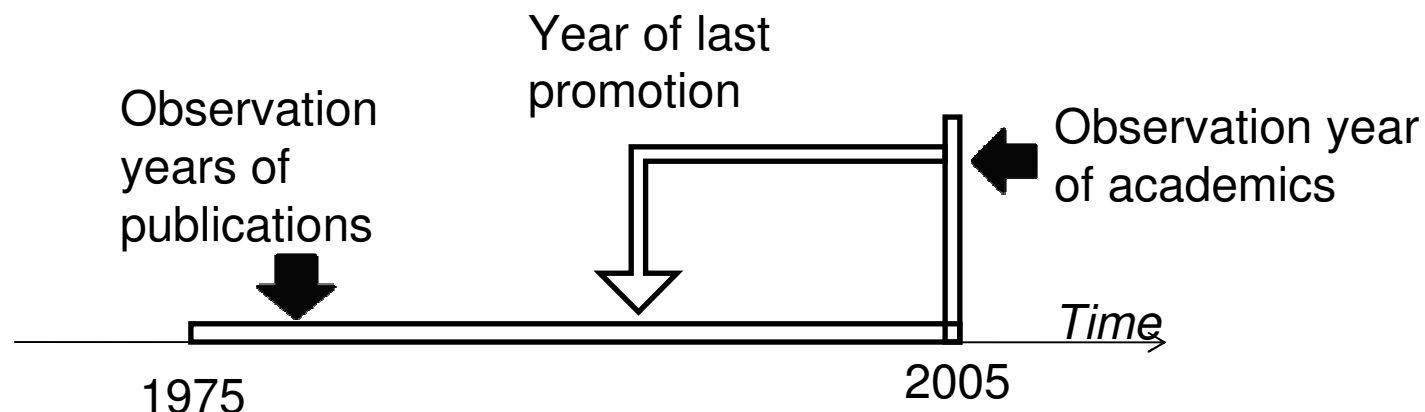
Research questions

- What are the determinants of promotion in French and Italian universities?
 - Age, Recruitment policies, Gender, Discipline,...
- What are the determinants of scientific productivity in Italy and France?
 - Age, Recruitment policies, Gender, Discipline, Co-authors' characteristics,...
- Do these determinants differ in terms of numbers of papers and journal average impact factor?
that is “Quantity”: $[\log(1+\text{number of papers}_{i,t})]$ and
“Quality”: $[\log(1+\text{avg impact factor}_{i,t})]$

Scientific careers and recruitment policies in France and Italy

- **Careers**
 - Italy: Ricercatore Universitario (RU) >> Professore Associato (PA) >> Professore Ordinario (PO)
 - France: Maitre de Conference (MCF) >> Professeur (PR)
- **Big recruitment waves**
 - During 60s and 70s increasing demand of higher education in Europe. Hired thousands of non-tenured young assistants. During 80s they obtain a tenured position as MCF (1984/85), RU or PA (1980), without facing a really selective competition.

Data: Description (1/2)



- Academic physicists active in 2004-2005 (Fr:2211; It:1816)
 - **Fields:** *Milieux denses et materiaux* (1505), *Milieux dilués et optique* (706); *Fisica Sperimentale* (1017), *Fisica Teorica, Modelli E Metodi Matematici* (355), *Fisica Della Materia* (444)
 - **Year of last promotion**
 - **Name, surname, gender, year of birth, affiliation in 2005**
- Publications from 1975 to 2005 (*ISI web of science*)
 - **Title, publication year, authors, pages, publisher, addresses, key-words,.....**
 - **For all international journals in physics with five years impact factor > 0.5**

Data: Description (2/2)

French universities			Italian universities		
28 Milieux denses et matériaux	1505	57 %	FIS/01 Fisica sperimentale	1017	40 %
29 Constituants élémentaires	448	17 %	FIS/02 Fisica teorica, modelli e metodi matematici	355	14 %
30 Milieux dilués et optique	706	27 %	FIS/03 Fisica della materia	444	17 %
			FIS/04 Fisica nucleare e subnucleare	173	7%
			FIS/05 Astronomia e astrofisica	187	7%
			FIS/06 Fisica per il sistema terra e per il mezzo circumterrestre	51	2%
			FIS/07 Fisica applicata (a beni culturali, ambientali, biologia e medicina)	319	13%
<i>total</i> 2659 100%			<i>Total</i> 2546 100%		

Data: Statistics (1/8)

Academic physicists in France and Italy, 2004-05; by cohort of birth and rank

	COHORT OF BIRTH					Total
	1930s	1940s	1950s	1960s	1970s	
<i>France-Ranks:</i>						
PR	23	423	179	153	3	781
% by cohort	<u>2.94</u>	54.16	22.92	19.59	0.38	100
MCF	12	341	134	586	357	1430
% by cohort	0.84	<u>23.85</u>	9.37	40.98	<u>24.97</u>	100
						2211
<i>Italy-Ranks:</i>						
PO	168	301	137	16		622
% by cohort	<u>27.01</u>	48.39	22.03	2.57		100
PA	72	222	177	187	3	661
% by cohort	10.89	33.59	26.78	28.29	0.45	100
RU	1	54	115	301	62	533
% by cohort	0.19	<u>10.13</u>	21.58	56.47	<u>11.63</u>	100
						1816
Total	276	1341	742	1243	425	4027

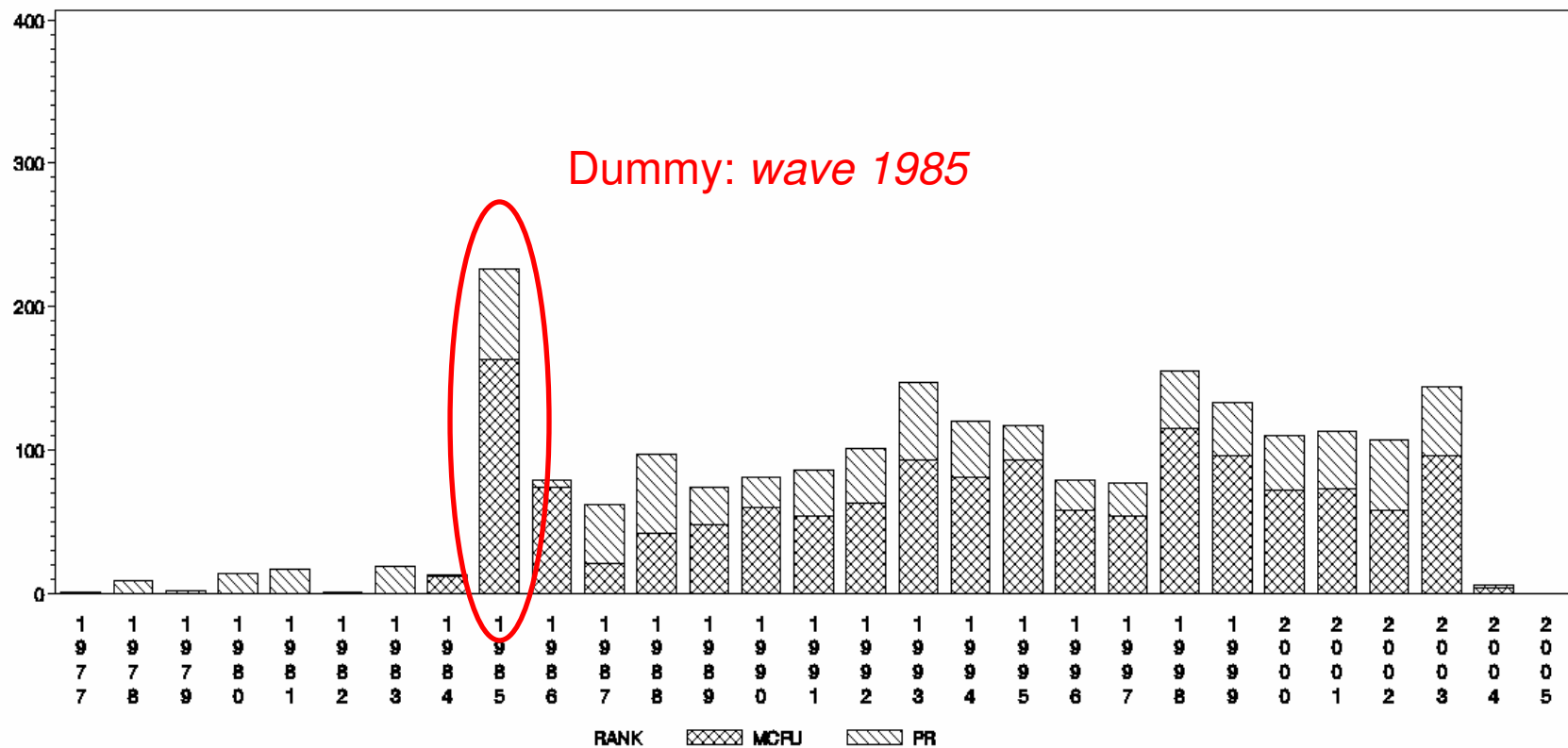
Data: Statistics (2/8)

France				Italy				
	Women	Men	<i>total</i>		Women	Men	<i>total</i>	
MCF	410	1020	1430		RU	132	401	533
PR	80	701	781		PA	102	559	661
<hr/>					PO	40	582	622
				Total				
<i>total</i>	490	1721	2211	4027	<i>total</i>	274	1542	1816
<hr/>				<hr/>				
	Women	Men	<i>Total</i>		Women	Men	<i>Total</i>	
MCF	299	912	1211		RU	124	387	511
PR	50	655	705		PA	93	525	618
<hr/>					PO	38	550	588
				Total				
<i>Total</i>	349	1567	1916	3633	<i>Total</i>	255	1462	1717

Data: Statistics (3/8)

Academic physicists in France, active in 2004-05;
distribution by year of recruitment (MCFs) or year of last promotion (PRs)

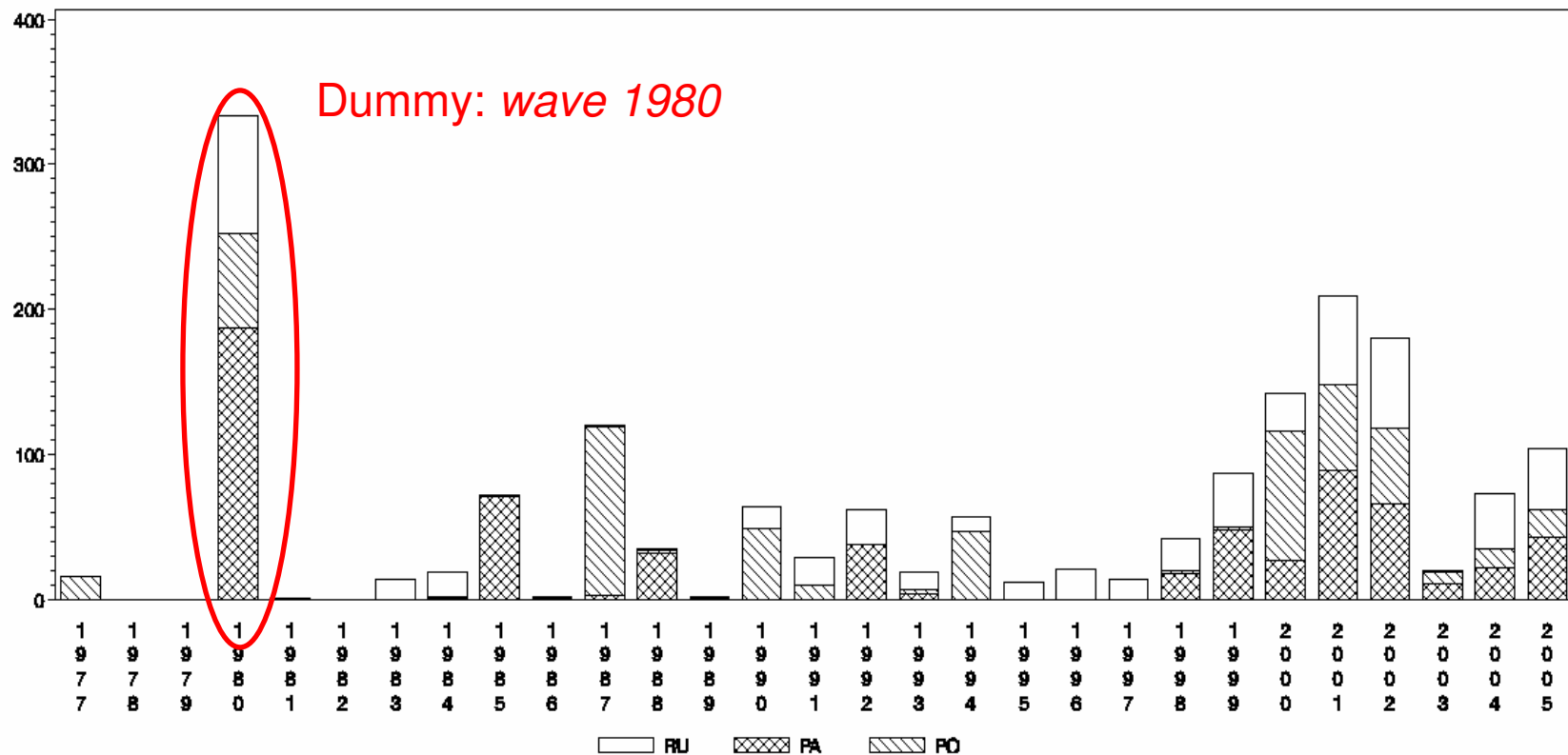
France



Data: Statistics (4/8)

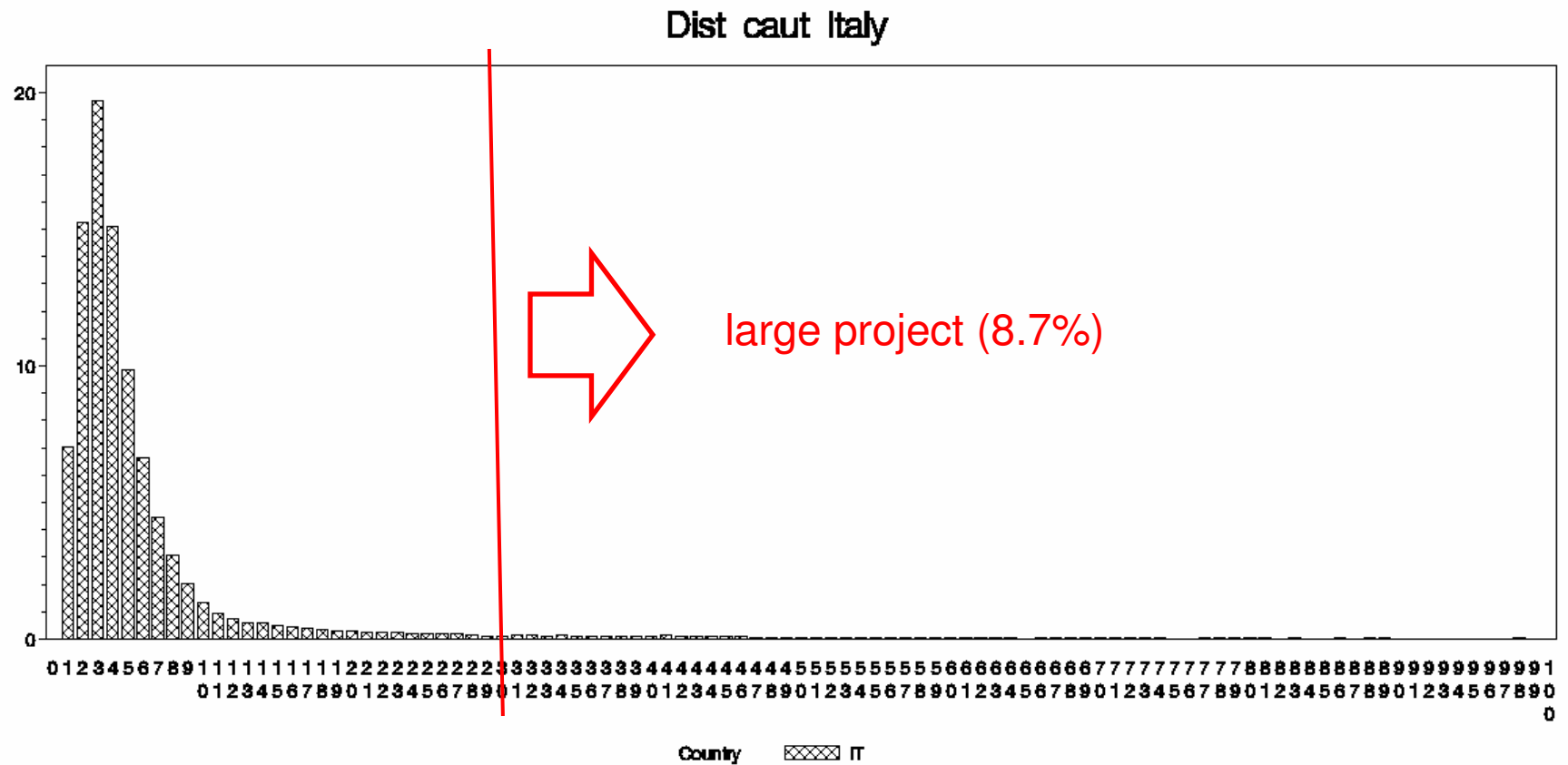
Academic physicists in Italy, active in 2004-05;
distribution by year of recruitment (RUs) or year of last promotion (PAs; POs)

Italy



Data: Statistics (6/8)

Italian **number of authors'** distributions:



Data: Statistics (7/8)

Italy (%)		Addresses					France (%)		Addresses				
		0-5	6-10	11-20	>20				0-5	6-10	11-20	>20	
Authors	1-5	65.6	1.3	0.0	0.0	66.9	1-5	65.7	0.2			65.8	
	6-10	15.6	1.9	0.0		17.5	6-10	23.3	0.8	0.0		24.1	
	11-20	3.2	1.8	0.1		5.2	11-20	2.6	0.8	0.1		3.5	
	21-29	0.6	0.9	0.3		1.8	21-29	0.3	0.2	0.0	0.0	0.6	
	Large projects	0.7	1.3	2.6	4.1	8.7	Large projects	0.3	0.7	1.1	3.9	6.0	
		85.7	7.2	3.1	4.1	100.0			92.1	2.7	1.3	3.9	100.0

Large projects: average number of authors (by affiliation)

	France		Italy	
1	US	4.39	US	2.60
2	GERMANY	1.70	INFN	2.30
3	INFN	1.28	ITALY	2.00
4	ENGLAND	1.28	GERMANY	1.25
5	ITALY	1.06	ENGLAND	1.08

Data: Statistics (8/8)

	PR	MCF	PO	PA	RU
Mean					
Large Project Dummy <i>(=1 if at least one Large Project in [t-1,t-3])</i>	0.02	0.02	0.22	0.16	0.20
Small Project with Foreign co-authors Dummy [t-1,t-3]	0.52	0.36	0.48	0.33	0.39
Small project with only National co-authors Dummy [t-1,t-3]	0.25	0.23	0.19	0.26	0.24
Small Project with co-authors of unknown affiliations Dummy [t-1,t-3]	0.05	0.06	0.01	0.02	0.02
Zero in 3 preceding years [t-1,t-3]	0.17	0.33	0.10	0.22	0.16
Total	1.00	1.00	1.00	1.00	1.00

Specification and Estimation (1/3)

- Due to the **data constraints**, and precisely because:
 - we observe only the scientists who are active in 2004-2005,
 - we only know their year of last promotion as PR in France and PA and PO in Italy, or of entering as MC in France and RU in Italy,
 - we have not enough information before entering for the MC and RU,
- **we specify and estimate a model for each rank:**
 - a generalized Tobit model consisting of a Probit promotion equation and a productivity regression for the three ranks of professors (PR, PA and PO),
 - and (only) a productivity regression for the two ranks of MC and RU.
- **One advantage of this approach is also to deal (at least to a large extent) with the intrinsic endogeneity of productivity and promotion and with the endogenous selection of our samples.**

Specification and Estimation (2/3)

- **Individual heterogeneity:**
 - “Ability” and “effort” are in general not directly observable individual characteristics but they have a crucial impact on promotion and productivity
 - We proxy for them by including past productivity variables in the promotion and productivity equations, that is:
 - in the promotion equations, the average flow of articles in the three years $t-2$, $t-3$ and $t-4$ and the corresponding average five year impact factor
 - in the productivity equations, the average number of articles per year published before the year of last promotion, and the corresponding average five year impact factor.

Specification and Estimation (3/3)

Equations and dependent variables:

Ranks:	PRs, PAs, and POs			MCFs and RUs	
Equations:	<u>Promotion</u>	<u>Productivity</u>		<u>Productivity</u>	
Model:	<i>Probit</i>	<i>Heckman</i>	<i>Heckman</i>	<i>OLS</i>	<i>OLS</i>
Dependent variable:	Promotion step dummy	“Quantity”	“Quality”	“Quantity”	“Quality”

<u>Covariates:</u>	<i>In both promotion and productivity equations:</i>	<i>Only in promotion equations:</i>	<i>Only in productivity equations:</i>
	<i>Wave 1980/1985</i>	<i>Quantity flow*</i>	<i>Avg. Quantity before promotion</i>
	<i>Gender</i>	<i>Quality flow*</i>	<i>Avg. Quality before promotion</i>
	<i>Age group dummies</i>	<i>Zero flow*</i>	<i>Zero before promotion</i>
	<i>Field</i>	<i>Nb of Academics per year</i>	<i>Co-authors quantity**</i>
	<i>(28 30 FIS01 FIS02 FIS03)</i>		<i>Co-authors quality**</i>
	<i>Year X cohort of entry</i>		<i>Co-authors affiliation **</i>
	<i>*avg. t-4 to t-2</i>	<i>** avg. t-3 to t-1</i>	<i>Zero in preceding years**</i>

Promotion equation

	PR (FR)	PO (IT)	PA (IT)
Quantity flow	0.047***	0.051***	0.087***
Quality flow	0.073***	-0.0033	-0.013
Zero flow	0.20***	0.18***	0.16***
Academics per year	0.0048***	0.0018***	0.0012***
Wave 85(FR)/80(IT)	0.27***	0.43***	0.43***
Gender age<30	-0.11***	-0.15***	-0.094***
40<=age<50	0.38***	0.50***	0.29***
50<=age<60	0.59***	0.68***	0.38***
age>=60	0.40***	0.56***	n.e.
Field 30 (FR) / Fis01 (IT)	0.039***	0.0030	0.027**
Fis02 (IT)		0.13***	-0.0035
Observations	11844	12431	9979

Productivity equation: Age

	Age				
	Italy			France	
	RU <i>OLS</i>	PA <i>Heckman</i>	PO <i>Heckman</i>	MCF <i>OLS</i>	PR <i>Heckman</i>
Quantity					
age<30	-0.015			0.098**	
40<=age<50	-0.070**	-0.11***	-0.22**	-0.061***	-0.28***
50<=age<60	-0.22***	-0.23***	-0.26**	-0.12***	-0.47***
age>=60	-0.37***	n.e.	-0.35*** [-1.73†]	-0.11***	-0.64*** [-2.04]
Quality					
age<30	-0.082			0.16**	
40<=age<50	-0.072*	-0.058	-0.018	-0.089***	-0.24***
50<=age<60	-0.29***	-0.15***	-0.093	-0.15***	-0.42***
age>=60	-0.60***	n.e.	-0.20	-0.14**	-0.58*** [-2.97~]

† interpretation in terms of articles (levels)

~ interpretation in terms of average impact factor

$$\frac{d(1+y)}{d(1+x)} = \frac{d \log(1+y)}{dx} = \frac{1}{(1+y)}$$

Productivity equation: Gender

	Gender				
	Italy			France	
	RU	PA	PO	MCF	PR
	<i>OLS</i>	<i>Heckman</i>	<i>Heckman</i>	<i>OLS</i>	<i>Heckman</i>
Quantity					
Gender	-0.11*** [-0.45]	-0.011	0.029	-0.079*** [-0.17]	-0.15*** [-0.46]
Quality					
Gender	-0.10*** [-0.61]	-0.013	-0.027	-0.11*** [-0.4]	-0.18*** [-0.94]

Productivity equation: Waves of recruitment (1/2)

	Waves				
	Italy			France	
	RU <i>OLS</i>	PA <i>Heckman</i>	PO <i>Heckman</i>	MCF <i>OLS</i>	PR <i>Heckman</i>
Quantity					
Wave 1980/1985	-0.14*** [-0.6]	-0.16*** [-0.6]	-0.084*** [-0.42]	-0.029* [-0.06]	-0.027
Quality					
Wave 1980/1985	-0.18***	-0.023	-0.030	0.0086	0.035

Productivity equation: Waves of recruitment (2/2)

- In 2005 in France are active respectively: 7.8% (55/705) PRs and 9.9% (121/1212) MCFs that have been recruited in 1985.
- In 2005 in Italy are active respectively: 11.1% (62/558) POs, 26.8% (166/618) PAs, and 14.28% (73/511) RUs that have been recruited in 1980.
- The **zero-productive** in all their career recruited during the waves of 1980/1985 are respectively 17% (40/235) in France and 36.5% in Italy (19/52)
- The “**productivity loss** “ in terms of number of articles is **around 3486 articles [=25*(26+69+44)] for Italy**

Productivity equation: Co-authors' Productivity

	Co-authors' productivity				
	Italy			France	
	RU <i>OLS</i>	PA <i>Heckman</i>	PO <i>Heckman</i>	MCF <i>OLS</i>	PR <i>Heckman</i>
Quantity					
Co-authors quantity	-0.040	0.011	0.064***	0.13***	0.054**
Co-authors quality	-0.018	0.013	0.0050	0.029	0.065**
Quality					
Co-authors quantity	-0.082**	-0.060**	-0.017	0.068***	-0.020
Co-authors quality	0.20***	0.25***	0.22*** [1.5]	0.20*** [0.74]	0.18***

Productivity equation: Co-authors' Affiliations

* REF: Zero in preceding year dummy

	Co-authors' affiliations				
	Italy			France	
	RU	PA	PO	MCF	PR
	<i>OLS</i>	<i>Heckman</i>	<i>Heckman</i>	<i>OLS</i>	<i>Heckman</i>
Quantity					
Large Project Dummy	0.97*** [4.05]	1.21*** [4.52]	1.12*** [5.57]	1.14*** [2.42]	1.12*** [3.55]
Small Project with Foreign co-authors Dummy	0.39***	0.57***	0.65*** [3.25]	0.43***	0.55***
Small project with only National co-authors Dummy	0.18***	0.34***	0.37*** [1.84]	0.21***	0.34***
Small Project with co-authors of unknown affiliations Dummy	0.092	0.22***	0.21**	0.14***	0.24***
Quality					
Large Project Dummy	0.95***	1.20***	1.25*** [8.5]	0.95*** [3.56]	0.98***
Small Project with Foreign co-authors Dummy	0.73***	0.90***	1.02***	0.72***	0.82***
Small project with only National co-authors Dummy	0.46***	0.59***	0.74***	0.43***	0.63***
Small Project with co-authors of unknown affiliations Dummy	0.36***	0.35***	0.48***	0.28***	0.46***

Productivity equation: Inverse mills ratios

***STATA
normalization**

	IMRs				
	Italy			France	
	RU	PA	PO	MCF	PR
	<i>OLS</i>	<i>Heckman</i>	<i>Heckman</i>	<i>OLS</i>	<i>Heckman</i>
Quantity					
Inverse Mills ratio	--	-0.25***	-0.14***	--	-0.33***
Quality					
Inverse Mills ratio	--	-0.035	-0.065	--	-0.24***

Conclusions

- We estimate a productivity loss of 3486 scientific articles due to the pure wave effect in Italy for the academics hired/promoted in 1980
- Negative gender effect in France across all ranks, in Italy only for RUs
- Negative impact of aging of the academics
- Work environment is very important, especially being involved in large projects (or at least having international co-authors) has a strong positive effect on quality and quantity of individual productivity

Questions and future work

- Work in progress...
- Modelling largely constrained by data
- Interpretation of results to be careful
- Could we do better with the data at hand ?
- If we had full history career data, what could we do better in terms of modelling?
- Future investigations ...