Gender bias in the Erasmus network of universities

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The Erasmus program

- Erasmus stands for European Region Action Scheme for the Mobility of University. It is a student mobility program created by the European Union in 1987 and it counted more than 10 million participants in 2018. It allows its participants to study or take an internship in a foreign country. Its popularity has made it a true cultural phenomenon.
- This is not the first study to apply Network Analysis to the flow of Erasmus students (Breznik, 2017; Breznik & Djaković, 2016; Breznik & Skrbinjek, 2020; Derzsi et al., 2011; Restaino et al., 2020), but the literature focusing on gender bias in the Erasmus flows is still quite scarce (Bottcher et al., 2016).

The Erasmus program

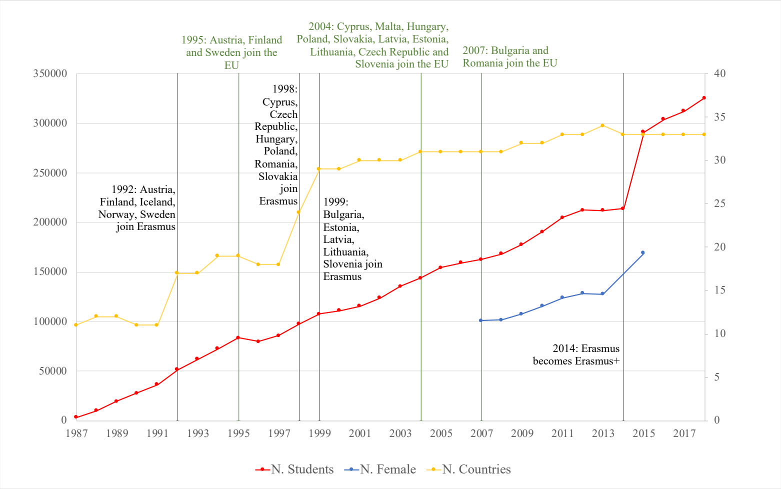

Figure 1: The history of Erasmus program from 1987 to 2018.

The Erasmus program

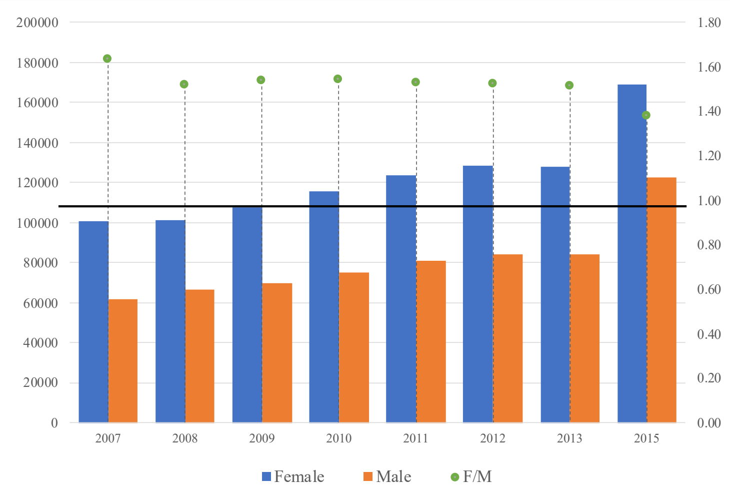

Figure 2: Gender balance in the Erasmus mobility over selected years.

The aim

Research questions

Focusing on Erasmus mobility for study reasons, the aim is to analyze the gender difference in the participation in the program and its variation over the years. This is done in three steps:

1. Descriptive analysis of gender bias by field of study, comparing 2008-2013 and STEM-non STEM disciplines, performed at country level;
2. Analysis of the network of universities participating in the Erasmus comparing 2008 and 2013;
3. Study of the degree distribution of the directed and unweighted Erasmus network of universities to explore possible changes along time and between gender.

Our unit of analysis for the Network Analysis is the university level.

1.Descriptive analysis by field

Measuring the bias

We use the symmetric transformation of the ratio F/M based on De Benedictis, 2005, given by:

$$F/M^B = \frac{(F/M) - 1}{(F/M) + 1},$$

where the superscript B stands for *bounded*.
The F/M^B index, $[-1, 1]$, provides a measure of female participation over male participation in such a way that:

- $F/M^B = 0$ corresponds to the absence of bias
- $F/M^B > 0$ corresponds to a female prevalence
- $F/M^B < 0$ corresponds to a male prevalence

STEM vs. non-STEM

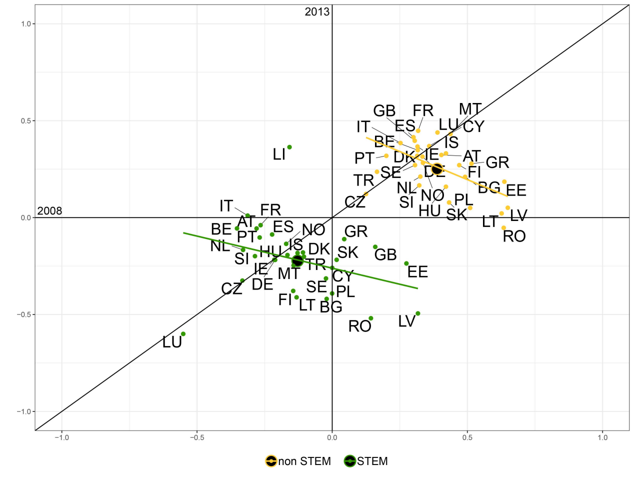

Figure 3: Gender balance in the incoming flows of students enrolled in STEM vs. non-STEM disciplines for the year 2008 against 2013

2.Network Analysis

The Erasmus Network of universities

- We examine the Erasmus network of universities in the two years $t = 2008; 2013$. In case of t=2008, $\mathcal{G}_{2008} = (\mathcal{V}_{2008}, \mathcal{L}_{2008}) = (3148, 62221)$, while $\mathcal{G}_{2013} = (3148, 76446)$. From 2008 to 2013, 14225 more partnerships were established.
- The network appears to be characterized by a **giant component**, as in Derzsi et al., 2011, and **numerous isolated nodes**; 861 are the total components that can be identified in 2008, while 497 in 2013.
- By gender:
  - $\mathcal{G}^F_{2008} = (\mathcal{V}^F_{2008}, \mathcal{L}^F_{2008}) = (3148, 47560)$
  - $\mathcal{G}^M_{2008} = (3148, 35558)$
  - The ratio between $\mathcal{L}^F$ and $\mathcal{L}^M$ was 1.338 in 2008 and 1.329 in 2013.
  - The values show a minimal variability during the years but, overall, **the gender bias remains quite persisten**t.

Summary statistics - Erasmus network

	2008			2013		
	all	M	F	all	M	F
Active Universities	2290	2117	2209	2658	2444	2549
sending	2056	1893	1984	2356	2172	2233
receiving	2090	1873	1980	2419	2158	2295
University partnerships	62221			76446		
Active connections	83118	35558	**47560**	103160	44276	**58863**
Isolates	858	1031	939	490	704	599
Density	0.006	0.005	0.004	0.008	0.006	0.004
Degree	0.123	0.080	0.106	0.135	0.089	0.117
out	0.119	0.087	0.096	0.139	0.096	0.115
in	0.127	0.084	0.115	0.131	0.082	0.119
Closeness	0.00046	0.00043	0.00044	0.00054	0.00049	0.00051
out	0.00022	0.00018	0.0002	0.00022	0.00021	0.00024
in	0.0002	0.0002	0.0002	0.00022	0.00023	0.00022
Assortativity	-0.0068	-0.0125	0.0029	0.0086	0.0087	0.0212
Reciprocity	0.45	0.32	0.39	0.47	0.34	0.41

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Summary statistics - Erasmus network

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Top-5 sending universities	GRA01 [395]	**PRA07 [286]**	GRA01 [318]	GRA01 [463]	**GRA01 [315]**	GRA01 [380]
	MAD03 [354]	GRA01 [274]	MAD03 [304]	MAD03 [413]	MAD03 [279]	MAD03 [351]
	BOL01 [305]	MAD03 [228]	WAR01 [256]	BOL01 [367]	BOL01 [256]	BOL01 [304]
	PRA07 [287]	BOL01 [215]	BOL01 [238]	VAL01 [348]	VAL01 [254]	VAL01 [284]
	VAL02 [286]	SEV01 [215]	LJU01 [222]	LJU01 [343]	BAR03 [223]	LJU01 [274]
Top-5 receiving universities	GRA01 [420]	**VAL02 [277]**	GRA01 [377]	GRA01 [437]	**GRA01 [273]**	GRA01 [392]
	VAL02 [371]	GRA01 [249]	MAD03 [316]	MAD03 [382]	PRA07 [236]	MAD03 [343]
	MAD03 [351]	MAD03 [212]	BOL01 [300]	BOL01 [366]	VAL02 [228]	BOL01 [325]
	BOL01 [339]	VAL01 [211]	VAL01 [295]	VAL02 [332]	MAD03 [226]	VAL01 [298]
	VAL01 [328]	LUN01 [198]	VAL02 [290]	LJU01 [329]	BOL01 [218]	BAR03 [273]

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3.Degree distribution analysis

Methodology

The methodology employed for fitting heavy-tailed distributions (Clauset et al., 2009; Gillespie et al., 2015) determines the optimal cut-off x_{min} by minimizing the distance D between the probability distribution of the data and the best-fit power law model, measured by the Kolmogorov-Smirnov (K-S) statistic:

$$D = \max_{x \geq x_{min}} \mid S(x) - P(x) \mid,$$

where $S(x)$ is the Cumulative Distribution Function (CDF) of the data and $P(x)$ is the CDF for the power-law fitted model.
A goodness-of-fit test, based again on the K-S, quantifies the following hypotheses:

H_0 : the power law fitted model is a plausible option
H_1 : the power law fitted model is not a plausible option

Comparison by gender - 2008

Estimates

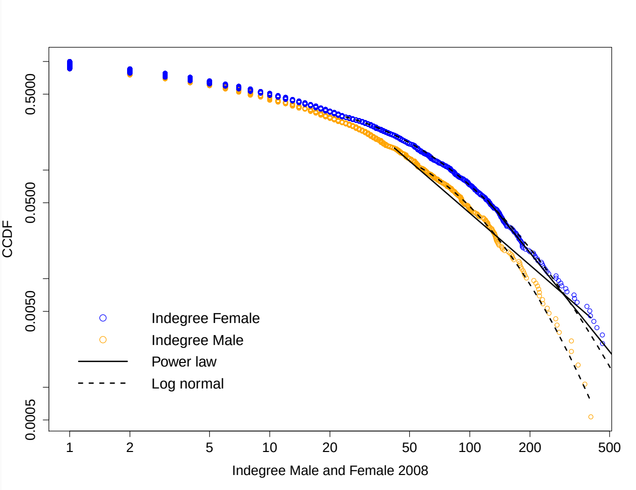

Figure 4: 2008 indegree distributions compared by gender

Comparison by gender - 2013

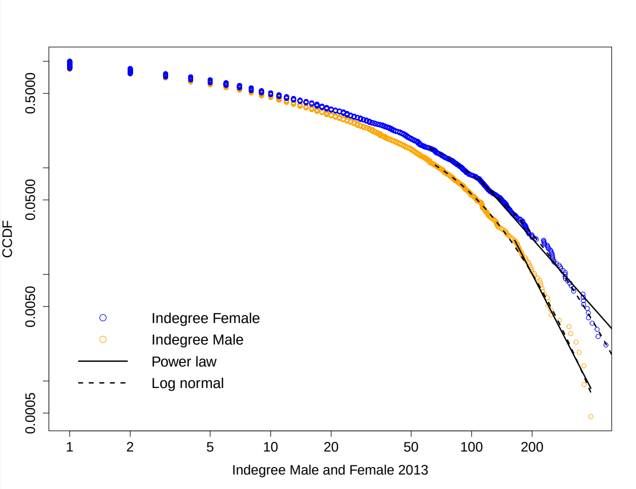

Figure 5: 2013 indegree distributions compared by gender

Summary

- Prevalence of female students in mobility in the non-STEM disciplines and the opposite for the STEM fields, with an increasing trend toward gender parity, especially in Eastern European and some Mediterranean countries.
- The gender bias persisted over time, given the denser network of connections involving female students.
- The female Erasmus network is characterized by a higher level of reciprocity and homophily.
- The network of universities is characterized by a giant component including the majority of nodes.
- The Universidad de Granada in Spain stands out as key sender and receiver in 2013 for the female and male network
- Considering the female network of universities, the tail of its degree distribution follows a power law model in 2008 while a lognormal distribution could better describe it in 2013; the opposite behavior characterizes the indegree distribution in the male network of universities, signaling a tendency towards balancing the initial strong gap in the incoming connections.

Future research

- The richness of the Erasmus data and relevance of the analysis on international formation of human capital call for future research, also in light of the recent COVID-19 outbreak and doubts arising from Brexit.
- The longitudinal data could be exploited in a more model-based analysis, for example using a gravity framework
- A further extension of the present work could be the adoption of a blockmodeling approach, along the lines of Restaino et al., 2020, to highlight the presence of sub-networks and communities in the network of universities.
- The bias in favor of female students may have a positive impact on women empowerment. On the other hand, considering that it is likely that men, in particular, will lead the labor markets in the future, enlarging their international experience could increase their skills and promote an internationl attitude.

Thank you

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back

Estimated parameter and lower bound for a power model fitted model with relative K-S statistic and p-value for the goodness-of-fit test.

		x_{min}	α	K-S	p-value
Female	Indegree 2008	123	3.28	0.035	0.87
	Indegree2013	109	3.13	0.064	0.02
	Outdegree 2008	126	3.64	0.046	0.68
	Outdegree 2013	153	3.68	0.045	0.66
Male	Indegree 2008	42	2.59	0.073	0
	Indegree 2013	164	4.66	0.070	0.32
	Outdegree 2008	109	3.75	0.041	0.97
	Outdegree 2013	109	3.56	0.049	0.48