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Corresponding Author:
Jérôme Lamy
jerome.lamy@laposte.net

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RESEARCH ARTICLE

Peer-making: The interconnections between PhD thesis committee membership and copublishing

Marie-Pierre Bès^{1*} , Jérôme Lamy² , and Marion Maisonobe³ 

¹LISST—Université Toulouse Jean Jaurès

²CNRS—CERTOP—Université Toulouse Jean Jaurès

³CNRS—Géographie-cités

*Marie-Pierre Bès passed away while this manuscript was under review.

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ABSTRACT

This article relies on the analysis of social networks to compare the networks at work in the composition of thesis committees between 2003 and 2008 in a French provincial university in three very different disciplines (astrophysics, archaeology, and economics) so as to test the hypothesis that connections actually existed before graduation. Were members coauthors of scientific publications or were committees constituted only for the sake of awarding a PhD? Astrophysics and its “equipment” ethos is the one that most often superimposes committee membership and copublishing. Archaeology falls somewhere in between, due to the greatest scarcity of committee members. The last of the three, economics, actually separates the two types of collaboration by most frequently inviting international researchers.

1. INTRODUCTION

Entering the field of science implies meeting a series of demands meant to test the graduate’s capacity to propose original scientific approaches but also to comply with the requirements generally set and agreed to by the research community (Millett & Nettles, 2006). While thesis committees (i.e., the examining committee acting at the thesis defense) *a priori* are transitory communities set up only for the sake of awarding a doctorate, the guiding hypothesis of this article is that they are shaped by some previous social density. Supervisors must embody disciplinary expectations, compliance with scientific ethos, norms validating the required work, and capacity for a critical evaluation of results. The group of peers thereby selected must assess the work presented but must also stand for the broader research community working in the field that the graduate will join.

There have been few studies so far to understand the complex processes at work in setting up thesis committees, to grasp the dynamics of scientific validation as well as the different types of relationships developed between and with committee members. Some studies have focused on the gender-based or linguistic distribution of PhD students when graduating (Breimer & Leksell, 2011; Breimer & Nilsson, 2010; Pezzoni, Mairesse et al., 2016). Others have underlined the influence of first publications on careers (Breimer & Nilsson, 2014; Fonseca, Velloso et al., 1998) without precisely measuring the concrete impact of the supervisors’ and committee members’ support (Ehrenberg, Zuckerman et al., 2010, p. 212). We suggest a novel approach, focusing on committee members’ copublishing practices and, as an

aside, on whether and to what extent PhD students are included in these research communities.

Our hypothesis is that setting up a thesis committee may well be an opportunity for reinforcing previous collaborations, actually evidenced by joint publications. Simultaneously, PhD graduation, which signals PhD students' entrance into the field of science, may be doubled up by a joint publication with one of the committee members. PhD students' contribution to scientific production is consistent (Larivière, 2012; Watts, 2012), and helps reinforce their recognition as fully fledged members of the research community (Donner, 2020).

In this article, we use social network analysis (SNA) to reveal the various types of thesis validation communities. This methodological and heuristic choice relies on a great number of research works carried out in sociology of science (Katz & Martin, 1997; Kretschmer, 1994; Moody, 2004; Newman, 2001, 2004).

Our investigation focuses on the formation of PhD thesis committees in three research departments from 2003 to 2008 in the city of Toulouse, France. The choice of this specific period allows us to grasp the way thesis committees were formed before the significant institutional changes that affected the French university system in 2009: a generalized trend to shorten thesis duration (including in social sciences), parity of standards in the constitution of juries, and the gradual disappearance of unfunded theses. We compare the actual publishing practices of PhD students and of their committee members in three different disciplines (astrophysics, economics, and archaeology).

To grasp the disciplinary specificities observed and to shed light on certain internal differences within the research departments under consideration, we complement the social network analysis of jury composition and coauthorship networks with qualitative material. A series of 10 interviews carried out with PhD thesis directors makes it possible to qualify the links observed and to understand the structuring of some of the thesis committees in our study. This article advocates a close articulation between quantitative and qualitative practices in science and technology studies; we therefore follow the path outlined by Leydesdorff, Ràfols, and Milojević (2020). This is why we do not separate, in the analysis, the study of copublications from the specific conditions of their realization.

Section 2 examines previous attempts to characterize the scientific community and graduates' admission, carried out in sciences and technology studies. Section 3 details the material collected, explains the method used to process it, and provides a general description of the data. Section 4 is an analysis of the various copublishing networks, which permits us to single out the formation of structured peer communities for the purpose of PhD validation.

2. A COMMUNITY AND ITS CANDIDATES

2.1. Organization of the Scientific Community: In-Between Hierarchies and Networks

The organization of the scientific community (and of its disciplinary components) has been the object of numerous sociohistorical studies which have demonstrated the importance of the "entry fee" and the way social boundaries are quickly delineated (Mullins, 1972). The position occupied by PhD studies has often been studied by sociologists of science from the perspective of the hierarchic relationships between supervisors and their PhD students. Hagstrom's work (1965) provides the twofold advantage of articulating the issue of thesis supervisor/PhD student relationships with the issue of the differences between disciplines. He describes the scientific world as rather individualistic, made up of dyadic relations governed by individualistic norms of independence. This type of relationship mostly fosters

exchanges along the logics of “reciprocal gift-giving” which also characterize the PhD students/supervisors’ relationships, the former complying with the latter’s “domination” in return for being trained into research. However, Hagstrom insists that the forms of collaboration differ according to three types of disciplines: theoretical sciences functioning rather individually and where PhD students merely contribute to their professors’ growing influence; laboratory sciences requiring assistants mastering scientific instruments; and “field” sciences, which demand distant investigations for which PhD students are extremely useful (Hagstrom, 1965, pp. 124 and following).

Pierre Bourdieu’s sociological concept of fields corroborates the way socioepistemic relationships between PhD students and supervisors are structured. When characterizing the scientific field, Pierre Bourdieu points out that the “pretenders” or “candidates” confront “the dominant” (i.e., the incumbent researchers) via “antagonistic strategies.” According to him, the “dominant” wish to keep their positions and all the institutions that have brought them where they are. On the other hand, candidates “may be geared towards succession strategies securing safe and rather stable positions,” or “towards subversion strategies,” which are riskier but whose potential benefits in terms of field redefinition are significant (Bourdieu, 1975, pp. 103–104). Those PhD students are not yet in a position in which they can *a priori* define their own strategies: They are caught in power struggles, which structure their disciplinary field.

In *Homo academicus*, Bourdieu (1984, p. 129) suggests carrying out studies that could “grasp the logics of the exchanges academics get involved in to form thesis committees (an academic asking a colleague to be part of a committee for the defense of a thesis he has supervised implicitly commits to granting reciprocity, thus integrating a chain of continuous exchanges), or for the sake of elections ...”. Terry Shinn (1998) also analyzes PhD student/thesis supervisor dyadic relationships as being based on implicit reciprocity: PhD students reinforce their supervisor’s power, as he or she finds the topic and helps with publishing. Shinn also demonstrates that researchers, in the course of their career, establish extensive social networks and consolidate their results through more fully developed phenomenological explorations. The social hierarchy of the scientific activity is therefore as much a hierarchy of “relationships” as a strictly cognitive hierarchy.

Network analysis is definitely a particularly fertile field to study the communities involved in research dynamics. Processing data collected by such analysis evidences some global structures that go beyond the organizational boundaries of scientific institutions—particularly all the studies on copublishing (Newman, 2004), “invisible” communities tied up by co-affiliations (thesis committees, disciplines, languages, etc), by citations (Milard & Tanguy, 2018), or by joint qualifications (Renisio & Zamith, 2015). Therefore, network analysis supplements more classical studies which focus on the organization of this activity (Gingras, 1991).

In the literature, there are two types of SNA research work on the relationships established while supervising or validating a thesis: On the one hand, in 2017, Chariker and his colleagues published a network-based analysis of mentor-mentee/doctoral student-thesis supervisor relationships from the Academic Family Tree, a web-based database of theses defended over two centuries in the United States. Their analysis indicates that the pattern of Nobel laureates’ mentoring relationships is nonrandom (Chariker, Zhang et al., 2017). Nobel laureates had a greater number of Nobel laureate ancestors, descendants, mentees/grand mentees, and local academic family.

On the other hand, some studies (Godechot, 2016; Renisio & Zamith, 2015; Verschueren, 2016), combined an analysis of research groups through their objective relationships (coauthoring, co-supervising, etc) with an analysis of differentiated individual positions such as PhD

students in front of thesis committees. The additional advantage of these studies is to acknowledge the social and relationship component of thesis committees instead of only using the rather naïve criteria of academic excellence. According to Godechot (2016), invitations to PhD committees are an indicator of disciplinary relationship patterns through which the concept of social capital can be explored at both individual and collective levels. Concerning the EHESS¹ recruiting process, the study demonstrates that statistical links exist between the probability for a PhD student of being granted a position and her or his supervisor's network as well as that of her or his committee.

By mobilizing network analysis and data on PhD committees, our article fits well into this recent line of work. It contributes to enriching this emerging field of research by offering a comparative point of view on three disciplines with very distinct characteristics (an experimental science: astrophysics; a fundamental science: standard economics; and a field science: archaeology), whereas the previously cited articles each focused on specific disciplines².

2.2. Role Played by Disciplines in Shaping Publishing Practices

Our research does not concern off-ground disciplinary scientific communities, but starts from PhD theses carried out in three departments of the same major provincial city (Toulouse)³

- the Institute of Research into the Fundamental Laws of the Universe (CESR, which merged with two other departments into the Research Institute in Astrophysics and Planetology in 2011)
- the GREMAQ (Research Group in Mathematical and Quantitative Economics), together with the university doctoral school in economics
- TRACES (the Laboratory of Archaeological Research on Cultures, Spaces and Societies)⁴.

We selected them along two sets of crossover criteria: First, their disciplines are very distant from one another (astrophysics, economics, archaeology). Second, they stand for three major cognitive areas (physics, social science, history). Third, they are part of three departments of similar importance, at least for their respective host universities (even though when compared one to the other, the gaps in size are quite noticeable). Last of all, the three doctoral schools they belong to are located in Toulouse.

The three departments studied correspond to three disciplines. Therefore, we must clarify what is meant by *discipline*. Yves Gingras (1991) listed the characteristics of disciplines (as opposed to professionalization); a discipline is characterized by its practice, its institutionalization (via reproduction and dissemination systems), and the development of a social identity (which may overlap with professionalization). Disciplines are a combination of a knowledge base, some knowhow, orthodox references, and the central base for a set of people recognized

¹ École des Hautes Études en Sciences Sociales.

² Pierre Verschuere (2016) has nevertheless used the data on post-war thesis committees held in physics in Paris to show the chain existing between disciplines.

³ By doing so, we meant to avoid the Parisian tropism, that is to say, an overrepresentation of Parisian committee members on Parisian thesis defenses, and to make it easier to conduct interviews with PhD directors, as we were all based in Toulouse at the time this research was done.

⁴ We also started looking at theses defended in another social science department of Toulouse 2 University (FRAMESPA for "Southern France and Spain: history of societies from the Middle Ages up to nowadays") but collecting theses defended over the selected period in this history department looked quite difficult.

for their qualification (Knorr Cetina, 1999). Disciplines are rather autonomous but remain connected to one another by a series of metaepistemic conventions (i.e., the search for truth, the use of rational arguments, objectivity) that provide some scientific convergence.

Our analysis means actually grasping the publishing practices of the groups studied at the very core of the specific conventions of each discipline. David Pontille, in his thesis about scientific authorship (2003), has shown that the ranking of authors characterizes the particular way in which a discipline organizes, functions, and determines socioepistemic hierarchies. According to us, the issue of publication visibility is central to our study of coauthorship, because graduates are bound to engage in some publishing practice that both determines their relationship to their discipline and their relationship to other more experienced researchers. By building on three departments and three disciplines, we attempt to account for the most marked differences (but also for the closest possible connections) existing in young candidates' practices of scientific coauthorship.

The differences in collaborative practices (the more or less great number of copublishers) depend on the specific epistemic concerns structuring each of the disciplines. In astrophysics, the instrumental dimension comes first and requires that teams should work on common subjects or shared techniques. Less systematically so, archaeology and its field constraints also imply collaborative practices. Economics is oriented more towards humanities or fundamental mathematics (Hagstrom, 1964) and values individual production.

As shown below, we found that this overall organization of publication modalities in astrophysics, archaeology, and economics was actually the case (as demonstrated in our study) and should be contemplated as the background to the various specific patterns of copublishing practices as instantiated at the time of a thesis defense.

3. DATA AND METHODS

3.1. Data Collection

Although our research focuses on the thesis as standing for a specific writing moment in the young candidates' experience, our sampling design is longitudinal. We have built a comprehensive corpus of theses defended in each of the three departments over the 2003–2008 period (that is before the new norms for committee composition in the 2009 reform, which imposed parity between local and outside members). The data collected concern PhD students (either via their curricula on the departmental websites, or, sometimes, by contacting them). Using thesis covers and laboratory databases, we pieced together the committees and collected information about each member's status (professor, researcher-lecturer, CNRS researcher, other), teaching and/or research place, nationality (taking in supervisors from foreign committees), and their publications (whether copublishing with PhD students or another member of the committee (the focus of our analysis) as well as their overall publishing profile).

Second, we carried out some systematic research concerning PhD students' copublications with the members of their committee. To build up our corpus, we first used public bibliometric data. In the case of the Institute in Astrophysics and Planetology we used the NASA/Astrophysics Data System database, which collects articles published in astronomy, astrophysics, physics, and geophysics (that is to say all the Institute in Astrophysics and Planetology disciplines). Concerning the doctoral school of economics (together with the GREMAQ department), we drew on the ECONPAPERS database (which collects over 800,000 articles in economics). For TRACES, we used the French database DAPHNE (Data in Archaeology, Prehistory and History on the Web), which provides bibliography information convergence.

Obviously, it may be objected that the use of three different databases might have biased our analysis. But we did not choose to draw on a single database (the Web of Science for example), partly because this type of multidisciplinary database tends to overrepresent some disciplines (particularly in the field of physics and natural sciences) at the expense of others (especially historical sciences). On the other hand, for the sake of balance, the Web of Science database was tested to assess the differences with the databases chosen: The specific databases we used proved systematically better stocked. We opted for accurate corpora and preferred to conform to the usual publishing practices in these disciplines. Moreover, although we limited the thesis chronotope to the 2003–2008 period, we did not set any time limits on the PhD students' and committee members' copublications. Selecting theses defended at that time enabled us to observe ex-post publications up to 2012.

A database was built on the information collected from both PhD students and committee members. Thus, we collected the number of publications of each PhD student as well as those of each committee member. In addition to these individual data, we collected relational data concerning the number of copublications between committee members and the number of copublications between committee members and PhD students. Then, we listed those who were thus interconnected through their copublications.

A series of 10 interviews (eight with economists carried out by Author 1, one with an astrophysicist by Author 2 and one with an archaeologist by Author 1) complemented our statistical data so as to confront researchers with the networks exposed by their copublications. This exercise clarified several aspects concerning the way in which local teams were structured.

3.2. Descriptive Analysis

Table 1 presents descriptive statistics about the PhD students in our corpus of theses.

For the same period (2003–2008), the number of theses per discipline is therefore different (34, 22, and 65), which is consistent with the difference in size of the three departments. When focusing on PhD students, there are both heterogeneous publishing practices which will be commented on later (all the PhD students in astrophysics had published one article) and diverging professional careers: Half of the astrophysicists and economists did not become researcher-lecturers or researchers with a tenured position.

3.2.1. Committee members

From CVs on the departmental websites, we collected some statistics (nationality, age, place of education) concerning the supervisors presented below. Our set of extended data characterizes the overall composition of committees per department and so per discipline (Table 2).

Table 1. Data on the PhD students and their thesis committees

Data		Astrophysics	Archaeology	Economics
PhD students	Number of PhD theses	34	22	65
	Number of men among the PhD students	28	14	40
	Number of PhD students having at least published one academic paper	34	11	46
	Percentage of PhD students who became tenured	50	78.6	47.7

Table 2. Data on thesis committees

Data	Astrophysics	Archaeology	Economics
Total number of committee members	152 (34 theses)	85 (22 theses)	163 (65 theses)
Participation frequency (total number of committee members/total number of PhD theses)	4.5	3.8	2.5
Percentage of men	82	90	90
Percentage of members affiliated to a French institution	82	88	44
Year of birth (median) and standard deviation	1954 9 years	1948 7 years	1960 7 years
Median number of committee members/jury	7	6	5

Our sample of theses defended in economics displays an almost exclusive majority of male supervisors, who were European but not local. The median year of birth is 1960 with rather low standard deviation. They supervised an average of five theses over the period considered.

In astrophysics, female supervisors are more numerous. Therefore, this group looks more local than the previous one. Astrophysics is singled out by the total number of committee members (higher than the archaeologists and economists) and the bigger size of their committees (an average of 6.6 members per jury). Over the period, each supervisor supervised an average of 1.5 theses.

In archaeology, our corpus comprises nine PhD supervisors, of whom three are women. They supervised an average of 2.7 theses with a standard deviation of 2. In the group, one supervisor supervised 10 theses. Committee members were born around 1948.

3.2.2. Copublishing

Before presenting our analyses from the data collected in the three Toulouse departments, it is necessary to briefly introduce the publication practices in the three disciplines of our corpus (number of coauthors, number of publications). In astrophysics, the average number of authors per publication is 31.8 (with a median number of 11 coauthors). It is only 7.6 in archaeology (with a median number of four coauthors) and only 2.71 in economics (with a median number of three coauthors). These copublishing collaborations are shaped by factors linked to common practices: common both to each of the disciplines and to their research communities and not specific to the PhD students or to the committee members of our corpus.

Similarly, the average number of copublications per researcher in each of the three disciplines is disproportionate: 14.4 in astrophysics against 2.8 in archaeology and 2.6 in economics. It shows that research in astrophysics is far more collaborative (11 times as much as in economics) but also more prolific (five times as much as economics) than the other two disciplines, which share similar characteristics of scientific production criteria.

Let us start with the global copublishing modes between PhD students and their committee and supervisor. In economics, 65 theses were defended, 46 of them with a PhD committee copublication (i.e., 70.7%). In archaeology, out of the 22 theses defended, 11 led to

Table 3. Copublications of doctoral students and members of their thesis juries

	Disciplines	Astrophysics	Archaeology	Economics
PhD students	Number of theses	34	22	65
	Median number of publications per PhD student	10	5	4
Copublications*	Total number of copublications	2,687	367	607
	Total number of copublications/number of authors (including the PhD student)	14.4	2.8	2.66
	Percentage of jury members with whom the doctoral student has published	54	8.5	14
	Number of copublications between the PhD student and his or her supervisor/total number of copublications	13.62	0.59	1.05
	Share of copublications between the PhD student and his or her supervisor on all its publications	84%	4.1%	11%
	Number of copublications between committee members/total number of copublications	43.74	8.68	5.35

* The copublications taken into account are those that involved at least two members of the same committee (including the thesis director) and those that involved the doctoral student with at least one of the members of his or her committee jury. The periods taken into account are respectively 1970–2011, 1972–2011 and 1974–2011.

copublications (50%). Last of all, in astrophysics all the theses ($n = 34$) were accompanied by a copublication. This is a standard approach to work in astrophysics, where theses are most often made up of a series of already published, or about to be published, articles (Table 1).

In our study, copublishing practices between PhD students and committee members, and then between committee members themselves, are seen as evidencing collaborations. These publishing practices precede the thesis defense and concentrate the social relations that are the object of our study. Copublishing involves a specific mode of socializing within the scientific community: It implies some epistemic and sometimes hierarchical proximity in the case of PhD students and thesis supervisors. Our sample of PhD students and committee members has enabled us to collect their copublications so as to establish the statistics in Table 3.

Our sample of PhD students is characterized by a big difference in the number of publications between astrophysics and archaeology compared with economics, which is less prolific. But the fact that the Institute in Astrophysics and Planetology depends on the thesis charter of the doctoral school, which requires candidates to publish articles that will make up the body of their thesis, should be taken into account. In other words, the publishing process itself is “encapsulated” in the thesis sequence⁵. Then, the observation of the PhD students’ copublications with members of their committee and with their supervisor reveals that both archaeology and economics break away from the more collaborative model in astrophysics.

Copublishing between committee members in astrophysics (43.74 copublications) is thus much more important and more collaborative than in the two other disciplines (Table 3). At the Institute in Astrophysics and Planetology, the salience of major space projects (the most

⁵ There is no such requirement in economics. The GREMAQ activity reports over the period studied do not mention any rules concerning the doctoral school.

recent being the Planck satellite), with the associated instrumental platforms and the abundance of results, also accounts for the great number of co-signed publications.

In terms of copublishing, archaeology falls between astrophysics and economics. Their relation to fieldwork (necessarily implying collaborative work) may account for this particular type of publishing practice. One of the former directors of TRACES and the supervisor of numerous theses explained that the specific fieldwork logics (i.e., pairing mixed methods) definitely characterizes archaeological work:

What I've always loved about archaeology is that you are right at the confluence between literature and history, to me, history is part of literature, a particular form of literature and life and natural sciences, geology archaeozoology, history, all of them mixed up and so, it's fascinating because you deal with everything, historians love it, it's their calling (...), we do make everything by ourselves, our documents, field, material, objects, there are no instructions for us, an object is found and we have to invent our instruction manual, you experience such joy when you find, propose interpretations, nevertheless always based on scientific reasoning.

Therefore, archaeology is not "instrumental" like astrophysics (in this discipline, platforms require an accurate distribution of tasks), but it conjures up the "do-it-yourself" practice identified by Claude Lévi-Strauss to single out practices combining material, methods, and heterogeneous approaches (Lévi-Strauss, 1966).

Even if mathematization plays an increasing part in economics, copublishing seems to rely on common research work based on models mastered by some teams made up of two or three people. This means that scientific citations reinforce relationships; hence committee membership invitations are then "taken for granted" by the researchers involved as part of their scientific exchanges.

About a committee member, Bruno, a CNRS research director told us:

I've known him since ... So, I first met X, I didn't know him before my thesis, he contacted me on my return back to Paris, so, I'd say I've known him since about 89 ... He started inviting me here, I remember coming here for the official opening, he had invited me to the opening ceremony of the Industrial Economics Institute and, before, to one or two thesis defenses at that time when you used to put on a toque, etc ... For thesis committees ... we've had quite a few exchanges, we used to discuss a lot, but we have never written together, we had one or two projects of articles together but we never did it ...

The proportion of PhD students' copublications with committee members is extremely variable and the same applies to their copublications with thesis supervisors.

To sum up, systematic publishing in astrophysics must be interpreted in the light of the compulsory contract compelling PhD students to publish in order to be able to defend their thesis (which is not the case for the archaeologists and economists we studied) and of the more collaborative nature of space projects.

4. THE INVISIBLE COMMUNITIES SURROUNDING THE THESIS

By applying social network analysis to our data, we first constructed and analyzed comembership and next, stronger networks associating both comembership and

copublications, from the point of view of their structural characteristics (density, configuration, average distance).

The professional relationships between scientists within their department are multiple; that is to say, they involve several types of collaborations, from participating in projects and sharing courses to copublishing, committee membership, etc. In this article, the method used consists in superimposing comembership in the same committee and copublishing collaborations.

The network analysis of comembership—whichever network involved—reveals that the structure of these communities almost match, at times, the structure of the department (in the case of the Institute in Astrophysics and Planetology or of TRACES), at times that of the doctoral School (in the case of economics). They quite systematically reflect the departmental teams and it is to be noted that very few committees are made up with members from different teams.

4.1. Comembership Networks and Copublishing Networks

We have successively analyzed the three disciplines in the three Toulouse departments: astrophysics, archaeology, and economics. For each discipline, committee comembership comes first, followed by that of comembership paired with copublishing. Dealing with comembership networks, the tie taken into account is “X and Y share the same jury.” This has nothing to do with the nature of the social relationships that may exist between the two members: One might have supervised the other, one might be the latter’s departmental colleague, they might know each other very well and be friends, etc. On the contrary, the second tie points to strong relationships of shared research work intensified by committee membership.

4.1.1. Astrophysics

The comembership network in astrophysics (Figure 1) displays three components around three researchers (Von Ballmoos, Rème, and Walters) among which the first two are structurally equivalent and the most central. The third one is less dense. One can make out an axis of oblique symmetry going through two researchers (Walters and Le Quéau), the most central researchers after the first two.

When comembership and copublishing networks in astrophysics are overlaid (Figure 2), the previous structure remains salient, as if the extra “copublishing with” relation did not appear as a strong constraint: It merely intensifies the previous type of collaboration.

The comembership and copublishing network in astrophysics (Figure 2) shows strong homogeneity of specialties in the formation of the candidates’ publishing environment. Team specialties and their themes of study are key elements and tend to isolate copublishers from the same department.

This network contains 152 members and 609 ties and only one component, which is rather striking: All the Institute in Astrophysics and Planetology committee members are indirectly interconnected. The network density is 5.31% and the average distance between two members is 3.13, which is rather weak (Table 4).

Two supervisors in the network stand out: Henri Rème and Peter Von Ballmoos, who are respectively connected with 29% and 28% of the sample (i.e., 44 and 43 persons) and who are not only thesis supervisors but also team leaders in the Institute in Astrophysics and Planetology department. The other professors are interconnected with between 3% and 15% of the sample. Rème and Von Ballmoos also hold the most intermediary positions in the network (43% of the network paths go through von Ballmoos and 29% through Rème).

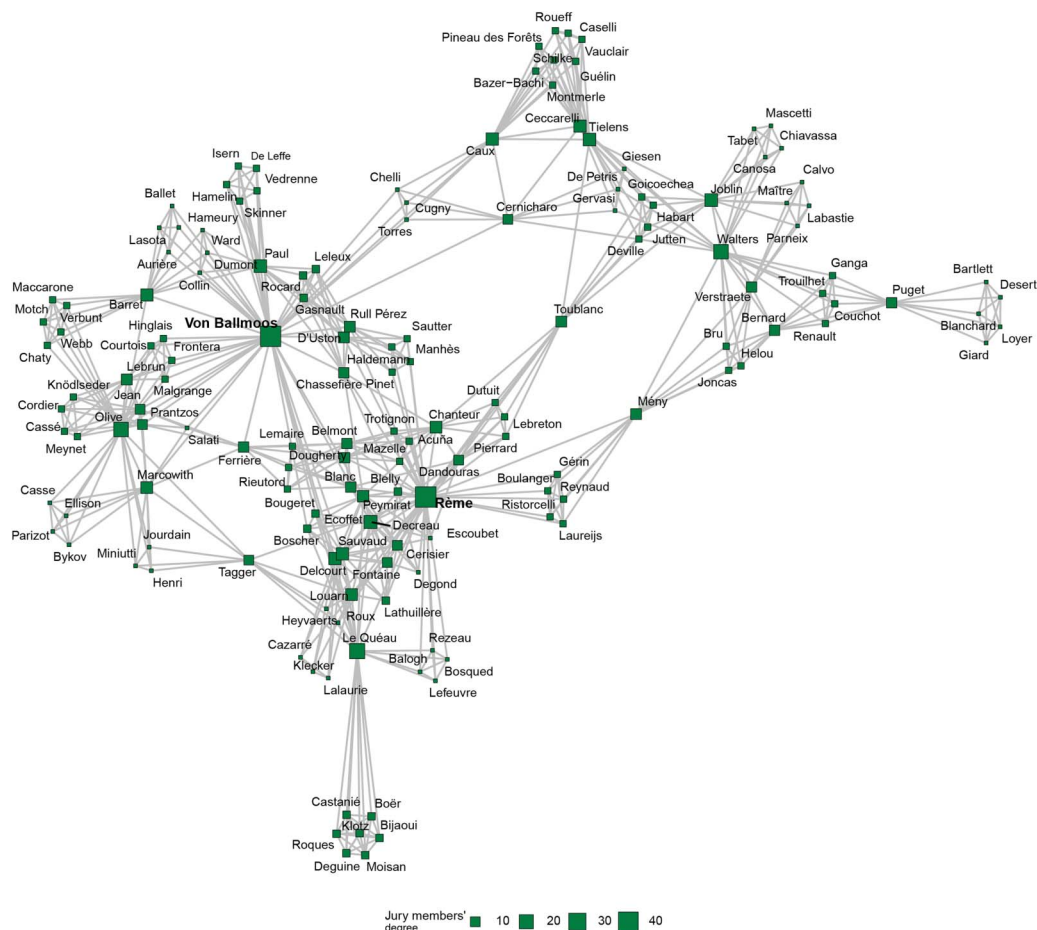


Figure 1. Comembership in astrophysics.

It may be noted that these two professors participate in the highest number of committees: 10 for Rème and eight for Von Ballmoos.

To avoid overemphasizing comembership ties that might prove occasional, and hence rather weak, it is necessary to raise the selection threshold up to comembership at several committees. In Figure 3, the tie is “X shares several thesis committees with Y.” The number of ties greatly decreases, down to a maximum of three common committees for two professors. The professors are thus rarely associated more than once.

The network is made up of six components away from a larger group structured around 13 other researchers.

By only keeping the ties with Rème and Von Ballmoos (Figure 4), only those professors sharing comembership with at least one of the two are selected: They are exactly 79 out of 149, which amounts to 53% of the total. Henri Rème chaired nine juries out of all these theses and supervised a thesis only once. Peter Von Ballmoos also chaired five committees, supervised two theses and, was only once a simple member. They are definitely far ahead of the other members and they also participated in the greatest number of thesis committees.

In the course of an interview with one of the Institute in Astrophysics and Planetology team leaders (Henri Rème), he told us that he did not share any collaboration with Van Ballmoos, as

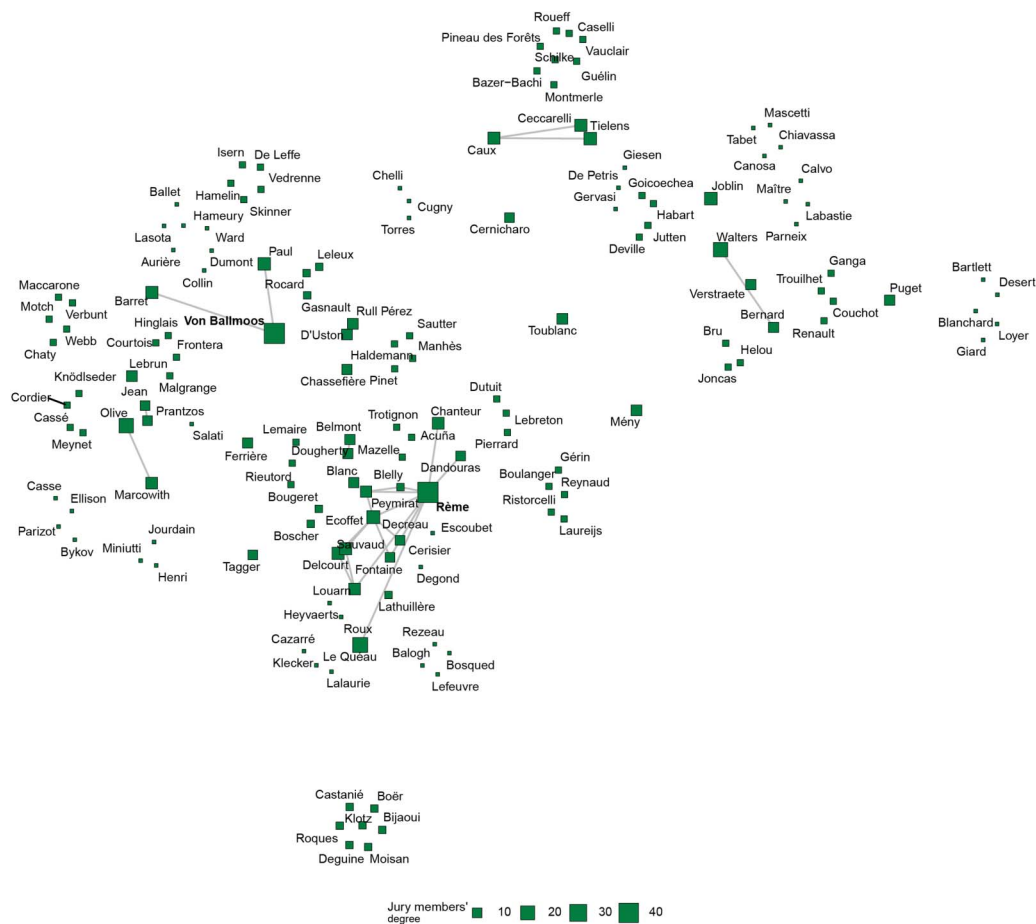
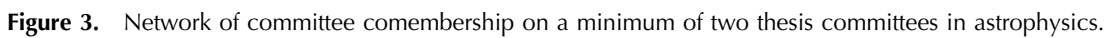


Figure 2. Committee comembership and copublishing network in astrophysics.

Table 4. Comparative characteristics of the two types of networks in the three disciplines

Discipline	Astrophysics 34 theses 152 members	Archaeology 11 theses 85 members	Economics 65 theses 163 members
Comembership network	609 ties density = 5.31% mean distance = 3.13	280 ties density = 7.84% mean distance = 2.61	1,180 ties density = 4.5% mean distance = 2.9
Comembership network and copublications network	227 ties density = 2% mean distance = 5.5	67 ties density = 1.88% mean distance = 2.63	168 ties density = 0.7% mean distance = 4.17
Share of common relations between the two networks	37%	32%	14.23%



When copublishing criteria are included, the two subgraphs come apart: most of the ties remain, but it is to be noted that none of the eight professors on the same thesis committees as Rème and Von Ballmoos copublished with the two of them. Among the eight, five copublished with Rème and three did not publish with either. One can see that Rème seems to have copublished with the highest number of researchers.

In the case of thesis defense comembership (Figure 5), each committee displays a minimum of three ties. The network density (that is to say the total number of possible ties divided by the total number of actual ties) is 7.84% (280 ties for 85 members). The average distance is 2.61 (i.e., going from one member to another requires an average of 2.61 intermediaries). It can also be observed that a group of five people (Senac, Rendu, Cursente, Barraud, and Bolos) is cut off from the rest of the committees. It means that this group of five researchers participated on the

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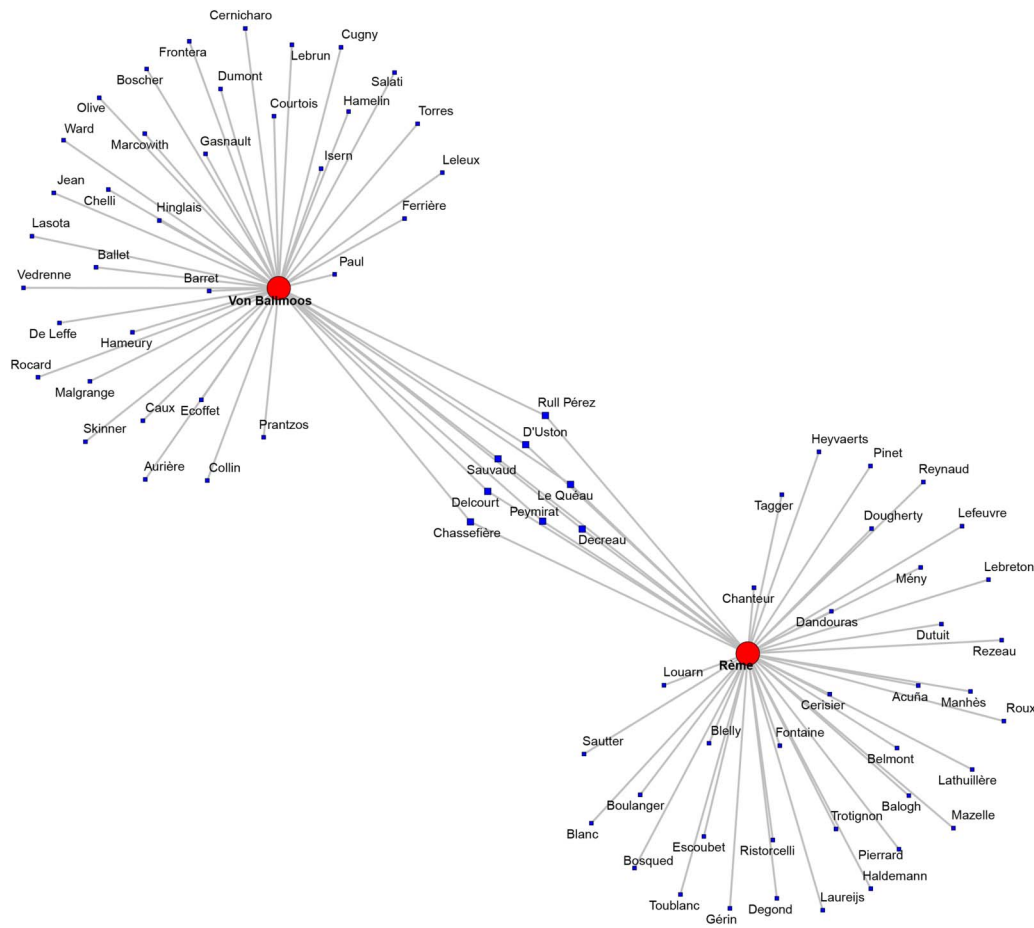


Figure 4. Graph of the comembership ties of the two most central committee members.

same committee, but none of them participated on another committee with one of the other sample members.

It is no surprise that Yvan Pailier and Michel Barbaza hold the most central position, as both of them are supervisors and participated in the greatest number of committees, respectively 10 and six. During an interview with Michel Barbaza (March 9, 2017), he wondered at the ties existing with the group of researchers Badillo, Perrot, Helly, and Ferjaoui, whose names he did not know. And yet, this set connects the two bottom and top subcomponents of the network. This observation calls for caution: Some relationships between committee members happen to be circumstantial and temporary. All the ties displayed do not necessary imply strong epistemic involvement. They may also be the result of incidental opportunities: A committee member may represent a circumstantial compromise.

The network of stronger ties between committee members (Figure 6) actually provides three isolated and not very dense components around three central professors from TRACES.

It should be noted that comembership of at least two thesis committees in archaeology is much more occasional, as it leaves us with 21 ties, that is 0.6% density. The maximum number of common committees for two members is three. The new network includes three components around three main TRACES professors: Barbaza, Pailier, and Sablayrolles.

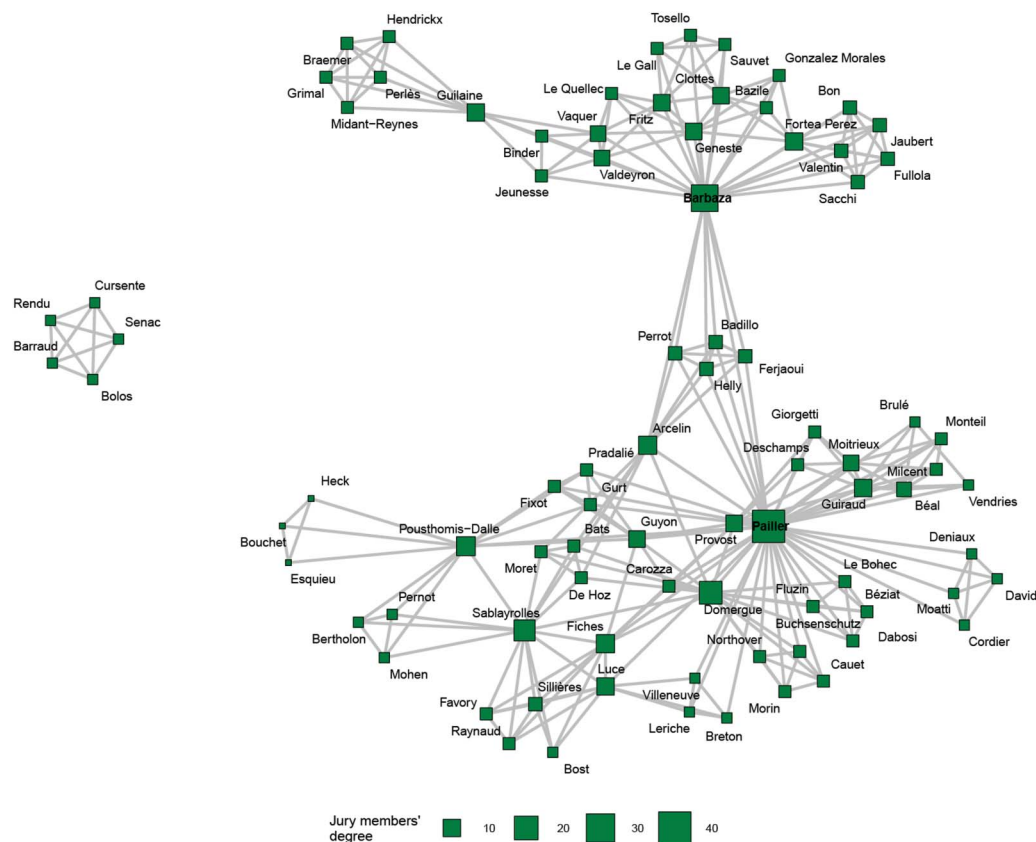


Figure 5. Committee comembership network in archaeology.

When one of them was asked what accounts for his choice of inviting this or that colleague to a thesis committee, he answered that

the teaching or research staff, the pool (for thesis committees) is rather limited, above all at that time of the year, you are bound to know everybody, we've got great relationships with Paris I, Bordeaux, with Aix-en-Provence, even though things are less smooth with the latter, we enjoy tight social, friendly, tactical and scientific relationships, of course, one should try ..., whenever possible, you know, to coordinate so that it doesn't look like convenience committees that we'd arrange together, it may be the case, back then it did happen, it's more difficult now, back then you just did whatever you wanted to do with theses, when I think of all the constraints we have today.

That was how he used many "strategies," more particularly to ensure the stability of the department's relationships with "those in Paris" and with the Ministère de la Culture. Concerning more specifically thesis committees and their composition, he finally listed four criteria without prioritizing them: He first justified invitations by referring to the researcher's expertise and specialization. He next mentioned strong budgetary constraints forcing him to finalize juries by resorting to "cheap people" from Bordeaux, Carcassonne, or Toulouse (because the train ticket is cheaper to come from these surrounding places than from Paris). He third pointed to some "polite invitations" for Spanish researchers. Last of all, he remarked that working relationships with Paris had undergone some changes: "Before, Toulouse was too

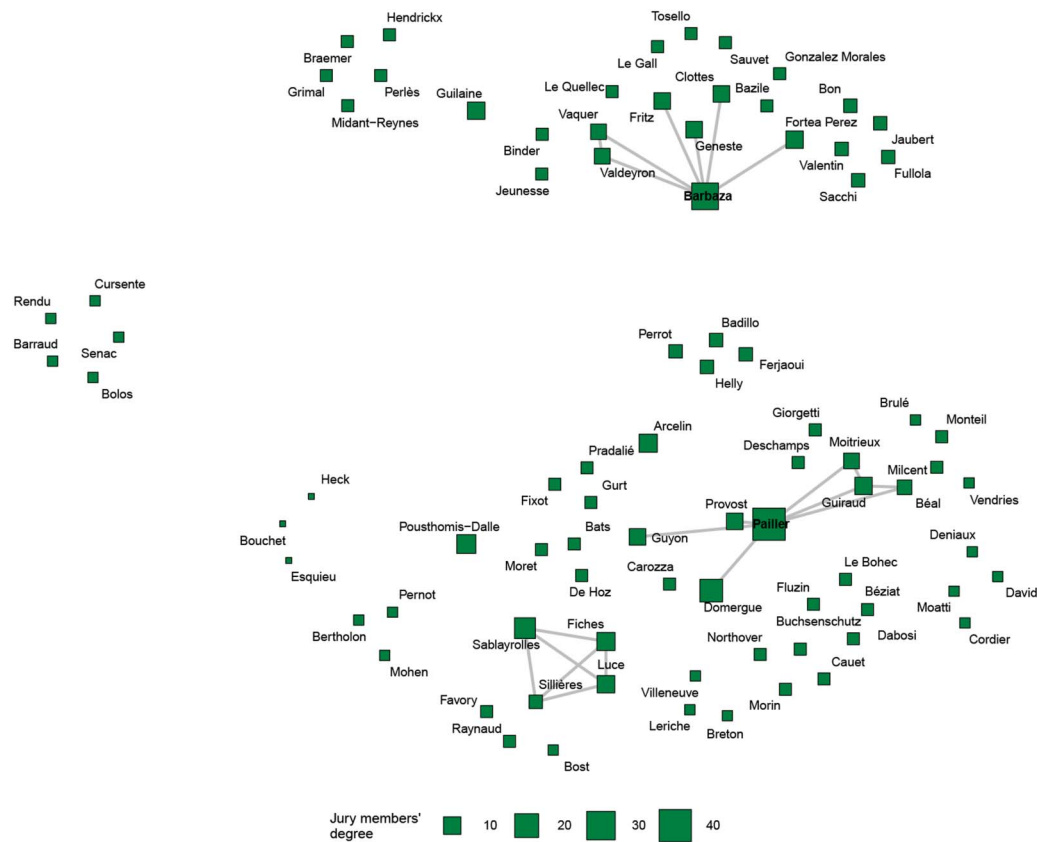


Figure 6. Network of comembership on at least two thesis committees in archaeology.

small to be attractive and those in Paris were rather reluctant to move, whereas provincials would more easily go Paris; now things have slightly changed.”

In short, finding the right sort of arrangement between keeping up relationships, holding up scientific requirements, and preserving friendships is the thesis supervisor’s main task in ensuring a positive defense in archaeology. The challenge consists in holding together heterogeneous logics (i.e., keeping or developing personal relationships may stand in contradiction with requiring the appropriate scientific level), while taking into account the whole set of institutional, political, personal, and epistemic constraints.

The comembership and copublication network in archaeology (Figure 7) shows that 35 members had never copublished with any other member of the same committee. The network only displays 67 ties, which corresponds to 1.88% density. Comembership within the same committee is represented by 280 ties. Therefore, this means that 32% of comembership ties within the same committee are also copublishing ties. The average distance is 2.63.

4.1.3. Economics

Concerning comembership of a thesis defense in economics (Figure 8), each member has at least two ties. There are 163 members and 1,180 ties. Hence, density is 4.5%. The average distance is 2.9, which means that going from one member to another implies an average of 2.9 intermediaries.

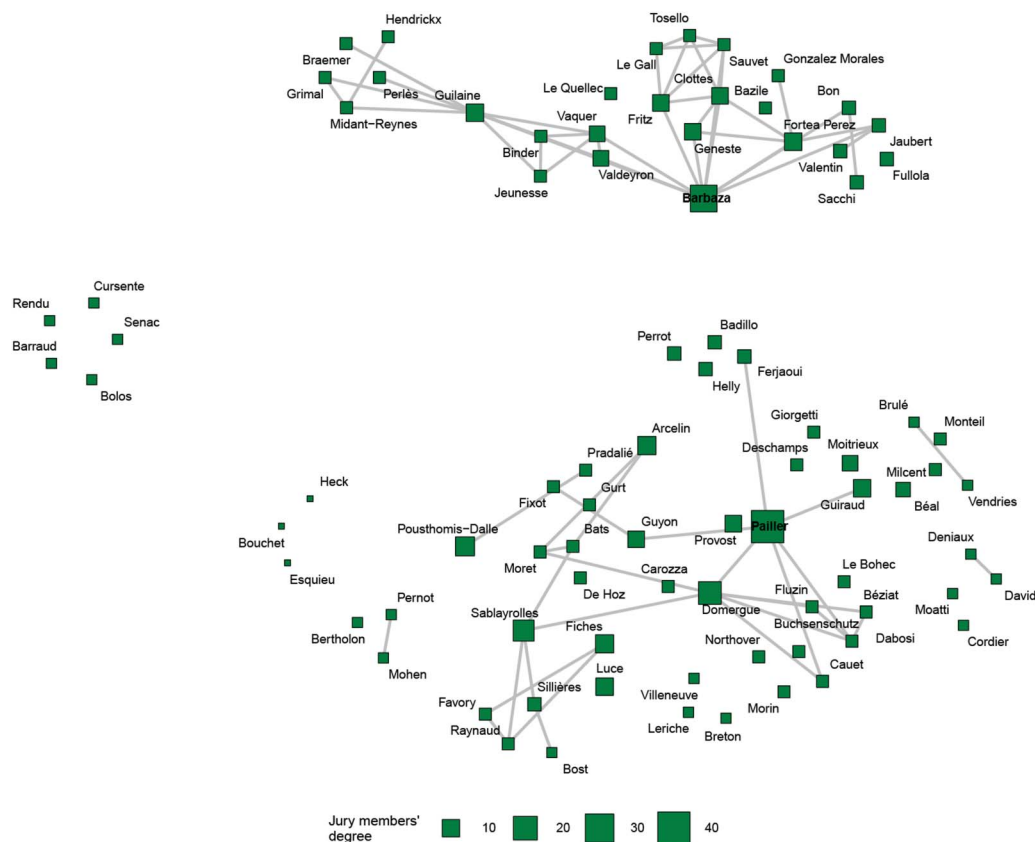


Figure 7. Committee comembership and copublication network in archaeology.

The network of comembership on at least two thesis committees in economics (Figure 9) displays those researchers who attended several thesis committees (at least two) together. It is no surprise to see that quite a number of ties have vanished. The network density is no more than 0.6% (152 ties) and three components stand out, the main one being around Jean Tirole but with a rather low local density.

When copublication and comembership at a thesis defense in economics are paired up (Figure 10), there are far fewer ties than in the comembership network only. The network density is 0.7% (i.e., 168 ties), whereas the comembership network has 1,180, which means only 14% of the ties remain in the copublishing network. The average distance is 4.17.

A series of eight interviews conducted in 2013 with some of the economists in our corpus helped specify the part played by copublishing between committee members and PhD students⁷. These interviews throw some light on their own career path (thesis, post-doc, successive positions, etc), on research training practices through supervising theses, and on copublishing with PhD students. Regarding copublishing between supervisors and PhD students, three recurring practices stand out.

First, it is usual that each thesis chapter should be a version of an article already published, sometimes with the supervisor or with another department member. The thesis therefore

⁷ These interviews were carried out by Author 1 as part of a research program, funded by the Agence Nationale de la Recherche, conducted by Béatrice Milard, between 2012 and 2015, studying citations of scientific articles (Milard, 2014).

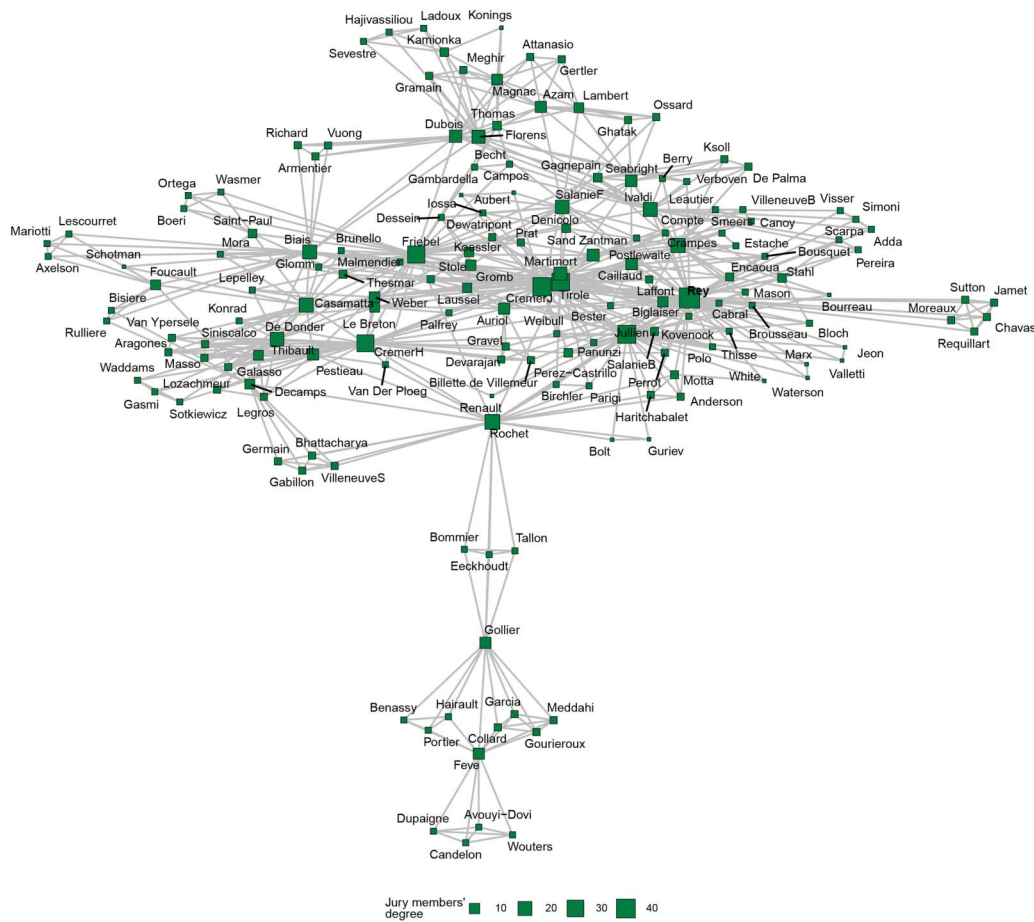


Figure 8. Committee comembership network in economics.

condenses publishing practices. Second, it is common practice to provide PhD students worth encouraging with a 1-year research contract to help them valorize their thesis into an article that will also be coauthored by their supervisor. And yet, supervisor-PhD student copublishing is not systematic and appears to depend on the supervisor's involvement in the thesis. For instance, Alban explained that the work he shared with one of his PhD students consisted in sharing tasks and competences: They were exploring a research area little studied so far (the economics of water resources), which required devising new methods. This involvement in concrete scientific work is also advocated by Michel as the usual norm. Talking about an article cowritten with a PhD student, he said that

in economics, supervision is usually much more than merely brainstorming ideas. It is actually real collaboration. Not for all the chapters, you hope that the student will be fully autonomous for a number of chapters, but, it's true that, at the beginning, or with some chapters, it is quite common to see both of them together, the professor working really hard, as much as the student to try and train her/him ... This is what happened then.

The educational dimension adds to the original scientific work. It is about learning to be a researcher by coworking with one's supervisor.

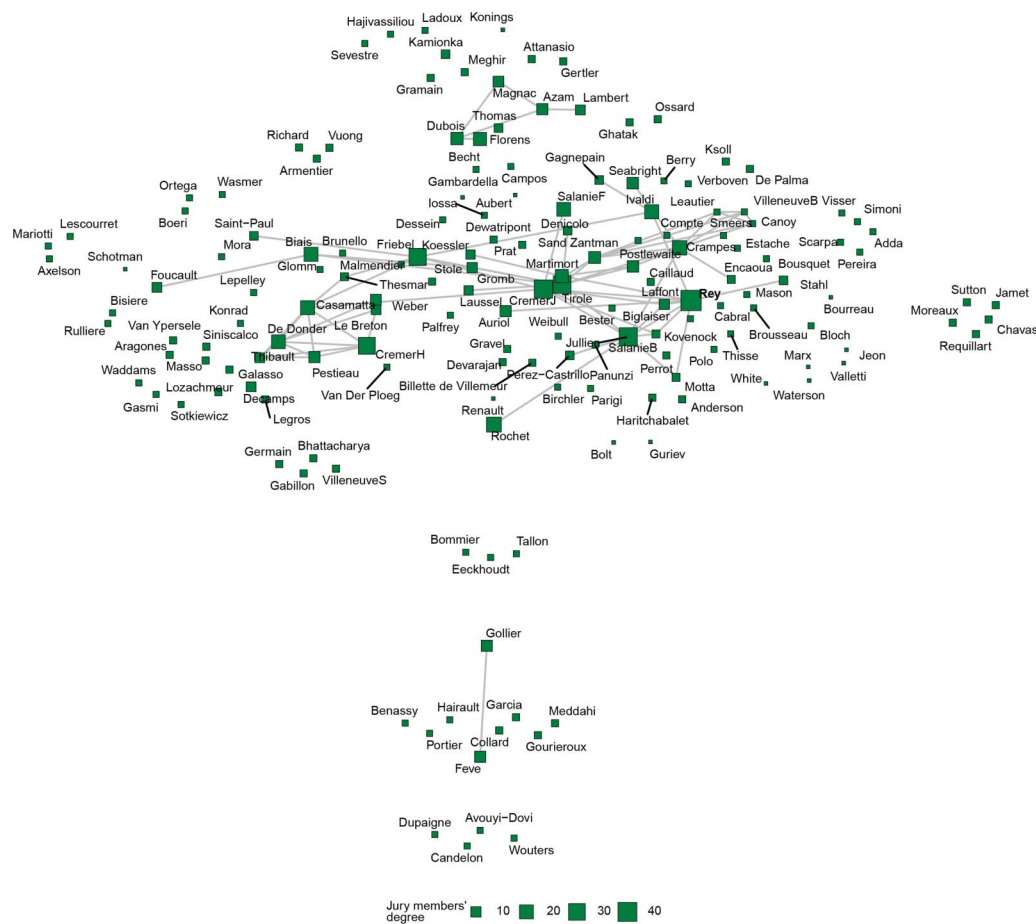


Figure 9. Network of comembership on, at least, two thesis committees in economics.

Last of all, all these interviews demonstrated that the economists shared the same approach to supervision as facilitating students' entry into the academic field as well as a time for acquiring research rules (article format, growing generalization, theorization, etc).

Talking about supervision relationships, a researcher referred to "filial" bonds between researchers and PhD students. He explicitly developed this idea when alluding to an article cowritten with two other colleagues (Herbert and Luigi):

There is a kind of lineage in connection with the thesis. Luigi was Herbert's PhD, Herbert was Pierre's PhD student and I was nobody's PhD student in the group. Luigi is Colombian, he defended his thesis here, he is now a professor, or the equivalent of assistant professor in Bogota, in Colombia, and back then he would often come back to Toulouse to carry on everything he had started here.

If there is no compulsory lineage in economics, like in astrophysics, the logic of copublishing remains fundamental to encourage an early career. This implies that the supervisor has noticed the graduate's potential qualities and has somehow forecast her or his future as a researcher. But this is not systematic, as opposed to what happens in astrophysics, where writing a thesis necessarily implies being committed to publishing—in most cases with the supervisor in charge of the research project.



Figure 10. Copublication and committee comembership network in economics.

4.2. Comparing Networks

Comembership and copublishing networks reveal two forms of socioepistemic relationships. Comembership indicates loose relatedness and extended affinities. Copublishing signals close relationships and shared practices, subjects, themes, and issues. In our analysis of the way committees participate in developing a form of sociability, it is necessary to grasp the specific characteristics of these two types of networks in the three disciplines.

The results from comembership networks show that density is higher in archaeology than in the other disciplines; that is to say, concentration is more important or fewer committees are more frequent. Besides, in archaeology, the average distance between two members is shorter, which means that it is a “smaller world” in which a great number of researchers have been invited to the same thesis committee. In astrophysics, density is lower but average distance is higher: The scientific community validating theses is less concentrated. The most scattered discipline is economics, but it is also the one with the greatest number of thesis committees. But even in this latter discipline, the average distance of 2.9 between two members remains short.

As for comembership and copublishing networks, they ought to be analyzed with respect to the evolution of indicators as compared to the first networks. Economics has lost a greater

number of ties than the other two (twice as many as astrophysics and archaeology) and the result is corroborated by the very low number of common ties between the two types of networks. That is to say, committee comembership is more frequent than copublishing between members of the same committee. Both networks in astrophysics display the greatest similarity. Comembership reinforces copublishing. Archaeology stands in between the other two disciplinary practices.

Therefore, comembership networks and copublishing networks single out disciplinary practices: The lack of personal connections in economics (i.e., comembership and copublishing hardly overlap, much less than in the other two disciplines) expresses some form of disciplinary individualism. In contrast, in astrophysics, which is based almost exclusively on vast projects requiring instruments that mobilize a great number of researchers, comembership and copublishing necessarily tend to tighten up.

5. CONCLUSION

Identifying how committee sociability is constructed enables us to single out some specific academic patterns of conduct when examining members' comembership and copublishing practices with one another and with supervised PhD students.

We note first that disciplinary identities (despite some clear convergences) remain very strong. Copublishing practices (unavoidable in astrophysics, less frequent in archaeology and economics) between PhD students and committee members bring to light publishing practices reflecting concrete scientific practices: Collaborative work (dominant in astrophysics and in archaeology) should not be mistaken as some possible (or hypothetical) move of historical or social sciences towards hard sciences. Publishing practices are first and foremost determined by the specificity of research methods (project work, task sharing, sequencing of activities, and socioepistemic hierarchies).

The clear thematic structuring definitely turns resources into those competences that committee organizers will request: Members are actually selected from the largely identified stock of interpersonal relationships already secured by some possible copublications. These two activities do not overlap as much in economics, as this discipline has only a few or very few collaborative research practices. Research in astrophysics is centered on vast programs and massive instruments, which at least partly accounts for the relative scientific proximity of committee members. Although the trend is less so in archaeology, collaborative fieldwork is a rallying factor which then plays a unifying role for thesis defenses.

In our study, committees stand (even defectively) not only for networks of interpersonal relationships achieved through the participation in an academic ritual of integration, but also for the working communities built up by disciplines.

Finally, the peer-making process characterized here is shaped by setups that are specific to each discipline. Astrophysics, as practiced at the Institute in Astrophysics and Planetology, puts copublishing and, more generally, research team work at the very core of scientific activities dedicated to instruments (most often to satellites, massive platforms requiring numerous collaborations). Economics—above all at the highly mathematized Toulouse doctoral school—relies on a repeated methodology in the training process experienced during the thesis, which means that the collaborative dimension is less important. Lastly, in archaeology, which requires collaborative fieldwork, copublishing is therefore quite common.

We also propose two further consequences of this network approach for the delicate phase of training for article writing and publishing via one's PhD.

On the one hand, the very heuristic nature of networks can bring to light some other elements structuring the scientific world, which other approaches cannot reveal. From this particular methodological perspective, our work is the continuation of other contemporary research using network analysis in science studies (Baccini, Barabesi et al., 2020; Milard, 2014, for example). By combining “bibliometric data” and comembership and copublishing network analysis, our method reveals both the relationships that are in the background of the composition of thesis committees and also reveals the “mentors” relationships to the PhD students that they supervise or whose final research work they assess. Indeed, most studies do not highlight the social setup at work behind either the formation of committees or the work of writing. Here, the social setup distinctly pertaining to each discipline can be clearly identified as an indicator of the different disciplinary practices, more or less collaborative and more or less “guiding” for PhD students.

On the other hand, the written material (theses and articles) allows us to situate the construction phase of a committee by exposing, just like in the case of citations (Milard, 2014), imprints of social relationships. Agreements passed between individuals, working relationships developed, and scientific coalition engaged, as well as the whole training involvement provided to young candidates, are all perceptible in the various ways of coauthoring or of involving coauthors.

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DATA AVAILABILITY

The coauthorship and PhD thesis committees data that support the findings of this study are available in the GitHub repository <https://github.com/Marion-Mai/peer-making> with the Zenodo identifier <https://doi.org/10.5281/zenodo.4966081>. All personal data (PhD students' and committee members' names, plus their publications' and PhD theses' titles) are available from Marion Maisonobe upon reasonable request.

These data have been collected by and under the supervision of Marie-Pierre Bès.

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