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# Co-authorship Networks in Swiss Political Research[1]

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**Abstract:** *Co-authorship is an important indicator of scientific collaboration. Co-authorship networks are composed of sub-communities, and researchers can gain visibility by connecting these insulated subgroups. This article presents a comprehensive co-authorship network analysis of Swiss political science. Three levels are addressed: disciplinary cohesion and structure at large, communities, and the integrative capacity of individual researchers. The results suggest that collaboration exists across geographical and language borders even though different regions focus on complementary publication strategies. The subfield of public policy and administration has the highest integrative capacity. Co-authorship is a function of several factors, most importantly being in the same subfield. At the individual level, the analysis identifies researchers who belong to the "inner circle" of Swiss political science and who link different communities. In contrast to previous research, the analysis is based on the full set of publications of all political researchers employed in Switzerland in 2013, including past publications.*

Keywords: Co-authorship, Switzerland, Political science, Public policy, Social network analysis, Centrality, Scientific community, Collaboration

## 1. Introduction

Publications are the "currency" of academic work. They are the single most important factor on the basis of which a researcher's academic performance is evaluated (Bernauer and Gilardi 2010; Plümper and Schimmelfennig 2007). While single-authored publications are often considered a clearer signal of the quality of a researcher, co-authorship publication strategies are on the rise in political science and elsewhere (Metz and Jäckle 2013). This might have several reasons. First, scholars are under constant pressure to produce publications and therefore tend to share the workload through co-authorship relations (Newman 2004). Second, political science today is characterized by increasing specialization: scholars tend to focus their expertise on one specific theoretical or methodological element. This enables them to trade their skills with other scholars who have different fields of specialization or complementary knowledge or data. And third, co-authored publications are also a signal to the rest of the discipline that a scholar is well-embedded in the scientific community, such that networking *per se* becomes an additional qualification criterion for scientific performance (Grossman 2002).

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While bibliographic data is now easily accessible, the abundance of information still makes it difficult for individual researchers to perceive overall structural patterns of the network they are embedded in or to anticipate research-related insights in the wider co-authorship network neighborhood. Also, for understanding the structure of scientific collaboration in political science more generally, such insights are relevant with regard to scientific communication and interaction (Mutschke 2004: 142), the comparison between communities (Newman 2004; Armingeon 1997), or the specificities and distinctiveness of one specific community (Metz and Jäckle 2013; Arzheimer and Schoen 2009).

In this article, we therefore seek to map and analyze all co-authorship activities of researchers in Swiss political science. There may be many criteria for assessing the performance of an individual researcher, and for the median researcher, there may indeed be more important ones than relational positions. However, we argue that some individuals are able to maintain a high visibility by connecting different parts of the overall co-authorship network. In the analysis presented below, we are able to identify those researchers that are structurally important for the cohesion of the discipline in Switzerland. Considering all researchers officially affiliated with a political science or public administration institute of a Swiss university in 2013, we address the following questions:

> Who are the out-performers in establishing and maintaining co-authorship relations in Swiss political science? And who is structurally most central in co-authorship activities?

While these questions target the individual members of the political science community, it is also important to look at the aggregate disciplinary level. Researchers engage in scientific communication and collaborative relations that traverse disciplinary boundaries and geographical borders. Co-authorship is thus one way to impact the cohesion and identity of the scientific community (Mutschke 2004). Yet, it is not clear what communities or subfields actually exist, how they are structured, and how they are interrelated. Switzerland as a multilingual nation is potentially a special case because it may be possible that language barriers cause insulation and prevent co-authorship across geographic regions. Moreover, as a relatively small country with a high immigration rate among academics, one may hypothesize that outside co-authorship relations with foreign colleagues are an important component of researchers' embeddedness in the scientific community. Additional questions at the community level thus read as follows:

> Is co-authorship driven by joint university affiliations, geographical location or shared language? And do Swiss researchers have the tendency to co-author publications within or across scientific subfields? Do they co-author with other researchers located in or outside of Switzerland?

To answer these questions and to map co-authorship activities within the Swiss political science community, we apply tools from social network analysis. In strong contrast to the few co-authorship network analyses in political science that have been conducted previously (Metz and Jäckle 2013; Arzheimer and Schoen 2009; Fisher et al. 1998), we not only base our research on one or several selected journals, but take the whole publication history and activity (including articles, chapters and books) of the identified researchers into account. This is a strong added value compared to previous analyses because these studies are limited either to publications in a specific language (e.g., German),

peer-reviewed journal articles, specific outlets, or a combination thereof, which strongly limits the ability to draw more general conclusions about the state of the discipline in Switzerland. This is an especially important point because political science is a discipline in transition from a nationally oriented, book-publication-based, network to an internationally competitive market with a stronger focus on journal articles. Unlike in the natural sciences, where lab-type collaborations and publications in journals have been the norm for decades, it is particularly important to avoid selection bias that would arise by only focusing on one of the two ideal types of research collaboration in Swiss political science. By doing a complete census of all work that current political scientists have ever published and reported on their homepages or curriculum vitae (as of the end of 2013), we are able to achieve a comprehensive description of the complete network and derive individual-level, as well as community-level, indices about the state of the discipline in Switzerland.

We have collected a total of 5,751 publications from 353 researchers at 12 university departments or research institutes across the country. This massive data collection effort results in a co-authorship network where a tie between two researchers can display several characteristics such as the number or type of co-authored publications. Through "attribute data" of researchers, we can evaluate if authors tend to work together because they belong to the same university, are in the same subfield in political science, or are located in the same geographical area.

For several reasons, the Swiss political science community is an interesting case study for analyzing scientific collaboration among political scientists. First, and from a very practical point of view considering data gathering, Switzerland is a small country, and the identification of all political scientists affiliated to a Swiss University can be called "a feasible" if still time- and resource-consuming task. Second, just like in other countries, political science is a relatively new discipline. First chairs related to political science and state affairs were installed in the middle of the last century and are typically still affiliated with institutes or chairs of history, law or sociology (Gottraux et al. 2004). With the exception of Geneva, political science was introduced as a major study area only around the 1990s (Linder 1996). However, having existed for several decades now, the challenge is no longer to create a community, but to consolidate and to strengthen the nation-wide critical mass and foster international recognition. Like other disciplines, political science is concerned with its own evolution (for an overview of German-speaking countries, see Armingeon 1997; for Switzerland, see Bernauer and Gilardi 2010, Linder 1996; for Germany, see Arendes 2004; for a European overview focusing on Portugal, see Cancela et al. 2014). One strategy to solidify collaboration and to enhance visibility is through national and international networking, not least through co-authorship activities. As Arzheimer and Schoen (2009: 2) put it, co-authorship is one reflection of science conceived as a collective enterprise where ideas and insights are impartially exchanged.

The remainder of this article is structured as follows. After an introduction to, and literature review of, co-authorship network analyses, we outline details about the systematic data gathering procedure, data quality and methods. We then show the results of our threefold analysis. First, we highlight general patterns of Swiss co-authorship activities focusing on geographical, sub-discipline and university-specific elements. Second, we investigate co-authorship profiles of individual researchers and assess centrality and positions in the network. And third, we broaden the scope by including international and interdisciplinary co-authorship activities. The article concludes by discussing the general relevance of assessing publication collaborations in academia and an evaluation of the

methodological appropriateness of social network analysis. We also draw conclusions about the state of the discipline and where it might move in the future.

## 2. Network analysis of co-authorship activities

Co-authorship can be considered as relevant from different perspectives. It is an indicator of personal contacts, trust and appraisal among researchers and it presumes a strong intellectual exchange and debate (Arzheimer and Schoen 2009: 4). It is thus one among many indicators for scientific collaboration and interaction (Metz and Jäckle 2013; Mutschke 2004; Zuccala 2005). But co-authorship as a measure of scientific collaboration also has its shortcomings: even when considering the order of names on a publication as one indicator of who contributed what (generally assuming that commitment and contribution decreases from the first to the last author or that contribution can be considered as equal when names are following alphabetical order) or as an indicator of who holds which academic position (e.g., in multi-authored pieces the main supervisor or principal investigator being listed last), one can never precisely tell the specific intellectual property that belongs to each author or the motivation for co-authorship. The nature of collaboration and the personal scientific performance of researchers become somewhat blurred through this lens. There is also a difference in the value and practice of co-authored publications. While co-authorships are very prominent in natural sciences, and large author teams co-produce publications, this is less often the case in the social sciences in general, and political science in particular (see Metz and Jäckle 2013; Arzheimer and Schoen 2009; Leahey and Reikowsky 2008; Moody 2004; Newman 2001). In German-speaking political science, for instance, most co-authorship teams consist of two researchers (17.6% of total publications) and even fewer (4.6%) of three (Metz and Jäckle 2013: 267). More than 50% of authors still publish on their own and have never engaged in joint publication work (Ibid: 270). Single-authored articles and monographs still seem of distinct merit.

Nevertheless, co-authorships might also be of particular value to researchers and the scientific community. Newman (2004: 5201) shows in his co-authorship analysis that mathematicians publish considerably less than scholars from biomedicine or physics and that they have much fewer co-authors per paper. He concludes that sharing publications thus also means reducing single workload and enhancing productivity. This argument can be further developed as an internal peer-review process is established through co-authorship: elaborating a joint publication also means that, ideally, co-authors review and comment on each other's contribution. As a consequence, time and resources can be saved and additional review rounds (such as conference participations or working paper elaboration) can be reduced. This internal peer review procedure might further incentivize co-authors to keep to joint deadlines and work more efficiently (but note that multiple co-authors can also lead to collective action problems and gridlock). Most importantly (see Metz and Jäckle 2013: 256), research questions, ideas, theories and methods might benefit from mutual reflections by, and joint exchange between, co-authors. Results of co-published work might thus gain in robustness and clarity.

To assess co-authorship activities, several authors apply concepts and methods borrowed from social network analysis (see for example Güdler 2003; White 2003; Grossman 2002; Barabasi et al. 2002; Newman 2001). From a network perspective, co-authoring can be conceived and assessed as a relation or tie among two or more actors (Newman 2004). There are two distinct approaches to the analysis of co-authorship data:

one can either create an affiliation network (also known as a two-mode network or bipartite graph) by modeling ties between authors and publications. Such a network is useful when one wishes to equally emphasize characteristics or attributes of the authors and of the publications. Or, one can create an adjacency network, or one-mode network, of authors, where a tie between two authors indicates co-authorship. While an affiliation network is binary, an adjacency network can be weighted because a tie between two researchers indicates the number of joint publications. It is the tie and the strength of ties across authors that indicate the quality and intensity of interaction. Researchers who closely collaborate tend to share multiple publications and have large dyadic weights. For the analysis presented here, the loss of information incurred by constructing an adjacency graph rather than an affiliation network is outweighed by the benefits of a more intuitive conceptualization of a tie weight as intensity of collaboration.

One of the most prominent co-authorship network analyses was conducted by Newman (2001; 2004). He highlights differences in co-authorship structures and habits between mathematics, physics, and biomedicine based on three bibliographic databases. He concludes that the latter have significantly more co-authors than the two former disciplines and relates this to labor intensity in biological research (Newman 2004: 5204). In a similar comparative way, Arzheimer and Schoen (2009: 21), who analyze co-authorship networks in political science, show that the discipline, at least in Germany and Austria, works in very different ways: co-authorships are less ubiquitous than in the natural sciences, and if they happen, do so in a looser way, where rather isolated sub-communities publish jointly together (for German-speaking political science, see also Metz and Jäckle 2013).

Besides comparative studies, network analysis is also useful for the identification of scientific communities and the positions of individuals within and between these communities. This can be done by using centrality measures like betweenness and eigenvector centrality (Freeman 1979), which assess the strategic position of nodes within the network based on their own connectedness and the structural properties of their neighborhoods. Such an analysis is useful for identifying researchers who are able to link different sub-disciplines and hold the community together (see also Metz and Jäckle 2013: 289; Newman 2004: 5204). Co-author network studies have shown that central actors decisively shape a scientific community and move topics to the mainstream of a discipline (Mutschke and Renner 1995). For several reasons, these central actors in co-authorship networks become the target of activities and attention: first, they are attractive publication partners for other researchers as their co-authorship activities gain visibility through their centrality (Barabasi et al. 2002). Second, Mutschke (2004) suggest integrating such centrality measures in web search tools in order to synthesize the heavy load of online bibliographic information and thus identify central actors more easily, as they have the largest impact on the contents that other researchers produce. Third, central actors are typically all-rounders rather than specialized experts if viewed from a structural perspective, as they engage in multiple ties towards others and display a wider network horizon.

There are competing normative interpretations of the structure of communities and the distribution of centrality in a national scientific field. It may be individually rational to become a "star" (Moody 2004) in a national setting in order to attract collaborators, reputation, and funding. The individual incentives, however, may be in stark contrast with a collective normative interpretation: if different communities are linked by scientific "connectors" or "mediators", this may, on the one hand, lead to spillover effects and a more efficient distribution of innovations across the whole field or, on the other hand, it

may lead to a situation of academic "echo chambers" (Goldie et al. 2014) where the whole national system becomes self-referential, resulting in scientific stalemate because innovations are no longer produced in independent parts of the network.

Whether one interpretation or the other is warranted depends, in part, on the international embeddedness of the national scientific field. If there are plenty of outside contacts, a high degree of domestic network integration is collectively less harmful than in insulated national scientific fields. Therefore we analyze both the connections between researchers in Switzerland and between these researchers and the outside world. At the individual level, one can expect to find researchers who gain reputation from national embeddedness and internationally oriented scholars who have strong publication records but are not centrally located in the Swiss collaboration network. The analysis presented here is therefore not an ideological judgment over "better" or "worse" positions in the Swiss network, but seeks to describe what the national discipline of political science looks like in Switzerland and who is successful at tying together different communities.

In this article, we therefore seek to highlight the characteristics of communities and subfields and, as a secondary goal, we take the network positions of individuals into account. The network approach in general, and social network analysis in particular, further helps us to visualize the overall structure of Swiss political science co-authorship activities, and to answer relevant community-specific questions, as outlined in the introduction.

## 3. Data and methods

### *3.1 Data gathering and selection of authors and publications*

Data gathering took place between July and December 2013. A single coder pursued a three-step coding procedure: he first created a list of all relevant university departments and research institutes that host political scientists in Switzerland, then he browsed the websites of these institutes and entered all researchers along with several details about them into a database, including their seniority status (predoctoral, postdoctoral, or professor) and the URL of their publication list (either the CV, the institutional website, a private homepage, or several of those items in order to get a complete publication profile of each person). After entering all researchers of an institute, the coder went through the researchers' publication lists and entered the following pieces of information for each publication into the database: the reporting author, the names of all co-authors, the title of the publication, the year, the name of the journal or book in which the publication appeared (if applicable), the names of all editors (if applicable), and a classification of the type of publication (academic journal, book chapter, monograph, edited volume, other). Most publications are relatively recent, but the earliest publications in the database date back to the 1960s. After completing these three steps, data entered at the beginning was double-checked in order to avoid bias due to new publications that may have shown up during the coding time period. This procedure is the best one can do in terms of completeness, but it should be clear that it crucially depends on the accuracy of the self-reported bibliographic information. For example, if a researcher did not update his or her CV or list of publications for the previous six months, those most recent publications only had a chance to enter the database if the co-authors listed the publication on their website. In some relatively rare cases, all authors failed to report recent updates, and this may

cause minor inaccuracies in the network dataset, mostly affecting very recent publications in 2013 because there is, on average, a reporting lag.

The coding procedure results in a set of 353 researchers from 12 institutes and 5,751 publications (1,945 journal articles, 1,718 book chapters, 349 monographs, 206 edited volumes, and 1,533 "other", non-peer-reviewed publications, e.g., newspaper articles or working papers). Twelve researchers have multiple affiliations; in these cases, all affiliations were initially entered, but the publications were only entered once for these persons. Where the affiliation is relevant for the analysis, only the main affiliation of a person is retained. Five researchers do not have a publication list online. However, this does not cause any validity problems because their relevant publications are contained in other researchers' publication lists.

The data were entered into a MySQL database, which is a relational database that links variables in one table (e.g., the author variable in the "publications" table) with variables in another table (e.g., with the name of the researcher in the "researchers" table) to achieve a higher consistency and less redundancy. A custom PHP frontend for the MySQL database was used to enter the data. PHP is a web programming language that allows for querying and updating MySQL databases using forms implemented in websites. The coder therefore merely had to use a web browser for data entry. After data collection was complete, Java code and R code (R Core Team 2015) was written to extract the data from the database, transform them to network matrices, and analyze the network data. Intercoder reliability cannot be checked because there was only one coder. However, the task was sufficiently easy and did not involve any interpretation element, and therefore the results are highly unlikely to suffer from reliability problems.

Of the 353 researchers that were initially identified, 233 persons had at least one publication; the others are mostly doctoral students in the early stage of their career. For the analysis, we focus on these 233 individuals and ignore the remaining persons who did not have any publications. The quality of the self-reported publication lists can be considered high because researchers usually have an incentive to list their achievements online for career purposes. Arbitrary spot checks and comparison with other sources like Google Scholar (Falagas et al. 2008) confirmed that the self-reported data are nearly complete.

When entering a new publication, the coder checked whether the publication was already in the database because it may have been entered by already coding another researcher's publication profile. This procedure ruled out duplicate publication entries, which would lead to overestimated "edge weights", i.e., too many joint publications for the same pair of authors. While we cannot rule out that a few duplicates exist in the database, this is not an important issue for the analysis because it mainly focuses on the existence of ties rather than the exact number of shared publications between researchers; structure is much more important than quantity for the analysis of co-authorship networks. Indeed, the fact that publications are reported by multiple researchers leads to an increased validity of the network data because complementary sources are used. This eliminates the problem that very recent publications may not have been reported in all cases.

Data collection was generally inclusive, meaning that subfields with strong relations to other disciplines, like public administration, are counted. The data collection strategy results in the set of all publications ever produced by political and public policy researchers who are currently affiliated with a Swiss research institution. The caveat is that publications from persons who were previously affiliated with such an institute, but were no longer affiliated in the reporting year of 2013, are not part of the analysis. Therefore, any

analysis of earlier years like the 1970s or 1990s would be necessarily incomplete because it would be based on a subset of all researchers: those who were still active in 2013. It is, however, possible to include current researchers' past publications as structural information in the current network. This inclusive data collection across subfields, publication types, sources, and time allows us to draw a much more comprehensive picture than previous co-authorship network analyses (Metz and Jäckle 2013; Arzheimer and Schoen 2009).

With regard to the definition of departments and researchers, our dataset is similar to the one used by Bernauer and Gilardi (2010). Similar to these two authors' citation analysis, we focus on university-based research and teaching (see Bernauer and Gilardi 2010: 280). In contrast to them, our selection was more inclusive because we included all researchers affiliated with an institute or department in the second half of the year 2013. Bernauer and Gilardi (2010) did not include PhD students in their analysis. Despite our efforts to include PhD students, there is an age effect because PhD students engage considerably less in co-authorships than more senior researchers (see also Figure 6). While Bernauer and Gilardi (2010) focus on ISI and Google Scholar publications, we consider all publication types and focus on self-reported citation information from the researchers' institutional and private websites and online CVs. Finally, while they analyze citations, we examine co-authorship in order to provide a complementary view on publication activities in Swiss political science and the macroscopic patterns emerging from them.

Our analysis, from a data and methods point of view, comes closest to the co-authorship network analysis of Metz and Jäckle (2013). But they only took 20 outlets in German-speaking political science into account. In contrast to their work (see also Arzheimer and Schoen 2009), the main innovation of our data collection effort is that we are focusing not only on journal articles, but rather on all publications, including book chapters, monographs, edited volumes, and other non-peer-reviewed publications. This provides a much more comprehensive picture than other co-authorship network analyses conducted so far. Where appropriate, we directly compare our results with those of Metz and Jäckle (2013) and Bernauer and Gilardi (2010).

Political science is a discipline in transition from book publishing to peer review. Therefore, conventional data sources that focus on journal publications would introduce a strong selection bias. Our approach, in contrast, allows us to learn something about all national members of the discipline. In contrast to co-authorship network analyses conducted in fields like physics or mathematics (Newman 2004), one can therefore expect a stronger clustering along the lines of publication strategies, not just contents.

Switzerland is an ideal case study for analyzing such comprehensive co-authorship networks because it is, on the one hand, small enough for a manual data collection to be feasible and, on the other hand, sufficiently internationally embedded to be an interesting research subject.

With respect to data analysis, two different one-mode networks are created: the first contains only Swiss political scientists (233 nodes; 8655 instances of co-authorship, leading to 893 edges; density = 3.8 percent).[2] The second network includes all co-authors listed in

[2] The edges, or co-authorship ties, in the network can be weighted because any two researchers can be tied by multiple publications. While "edges" refers to the number of ties in the network irrespective of the weight, "instances of co-authorship" counts each co-authorship as a separate tie. For example, if researchers A and B have three publications in common, this counts as three instances of co-authorship but as one edge or tie. "Density" refers to the number of edges that are present as a proportion of the maximum number of edges possible in the network.

the publications, including scholars from other countries and disciplines (1835 nodes; 25,013 instances of co-authorship, leading to 10,717 edges; density = 0.4 percent). In the second network, the additional non-Swiss or non-political science authors were treated as "passive" nodes, meaning that their respective publication profile was not additionally coded; they entered the network only through co-authoring activities with political scientists who were affiliated with a Swiss university or institute in 2013. This permits us to analyze the complete picture of outside relations around the Swiss network. In both networks, ties indicate the frequency of co-authorships, i.e., the number of joint publications among any pair of authors.

### *3.2 Summary statistics for authors, publications, and universities*

Of the 5,751 publications, 5,009 (87%) are single-authored, 635 (11%) have two authors, 93 (1.6%) three authors, 9 (0.16%) four authors, and 5 (0.09%) five authors. The average number of co-authors per publication is therefore 1.15, which is low compared to the number of 1.52 reported by Metz and Jäckle (2013) for 20 German-language journals. The Swiss network contains 53 isolates: these are mostly doctoral students who have only single-authored publications and are thus not connected to any other node. Including these isolates, the mean share of co-authored publications among all publications per person is about 39 percent.

Table 1 shows the distribution of different types of researchers per institution. 94 researchers hold a doctoral degree but are not (yet) professors; this is the largest group of persons. The largest universities in terms of academic staff are the Universities of Zurich and Lausanne, followed by ETH Zurich and the University of Geneva.

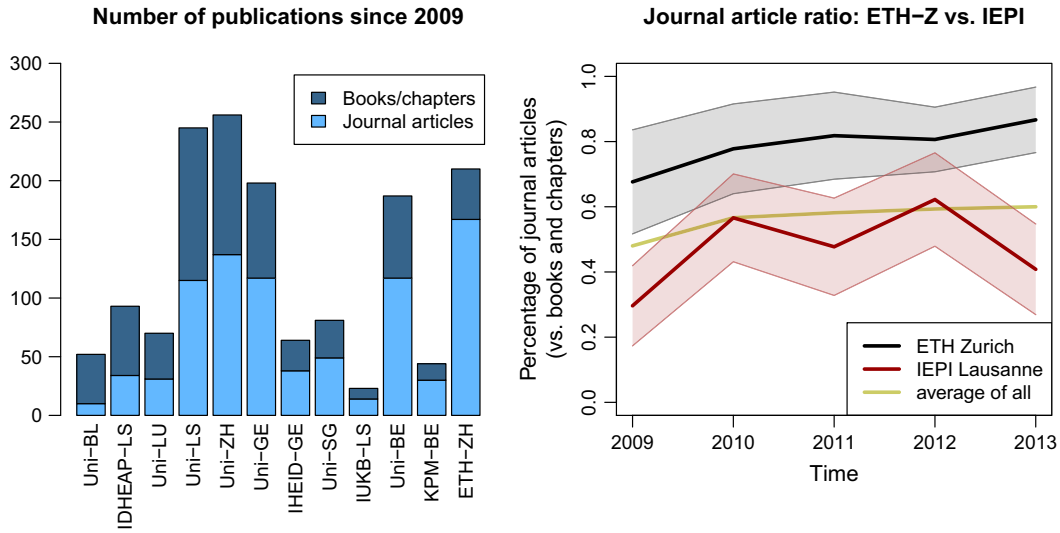
The left panel of Figure 1 shows the number of publications reported for each institute or university (note that this is not per capita), separately for academic journal articles and book-related publications (book chapters, edited volumes, and monographs), sorted by the relative share of journal articles in ascending order. One can see that ETH Zurich has the largest share of journal publications, followed by the University of Bern. On the lower end, the University of Lausanne has a relatively large overall publication output with a

Table 1: Number of researchers per institution who are part of the network

| | PhD students | Postdocs | Professors | Total |
|---|---|---|---|---|
| ETH-ZH | 13 | 16 | 8 | 37 |
| IDHEAP-LS | 9 | 2 | 7 | 18 |
| IHEID-GE | 0 | 6 | 4 | 10 |
| IUKB-LS | 0 | 0 | 2 | 2 |
| KPM-BE | 2 | 0 | 1 | 3 |
| Uni-BE | 8 | 7 | 6 | 21 |
| Uni-BL | 1 | 4 | 2 | 7 |
| Uni-GE | 8 | 13 | 10 | 31 |
| Uni-LS | 7 | 19 | 15 | 41 |
| Uni-LU | 2 | 3 | 4 | 9 |
| Uni-SG | 3 | 1 | 6 | 10 |
| Uni-ZH | 14 | 23 | 7 | 44 |
| Total | 67 | 94 | 72 | 233 |

Figure 1: Share of journal articles among all publications per institution




relatively low share of journal articles. These results are completely in line with the analysis presented by Bernauer and Gilardi (2010), where in 2009 the political science department at the University of Lausanne ranked lowest, and ETHZ and the University of Bern ranked highest in terms of publications in ISI and Google scholar indicators. The right panel of Figure 1 contrasts these two extreme cases (ETHZ and IEPI Lausanne) over the duration of five years from 2009 to 2013. The upper black line shows the share of journal publications in each year for ETH Zurich and the lower red line for IEPI Lausanne. The 95 percent confidence intervals around the two curves demonstrate that this is a consistent finding irrespective of the year and size of the departments.[3] Note that the lines reflect the publication activity of all researchers affiliated with the respective department in 2013 and their development in recent years and does not include former employees. In other words, the five measurement points reflect intrapersonal, rather than intra-institutional developments and thus lend more credibility to the claim that researchers affiliated with the two universities in 2013 had strikingly dissimilar publication behavior, even at relatively stable rates over time. While these observations do not imply a normative statement about which publication strategy is preferable or makes more sense in a given research specialty or context, different universities do follow notably different publication strategies or cultures.

[3] Confidence intervals are a measure of uncertainty for point estimates. While they are mostly used in the context of random samples, rather than complete populations, uncertainty measures are also important for assessing causal uncertainty of parameters for finite populations (Abadie et al. 2014; Western and Jackman 2004). In this interpretation, assignment of individuals to a university serves as a treatment, and observed values reflect only the population of realized, as opposed to potential, outcomes. Therefore confidence intervals can be interpreted as a measure of causal uncertainty given the number of researchers affiliated with each group. Were there only a handful of researchers at each institution, uncertainty over whether the researchers' selection into universities was responsible for the universities' aggregate publication behavior would be much more pronounced. In this case, the confidence intervals provide some guidance as to how trustworthy the lines are, given the number of researchers in each group. Indeed, there are significant differences between the two universities, given the group sizes.

We classified the 233 researchers into six subfields by interpreting the names of their chairs or research groups and by looking at publication titles in uncertain cases. This is only a rough measure of subfields, but it is useful for the visualization of the network and interpretation of subgroups. There are 61 researchers in comparative politics (including political sociology with a comparative focus and European politics), 69 in international relations, 6 in methodology, 58 in public policy or administration, 8 in political theory, and 16 in Swiss politics. The remaining 15 researchers could not be reliably classified because they are not affiliated with a research group and have too few publications for a reliable classification. It is possible that some researchers have ambiguous or overlapping subfield affiliations. In these cases, we gave preference to the interpretation of the chair title over the content of the publications. Ambiguous subfield memberships do pose a minor problem for the interpretability of visualizations because some borderline cases can be interpreted as either comparative politics or public policy, for example. The alternative would be to derive a fuzzy classification of authors from publication titles, thereby introducing artifacts due to different languages as well as a high number of different color shades one could no longer interpret visually. Therefore we prefer a discrete and potentially inexact measure over a continuous partitioning that would jeopardize intuitive interpretability due to manifold color combinations and that would risk faulty classifications due to incomparability of terms across languages.

### *3.3 Network methodology*

The 233 (actors) x 5,751 (publications) affiliation matrix is first transformed into a 233 x 233 one-mode projection by multiplying the affiliation matrix by its transpose. In the resulting co-authorship network, ties indicate the number of times two authors engage in joint publication activities. This one-mode network is visualized using the software packages *visone* (Baur et al. 2015) and *statnet* (Handcock et al. 2008).

Two different centrality indices are employed to measure the structural importance of individual researchers in the network. Betweenness centrality (Freeman 1979) measures the extent to which a node is situated on the shortest path between other pairs of nodes. Substantively, this captures the extent to which a researcher connects different social circles or subfields in the scientific collaboration network. It therefore permits interpretation of the connective capacity and importance of researchers for the cohesion of the national discipline. Eigenvector centrality (Bonacich 1987) captures a different aspect of importance: a node is central if it has many central neighbors in the network. This is the number of adjacent nodes weighted by their respective numbers of adjacent nodes etc. In practice, the theoretical interpretation is that researchers receive a high eigenvector centrality score if they are in the inner circle of the network. The two centrality measures, betweenness and eigenvector centrality, therefore capture complementary and substantively interesting properties of individuals in terms of their structural position.

Note that the centrality indices, just like the other network methods, focus on relational performance rather than individual performance. Individual persons may, for example, have an excellent track record of single-authored publications, which are not considered in the relational analysis.

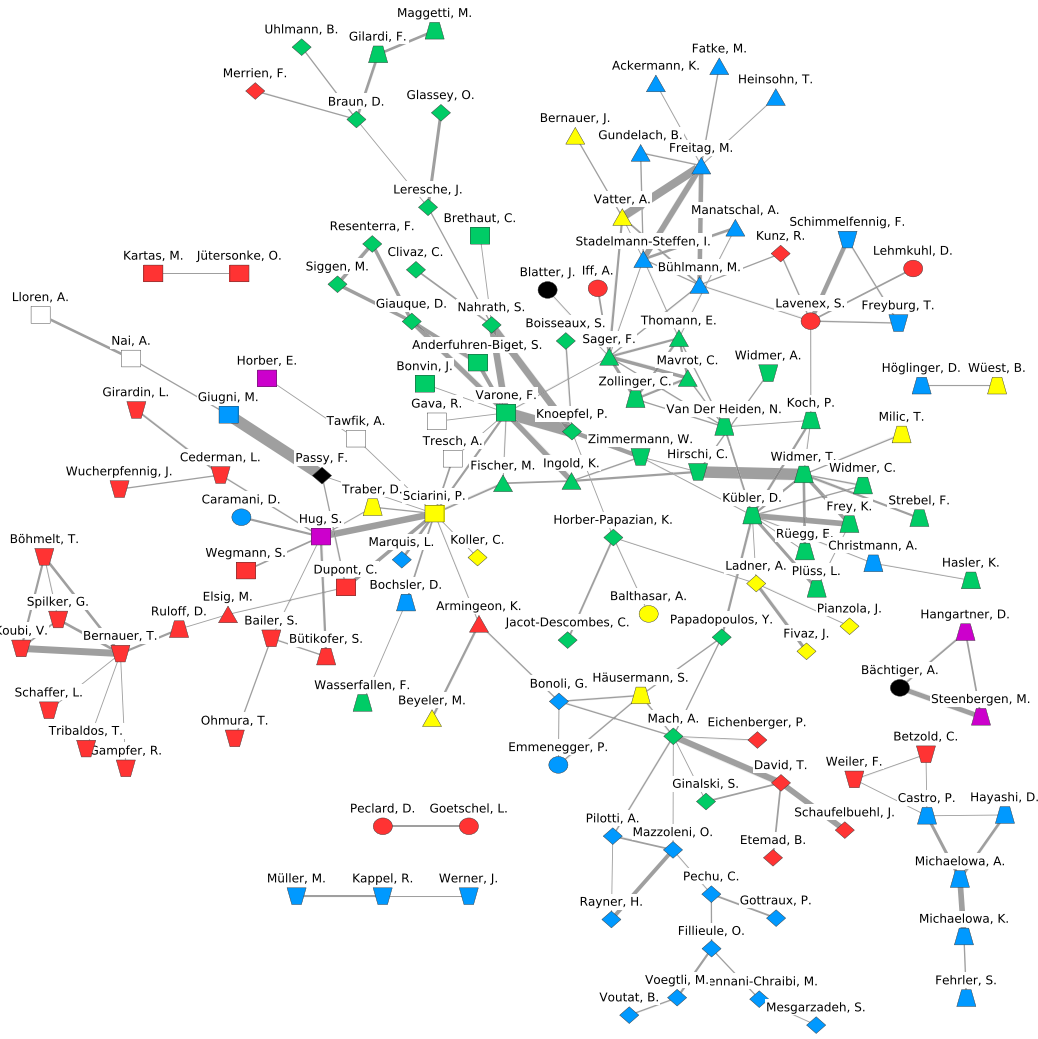
 

## 4 Results

### *4.1 Mapping of co-authorship*

Figure 2 shows the Swiss co-authorship network. Only "intense" collaboration ties are retained in this visualization, meaning that an edge is only displayed when two researchers

Figure 2: The Swiss co-authorship network: for better readability, only edges with at least two publications are retained and isolates are removed. Node shapes represent locations/affiliations: triangles = Bern (IPW and KPM); trapezoids = University of Zurich; inverse trapezoids = ETH Zurich; diamonds = Lausanne (IEPI, IDHEAP, IUKB); rectangles = Geneva (IHEID, University); circles = others (St. Gallen, Basel, Lucerne). Colors represent subfields: blue = comparative politics; red = international relations; green = public policy or administration; yellow = Swiss politics; purple = methodology; black = political theory; white = other or NA. Line width is proportional to the number of joint publications between two researchers



have at least two joint publications. This enhances readability and facilitates a clearer interpretation of scientific communities in Swiss political science.

There is strong subgroup clustering both by subfield and location. The center of the network is dominated by researchers in public policy and administration. This is in contrast to the Portuguese case examined by Cancela et al. (2014), where international relations and comparative politics are the most productive and interactive subfields. In Switzerland, public policy and administration additionally display a tendency for cross-institutional participation with researchers from Swiss occidental universities (Geneva and Lausanne) and Zurich and Bern.

The subfield of international relations is relatively dominated by ETH Zurich (mostly displayed in the left part of the diagram). Lausanne, Bern, and the University of Zurich are strong in comparative politics (bottom and upper right corner of the diagram). In this subfield, there is a relatively strong tendency for co-authorship within, but not across, language regions and universities.

There are also some sub-disciplines, such as methodology (purple) or Swiss politics (yellow), that are smaller but not less connected. Researchers belonging to those two rather small subfields thus often occupy a "bridge function" in the network: they connect with different other subfields and publish across university and language borders.

Several triangles and dyads are particularly strongly tied by joint publications: Giugni—Passy (Geneva, Lausanne), Bernauer—Koubi (ETH Zurich), Hug—Sciarini (Geneva), Hirschi—Widmer (Zurich), Vatter—Freitag—Stadelmann-Steffen (Bern), and Varone—Knoepfel—Nahrath (Geneva, Lausanne).

These results answer several questions outlined in the introduction. First, co-authorships occur within rather than across sub-disciplines of Swiss political science. Second, sub-disciplines are a stronger driver of co-authorship than university affiliation. Nevertheless, there is the tendency of a "language and geographical barrier" at least in some sub-disciplines, where researchers have the tendency to co-author publications with their peers within the German- or French-speaking part of the country, respectively. In some sub-disciplines, like comparative politics, co-authorships are even insulated completely in language regions and occur only within some selected universities, but very rarely across locations. Finally, the subfield of policy analysis and public administration seems to hold the whole network together, with frequent cross-institutional and cross-subfield ties.

While Figure 2 shows all publications in one diagram and ignores temporal evolution, Figure 3 plots the development of the co-authorship network for each year between 2006 and 2013. Each time period contains all publications until the year reported. As co-authorship activities are cumulated in each year, the network gets denser over time (as in Cancela et al. 2014; Metz and Jäckle 2013; Newman 2004). Figure 3 also nicely confirms the sub-disciplinary pattern: researchers have a strong tendency to publish with political scientists from the same, rather than different, sub-discipline. While within-subfield publications in policy analysis and public administration were already mainstream in 2006 and for the remaining years, other disciplines (comparative politics or international relations) show more isolates and ad-hoc co-authorships in the early years, but are able to consolidate their co-authorship activities over time. The development portrayed in Figure 3 shows how the researchers of 2013 developed a denser collaboration network over time rather than reinforcing existing communities; former employees of Swiss universities or institutes are not part of the time series.

Figures 2 and 3 display only intense edges, and they conflate different publication types. Figure 4 distinguishes between journal articles and book publications (chapters,

Figure 3: Development of the field. Cumulative, annual time windows of the one-mode network of all researchers recorded in 2013. Colors represent subfields (as in Figure 2)

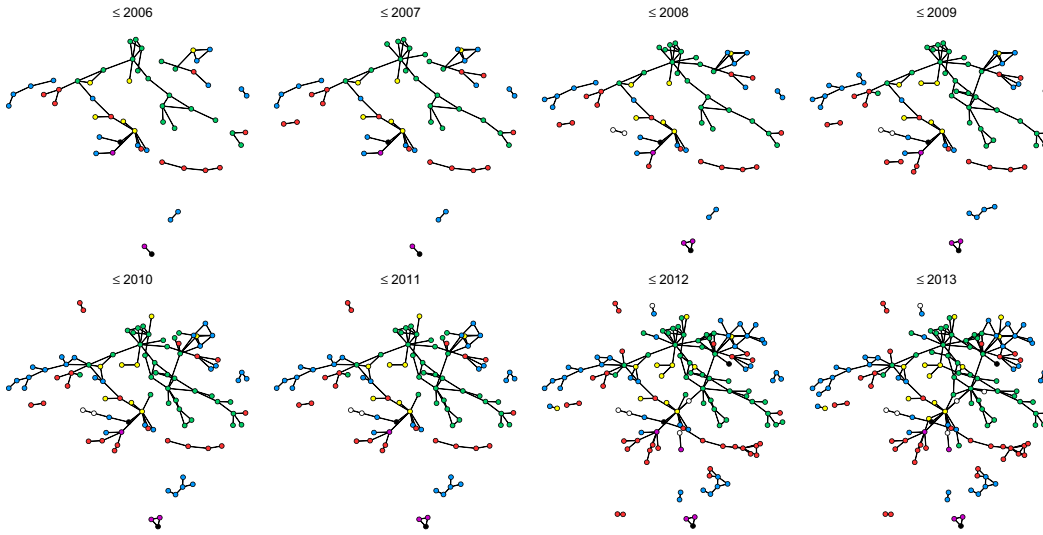
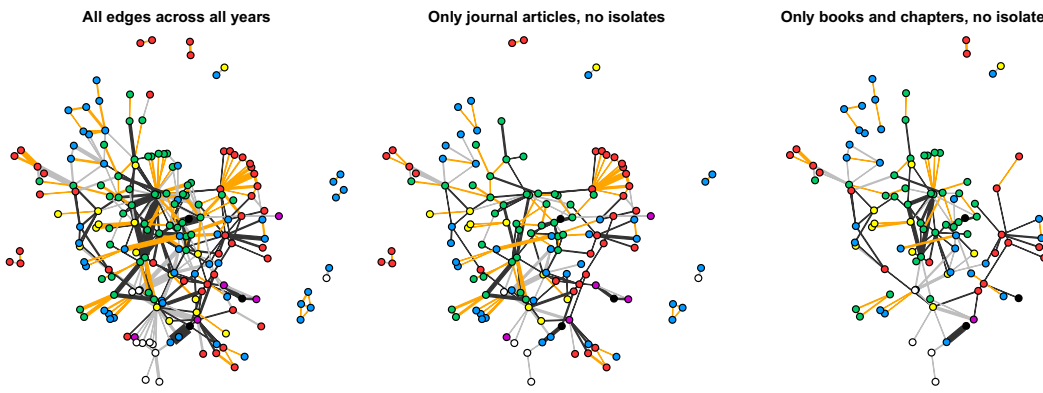



Figure 4: The journal article vs. book (chapter) sub-networks. Isolates are not displayed. Orange lines are within-chair or within-team co-authorship ties, gray lines indicate co-authorship within the same institute but not in the same team or chair, black lines are cross-institutional ties. Colors are subfields (see Figure 2)




monographs, and edited volumes). Several observations can be made: First, Swiss political scientists engage in more co-authorship when publishing articles (second panel) than books or chapters (third panel); the article network is denser and its "giant component" has a smaller diameter. Second, the overall co-authorship pattern does not change considerably when distinguishing between publication types. Policy analysis is still the most connected co-authorship sub-discipline in both sub-networks. However, co-authorship is more mixed across subfields in the journal article network: the policy cluster is not as homogenous in the article network as in the book network.

Table 2: Betweenness centrality in the one-mode network. Top 25 researchers[4]

| | Betweenness centrality | Affiliation | Subfield |
|---|---|---|---|
| Sciarini, P. | 3064,22 | Uni-GE | Swiss Politics |
| Kübler, D. | 2968,63 | Uni-ZH | Public Policy and Administration |
| Varone, F. | 2420,52 | Uni-GE | Public Policy and Administration |
| Bernauer, T. | 1897,01 | ETH-ZH | International Relations |
| Knoepfel, P. | 1841,26 | IDHEAP-LS | Public Policy and Administration |
| Sager, F. | 1568,88 | KPM-BE | Public Policy and Administration |
| Ladner, A. | 1376,42 | IDHEAP-LS | Swiss Politics |
| Leresche, J. | 1303,39 | Uni-LS | Public Policy and Administration |
| Hug, S. | 1118,06 | Uni-GE | Political Methodology |
| Lavenex, S. | 1000,87 | Uni-LU | International Relations |
| Widmer, T. | 966,87 | Uni-ZH | Public Policy and Administration |
| Mazzoleni, O. | 913,10 | Uni-LS | Comparative Politics |
| Bühlmann, M. | 908,17 | Uni-BE | Comparative Politics |
| Freitag, M. | 892,00 | Uni-BE | Comparative Politics |
| Mach, A. | 866,05 | Uni-LS | Public Policy and Administration |
| Vatter, A. | 704,79 | Uni-BE | Swiss Politics |
| Papadopoulos, Y. | 644,41 | Uni-LS | Public Policy and Administration |
| Bochsler, D. | 638,78 | Uni-ZH | Comparative Politics |
| Armingeon, K. | 592,55 | Uni-BE | International Relations |
| Michaelowa, K. | 592,24 | Uni-ZH | Comparative Politics |
| Fillieule, O. | 579,76 | Uni-LS | Comparative Politics |
| Gilardi, F. | 524,77 | Uni-ZH | Public Policy and Administration |
| Häusermann, S. | 519,55 | Uni-ZH | Swiss Politics |
| Ingold, K. | 483,21 | Uni-BE | Public Policy and Administration |
| Zimmermann, W. | 447,18 | ETH-ZH | Public Policy and Administration |

Orange ties in Figure 4 indicate co-authorship within the same team or chair, and gray edges indicate co-authorship at the same institute or university (but not in the same group). In all three panels of Figure 4, orange and gray ties are very prevalent.

### *4.2 Most active and central researchers within Switzerland*

Table A1 in the Appendix gives an overview of the 25 researchers with the largest number of publications, irrespective of publication type or co-authorship. Not surprisingly, this list exclusively contains professors and senior researchers who have been integrated into academia for several decades after their PhD (see also Bernauer and Gilardi 2010). Knoepfel, A. Michaelowa and Varone are the Swiss researchers with the largest output quantity (261, 248, and 191 items, respectively).

To answer the question who are the structurally most central political scientists in the co-authorship network, Table 2 shows the 25 researchers with the highest betweenness centrality scores. Betweenness centrality expresses how often an actor lies on the shortest path between two other actors. Betweenness centrality is an indicator of researchers'

[4] For exact interpretation of the betweenness centrality values, see Hennig et al. (2012: 126). Note, however, that only the relative order, rather than the exact magnitude, matters for interpretation (Hennig et al. 2012: 128).

Table 3: Eigenvector centrality in the one-mode network. Top 25 researchers[5]

| | Eigenvector centrality | Affiliation | Subfield |
|---|---|---|---|
| Kübler, D. | 0,36 | Uni-ZH | Public Policy and Administration |
| Sager, F. | 0,26 | KPM-BE | Public Policy and Administration |
| Varone, F. | 0,25 | Uni-GE | Public Policy and Administration |
| Sciarini, P. | 0,24 | Uni-GE | Swiss Politics |
| Widmer, T. | 0,21 | Uni-ZH | Public Policy and Administration |
| Hirschi, C. | 0,19 | ETH-ZH | Public Policy and Administration |
| Vatter, A. | 0,19 | Uni-BE | Swiss Politics |
| Zimmermann, W. | 0,18 | ETH-ZH | Public Policy and Administration |
| Knoepfel, P. | 0,18 | IDHEAP-LS | Public Policy and Administration |
| Frey, K. | 0,17 | Uni-ZH | Public Policy and Administration |
| Bühlmann, M. | 0,16 | Uni-BE | Comparative Politics |
| Van Der Heiden, N. | 0,16 | Uni-ZH | Public Policy and Administration |
| Stadelmann-Steffen, I. | 0,15 | Uni-BE | Comparative Politics |
| Ladner, A. | 0,15 | IDHEAP-LS | Swiss Politics |
| Ingold, K. | 0,14 | Uni-BE | Public Policy and Administration |
| Widmer, C. | 0,13 | Uni-ZH | Public Policy and Administration |
| Freitag, M. | 0,13 | Uni-BE | Comparative Politics |
| Rüegg, E. | 0,12 | Uni-ZH | Public Policy and Administration |
| Widmer, A. | 0,12 | ETH-ZH | Public Policy and Administration |
| Papadopoulos, Y. | 0,12 | Uni-LS | Public Policy and Administration |
| Plüss, L. | 0,12 | Uni-ZH | Public Policy and Administration |
| Koch, P. | 0,11 | Uni-ZH | Public Policy and Administration |
| Milic, T. | 0,11 | Uni-ZH | Swiss Politics |
| Leresche, J. | 0,1 | Uni-LS | Public Policy and Administration |
| Thomann, E. | 0,1 | KPM-BE | Public Policy and Administration |

ability to connect otherwise disconnected authors (and thus sub-communities) through joint publications. For the cohesiveness of the discipline (whether for good or bad), such "connectors" or "mediators" seem crucial, as they are able to control scientific information flows and transport and disseminate ideas through personal contact (Newman 2004: 5204), shape content-wise conceptualization of a field (Mutschke 2004: 153), and are particularly visible (Metz and Jäckle 2013: 289).

Sciarini is the researcher with the highest betweenness centrality. Being attributed to the field of Swiss politics, a rather small sub-discipline in the overall network, this scholar manages to link researchers from various other fields and universities in Swiss political science. He is followed by Kübler and Varone, both active in public policy and integrating this field through frequent publication activities. But they additionally link researchers from other subfields through co-authorship activities and publish with co-authors from different geographical and language areas.

Table 3 shows the top 25 researchers with regard to eigenvector centrality, a measure of the tendency to be part of the "influence core" of the network by being surrounded by other important nodes. There are some similarities to the data displayed in the

[5] For exact interpretation of the eigenvector centrality values, see Hennig et al. (2012: 127). Note, however, that only the relative order rather than the exact magnitude matters for interpretation (Hennig et al. 2012: 128).

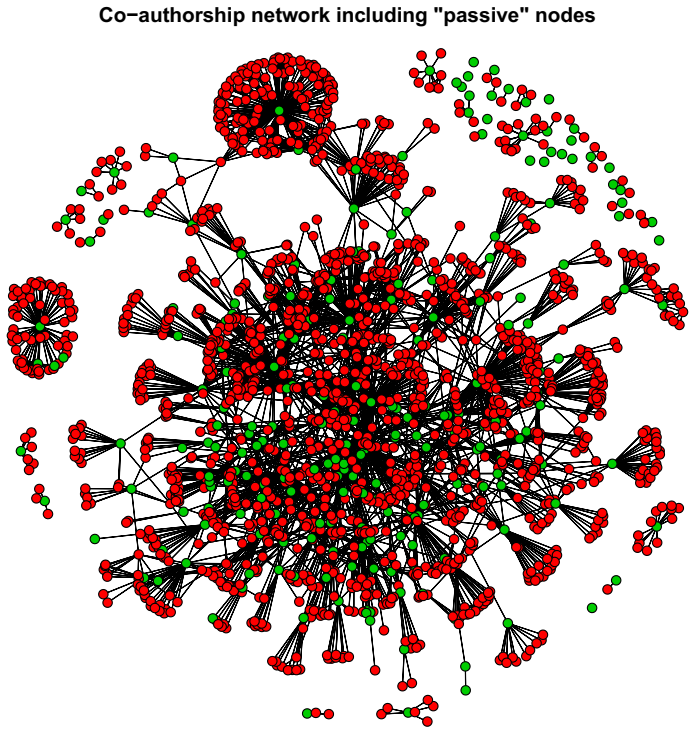
 

betweenness table (Table 2), but also notable differences. As public policy and administration make up the core of the network, many researchers from this subgroup also have large eigenvector centrality scores. The top three central researchers are Kübler, Sager and Varone.

The centralities presented here come very close to the index Metz and Jäckle (2013: 287) calculated, and the results are comparable. Therefore, it might not be a surprise that the four most central Swiss scholars in their study (Freitag, Vatter, Bühlmann, Sciarini) also rank among the most central authors in our study. The remaining differences in results can be explained by two factors: first, Metz and Jäckle (2013) only relied upon 20 German-language journals rather than the full range of publications, thus the picture provided here is more complete and also covers English publications and book publications. Second, due to their omitted English and book publications, their network is sparser than the complete network and consists of several disconnected components. Metz and Jäckle (2013) compute the centrality scores separately for the three largest components. We prefer computing centrality over the whole co-authorship network; this is possible because we find one "giant component" (see Figures 2–5) rather than separate, relatively large components.

Table 3 contains considerably more junior scientists than Table 2. This follows from the definition of eigenvector centrality: if a node is connected to another node that occupies a

Figure 5: All co-authorship ties including former, retired, international and non-political-science co-authors. Green nodes are Swiss political scientists; red nodes are other co-authors listed in their publications



central position in a network's influence core, this increases the node's own centrality ranking. Comparable results were also observed in Metz and Jäckle's (2013) analysis where young scholars entered their top-20 ranking only by being connected to senior and well embedded co-authors. This kind of "pedigree" may or may not transform into actual influence in their further career trajectory.

Another notable aspect is that some well-known political researchers at Swiss universities are absent from the lists or play a minor structural role despite their successful publication records and international visibility (e.g., through international awards or prestigious grant acquisitions). These researchers gain reputation mainly from international collaborations and their position in the international political science network as well as single-authored publications, rather than structural positions in the Swiss co-authorship network.[6]

### *4.3 International and interdisciplinary co-authorship*

In the analyses presented so far, only political scientists affiliated with Swiss universities in 2013 and engaging in co-authorship activities with other political scientists from Swiss universities have been considered. However, ignoring co-authorship with researchers who are not affiliated with a Swiss institute as a political scientist would draw an incomplete picture of the national discipline (Cancela et al. 2014). This is why we include, in a second step, co-authorship ties that relate a Swiss political scientist to colleagues from other disciplines or international peers. It would be beyond the scope of this article to identify and classify all these foreign, interdisciplinary, or formerly Swiss researchers and their publication patterns. These include retired professors, Swiss political scientists who moved to other countries, researchers from other disciplines, and international collaborators. However, by treating nodes that do not qualify as political scientists at Swiss universities in the year 2013 as "passive nodes" and including them in the visualization and centrality analysis, we can draw a more complete picture with regard to the national political researchers.

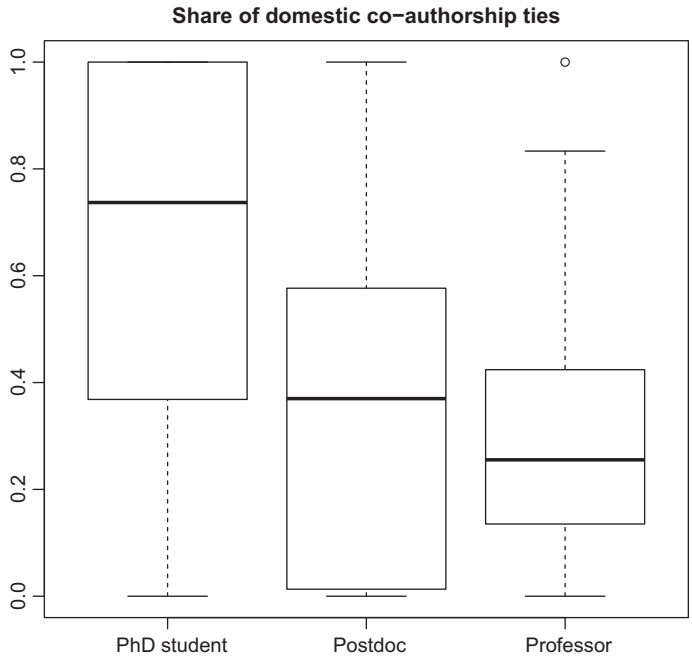
Figure 5 shows this comprehensive network. Swiss political scientists (green nodes) strongly engage in international and interdisciplinary co-authorship relations (red nodes). Whereas the Swiss network (Figures 2 to 4) was still clear and easily interpretable, this broader network is denser and more complex.

An interesting question is whether political scientists in Switzerland tend to collaborate with each other or with other researchers. Figure 6, which is derived from Figure 5, shows that the minority of ties occurs between domestic political scientists, but this pattern varies by seniority status. Doctoral students publish mostly within their local environment (i.e., members of their team, chair or university), and only later more far-reaching contacts are established. Professors tend to have more than two thirds of their collaborators outside Switzerland or outside the discipline.

[6] Overall performance of researchers, rather than structural position, may be measurable by retrieving citation metrics for all 5,751 publications by matching their titles and authorship information with the entries of online databases like Google Scholar (or possibly other databases that include non-peer-reviewed publications). However, this would imply a strong bias in favor of senior professors whose publications have had more time to be cited and would discount the performance of young researchers whose future citations cannot be taken into account. Finding an appropriate methodology for tackling this problem may be a topic for future research. Here, the focus is on the structural position of researchers in the national field of Swiss political research.

Figure 6: Share of domestic co-authors per researcher




Finally, Table 4 shows the betweenness centrality scores of the top 25 researchers in the extended network. A comparison with Table 1, the betweenness scores of the domestic political science network, reveals that some researchers are able to achieve high scores in both versions of the network while there are other researchers who only score high in one of them. For example, Mosler is ranked 24$^{th}$ even though he is an environmental psychologist at Eawag, the water research institute of ETH domain in Zurich, and has only three joint publications with political scientists: one with Bernauer and two with Günther. Both researchers are highly connected, but belong to different communities, which causes Mosler to have a relatively high connective capacity. This explains why an "outsider" to political science is able to rank highly with regard to betweenness centrality. Similarly, A. Michaelowa (ranked 4$^{th}$) is an economist by training but is indirectly connected to a group of international relations scholars at ETHZ as well as K. Michaelowa. Moreover, he has several co-authors who are connected to different parts of the domestic network or to other "passive" nodes.

D. Schwarz (ranked 25$^{th}$) was a postdoctoral fellow at the London School of Economics at the time of data collection and is now at the University of Bern. He is connected to other highly connected researchers at different Swiss universities, e.g., A. Vatter (Uni-BE), A. Ladner (Uni-LS), A. Bächtiger (Uni-LU), G. Lutz (Uni-LS), and L. Goetschel (Uni-BL), but is only listed in Table 4 because of his expatriate status. Another interesting case is Kriesi, who is one of the most prominent political scientists in Switzerland, but has recently moved to the European University Institute in Italy. He still has an important bridging function in the Swiss network, even though he enters the network as a "passive node" (i.e., through co-authorship with political scientists currently affiliated with a Swiss university).

Table 4: Betweenness centrality in the comprehensive network (including "passive" nodes). Top 25 researchers

| Researcher | Betweenness centrality | Affiliation | Subfield |
|---|---|---|---|
| Ladner, A. | 260409,54 | Uni-LS | Swiss Politics |
| Kübler, D. | 259250,04 | Uni-ZH | Public Policy and Administration |
| Michaelowa, K. | 249505,12 | Uni-ZH | Comparative Politics |
| Michaelowa, A. | 228682,9 | Uni-ZH | Comparative Politics |
| Bernauer, T. | 216197,25 | ETH-ZH | International Relations |
| Knoepfel, P. | 204172,03 | Uni-LS | Public Policy and Administration |
| Varone, F. | 197204,5 | Uni-GE | Public Policy and Administration |
| Lavenex, S. | 153222,56 | Uni-LU | International Relations |
| Leresche, J. | 127044,34 | Uni-LS | Public Policy and Administration |
| Sager, F. | 126510,41 | Uni-BE | Public Policy and Administration |
| Kriesi, H. | 107828,9 | EUI | Comparative Politics |
| Sciarini, P. | 102353,41 | Uni-GE | Swiss Politics |
| Mazzoleni, O. | 88118,64 | Uni-LS | Comparative Politics |
| Bühlmann, M. | 83313,22 | Uni-BE | Comparative Politics |
| Widmer, T. | 78647,63 | Uni-ZH | Public Policy and Administration |
| Hug, S. | 73743,02 | Uni-GE | Political Methodology |
| Ingold, K. | 59311,88 | Uni-BE | Public Policy and Administration |
| Steenbergen, M. | 56929,6 | Uni-ZH | Political Methodology |
| Armingeon, K. | 55197,06 | Uni-BE | International Relations |
| Fillieule, O. | 54875,73 | Uni-LS | Comparative Politics |
| Mach, A. | 49306,93 | Uni-LS | Public Policy and Administration |
| Vatter, A. | 47607,87 | Uni-BE | Swiss Politics |
| Giugni, M. | 46378,94 | Uni-GE | Public Policy and Administration |
| Mosler, H. | 45024 | Uni-ZH | Psychology |
| Schwarz, D. | 42641,94 | LSE | Public Policy and Administration |

## 5. Discussion and conclusion

In this article, we have characterized scientific collaboration between political researchers in Switzerland. In contrast to other relational attempts at describing the discipline (both in Switzerland and elsewhere), an important advantage of our study is that we have considered nearly all publications ever produced by any researcher currently (in the second half of 2013) affiliated with a political science or public administration institute in Swiss universities. This includes book chapters and other publications that are hard to access in publication databases. This comprehensive approach to data collection makes a crucial difference because Swiss political science is composed of institutes and universities with very different publication strategies and cultures. Focusing only on one type of publication, like journal articles or one language like English, German or French would have missed out on an important part of the domestic discipline. This is at the same time one of our most interesting substantive findings: even though the discipline at large is somewhat connected across language and regional borders, there is nonetheless clear evidence for differential publication strategies or cultures with regard to what publication types or outlets institutes deem important in their communication of scientific findings, and these publication strategies or cultures are clustering by institution and partly language region.

A related finding is that Swiss political science is held together by a group of researchers broadly engaged in public policy and administration research from various universities

across the country. Were these public policy and administration researchers not there, the Swiss co-authorship network would no longer have one single "giant component" and it would literally "fall apart." This integrative role of policy topics may seem surprising to some, but an explanation may be that public policy and administration are *per se* relatively broad fields with topics that are related to other subfields. By contrast, international relations and, especially, comparative politics have several insulated sub-communities in the Swiss co-authorship network. As discussed in the theoretical section, bridging these communities may be advantageous from an individual perspective but may potentially hamper scientific progress collectively.

Another important fact about co-authorship in Swiss political science seems to be that communities are driven by a combination of several factors: geographic (and language) proximity, shared institutional affiliations and—most importantly—joint research topics as operationalized by the classification of researchers into subfields.

The network approach we have adopted in this article has allowed us to overcome the complexity and information overload of bibliographic data (Mutschke 2004) and analyze Swiss political science at multiple levels. Besides conclusions about the structure and cohesion of the co-authorship network and its communities, we are able to enumerate precisely who is structurally important for the national discipline by a) connecting different branches of the network through joint publication activities and/or b) belonging to the "inner circle" of highly connected researchers. Interestingly, some of the most structurally important researchers, depending on the measure being employed, come from very different universities, like the University of Zurich (Kübler), University of Geneva (Sciarini, Varone), ETH Zurich (Bernauer), and the University of Bern (Sager). This leads us to conclude that the Swiss political science community is relatively well integrated and consolidated (Arzheimer and Schoen 2009) when it comes to collaboration across regions and language borders, while some of the specific communities (see, for example, the blue nodes in Figure 2) still talk past each other, which may be due to different publication profiles existing across departments (see Figure 1).

Finally, one may have different views on whether Swiss political science is a typical or special case in terms of co-authorship, collaboration patterns and disciplinary cohesion. Whether one tends toward one or the other opinion depends on the group one chooses for comparison. On the one hand, Switzerland may be comparable with other continental European countries, in that it is currently in the middle of a transition from domestically to internationally oriented research, which entails writing in English, publishing in international journals, teaming up with co-authors from other countries and engaging in replicable and systematic inquiry. Time will tell if this development will continue or if the current bifurcation on these variables in Swiss political science will persist over the years. On the other hand, Swiss political science may potentially be viewed as special because it manages to integrate different regions in joint publication activities. Future research should evaluate to what extent this is a general trend that is observable in multilingual countries including Belgium and Canada, for example.

## References

Abadie, A., S. Athey, G. W. Imbens and J. M. Wooldridge (2014). Finite Population Causal Standard Errors. National Bureau of Economic Research (NBER) Working Paper no. w20325.

Arendes, C. (2004). *Politikwissenschaft in Deutschland. Standorte, Studiengänge und Professorenschaft 1949-1999*. Wiesbaden: VS Verlag für Sozialwissenschaften.

Armingeon, K. (1997). Karrierewege der Professoren und Professorinnen der Politikwissenschaft in der Schweiz, Österreich und Deutschland. *Swiss Political Science Review* 3(2): 1–15.

Arzheimer, K. and H. Schoen (2009). Isoliert oder gut vernetzt? Eine vergleichende Exploration der Publikationspraxis in der PVS. *Politische Vierteljahresschrift* 50(3): 604–626.

Barabási, A., H. Jeong, Z. Néda, E. Ravasz, A. Schubert and T. Vicsek (2002). Evolution of the social network of scientific collaborations. *Physica A* 311(3–4): 590–614.

Baur, M., M. Benkert, U. Brandes, S. Cornelsen, M. Gaertler, B. Köpf, J. Lerner and D. Wagner (2002). Visone Software for Visual Social Network Analysis. In Mutzel, P., M. Jünger and S. Leipert (eds.), *Graph Drawing. Proceedings of 9th International Symposium,GD 2001* Vienna/Berlin/Heidelberg: Springer (463–464).

Bernauer, T. and F. Gilardi (2010). Publication Output of Swiss Political Science Departments. *Swiss Political Science Review* 16(2): 279–303.

Bonacich, P. (1987). Power and Centrality: A Family of Measures. *American Journal of Sociology* 92 (5): 1170–1182.

Cancela, J., T. Coelho and J. Ruivo (2014). Mapping Political Research in Portugal: Scientific Articles in National Academic Journals (2000-2012). *European Political Science* 13(4): 327–339.

Falagas, M., E. Pitsouni, G. Malietzis and G. Pappas (2008). Comparison of PubMed, Scopus, Web of Science, and Google Scholar: Strengths and Weaknesses. *The FASEB Journal* 22(2): 338–342.

Fisher, B., C. Cobane, T. Vander Ven and F. Cullen (1998). How Many Authors Does It Take to Publish an Article? Trends and Patterns in Political Science. *Political Science and Politics* 31(4): 847–856.

Freeman, L. (1979). Centrality in social networks: Conceptual clarification. *Social Networks* 1: 215–239.

Goldie, D., M. Linick, H. Jabbar and C. Lubienski (2014). Using Bibliometric and Social Media Analyses to Explore the "Echo Chamber" Hypothesis. *Educational Policy* 28(2): 281–305.

Gottraux, P., P. Schorderet and B. Voutat (2004). La création de l'Association suisse de science politique: émergence d'une discipline scientifique (1951-1959). *Swiss Political Science Review* 10(1): 1–28.

Grossman, J. (2002). Patterns of Collaboration in Mathematical Research. *SIAM News* 35(9): 8–9.

Güdler, J. (2003). *Kooperationsnetzwerke in der Forschung. Entstehung, Struktur und Wirkung am Beispiel der Soziologie*. Bonn: Informationszentrum Sozialwissenschaften.

Handcock, M., D. Hunter, C. Butts, S. Goodreau and M. Morris (2008). statnet: Software Tools for the Representation, Visualization, Analysis and Simulation of Network Data. *Journal of Statistical Software* 24(1): 1–11.

Hennig, M., U. Brandes, J. Pfeffer and I. Mengel (2012). *Studying Social Networks: A Guide to Empirical Research*. Frankfurt-on-Main: Campus Verlag.

Leahey, E. and R. Reikowsky (2008). Research Specialization and Collaboration Patterns in Sociology. *Social Studies of Science* 38(3): 425–440.

Linder, W. (1996). Schweizerische Politikwissenschaft: Entwicklungen der Disziplin und ihrer Literatur. *Swiss Political Science Review* 2(4): 1–29.

Metz, T. and S. Jäckle (2013). Koautorenschaften in der deutschsprachigen Politikwissenschaft – Eine Netzwerkanalyse auf Basis von Fachzeitschriftenartikeln. *Politische Vierteljahresschrift* 54(2): 256–291.

Moody, J. (2004). The Structure of a Social Science Collaboration Network: Disciplinary cohesion from 1963 to 1999. *American Sociological Review* 69(2): 213–238.

Mutschke, P. (2004). Autorennetzwerke: Netzwerkanalyse als Mehrwertdienst für Informationssysteme. In Bekavac, B., J. Herget and M. Rittberger (eds.), *Informationen zwischen Kultur und Marktwirtschaft. Proceedings des 9. Internationalen Symposiums für Informationswissenschaft (ISI 2004)*, Chur/Konstanz: UVK (141–162).

Mutschke, P. and I. Renner (1995). Wissenschaftliche Akteure und Themen im Gewaltdiskurs. Eine Strukturanalyse der Forschungslandschaft. In Mochmann, E. and U. Gerhard (eds.), *Gewalt in Deutschland. Soziale Befunde und Deutungslinien*. Munich: Oldenbourg Verlag (147–192).

Newman, M. (2001). Scientific collaboration networks. I. Network construction and fundamental results. *Physical Review E* 64(1): 016131/1–016131/8.

—— (2004). Coauthorship networks and patterns of scientific collaboration. *PNAS* 101(1): 5200–5205.

Plümper, T. and F. Schimmelfennig (2007). Wer wird Prof – und wann? Berufungsdeterminanten in der deutschen Politikwissenschaft. *Politische Vierteljahresschrift* 48(1): 97–117.

R Core Team (2015). *R: A Language and Environment for Statistical Computing*. Vienna: R Foundation for Statistical Computing.

Western, B. and S. Jackman (2004). Bayesian Inference for Comparative Research. *American Political Science Review* 88(2): 412–423.

White, H. (2003). Pathfinder networks and Author Cocitation Analysis: A Remapping of Paradigmatic Information Scientists. *Journal of the American Society for Information Science and Technology* 54(5): 423–434.

Zuccala, A. (2005). Modeling the Invisible College. *Journal of the American Society for Information Science and Technology* 57(2): 152–168.

## Appendix

Table A1: Researchers with the largest publication portfolio, irrespective of publication type

| | Publications | Affiliation | Subfield |
|---|---|---|---|
| Knoepfel, P. | 261 | IDHEAP-LS | Public Policy and Administration |
| Michaelowa, A. | 248 | Uni-ZH | Comparative Politics |
| Varone, F. | 191 | Uni-GE | Public Policy and Administration |
| Kübler, D. | 188 | Uni-ZH | Public Policy and Administration |
| Armingeon, K. | 184 | Uni-BE | International Relations |
| Widmer, T. | 147 | Uni-ZH | Public Policy and Administration |
| Schimmelfennig, F. | 140 | ETH-ZH | Comparative Politics |
| Sager, F. | 130 | KPM-BE | Public Policy and Administration |
| Bernauer, T. | 127 | ETH-ZH | International Relations |
| Braun, D. | 118 | Uni-LS | Public Policy and Administration |
| Giugni, M. | 114 | Uni-GE | Comparative Politics |
| Sciarini, P. | 113 | Uni-GE | Swiss Politics |
| Hug, S. | 104 | Uni-GE | Political Methodology |
| Leresche, J. | 104 | Uni-LS | Public Policy and Administration |
| Lavenex, S. | 99 | Uni-LU | International Relations |
| Ladner, A. | 99 | IDHEAP-LS | Swiss Politics |
| Ruloff, D. | 98 | Uni-ZH | International Relations |
| Balthasar, A. | 97 | Uni-LU | Swiss Politics |
| Vatter, A. | 95 | Uni-BE | Swiss Politics |
| Mazzoleni, O. | 92 | Uni-LS | Comparative Politics |
| Kappel, R. | 83 | ETH-ZH | Comparative Politics |
| Blatter, J. | 81 | Uni-LU | Political Theory |
| Freitag, M. | 80 | Uni-BE | Comparative Politics |
| Fillieule, O. | 77 | Uni-LS | Comparative Politics |
| Schwok, R. | 76 | Uni-GE | International Relations |

Table A2: Researchers with the largest journal article portfolio

| | Articles | Affiliation | Subfield |
|---|---|---|---|
| Michaelowa, A. | 110 | Uni-ZH | Comparative Politics |
| Varone, F. | 73 | Uni-GE | Public Policy and Administration |
| Bernauer, T. | 62 | ETH-ZH | International Relations |
| Vatter, A. | 57 | Uni-BE | Swiss Politics |
| Schimmelfennig, F. | 54 | ETH-ZH | Comparative Politics |
| Hug, S. | 53 | Uni-GE | Political Methodology |
| Freitag, M. | 51 | Uni-BE | Comparative Politics |
| Armingeon, K. | 51 | Uni-BE | International Relations |
| Sager, F. | 49 | KPM-BE | Public Policy and Administration |
| Sciarini, P. | 47 | Uni-GE | Swiss Politics |
| Giauque, D. | 44 | Uni-LS | Public Policy and Administration |
| Knoepfel, P. | 40 | IDHEAP-LS | Public Policy and Administration |
| Giugni, M. | 39 | Uni-GE | Comparative Politics |
| Braun, D. | 38 | Uni-LS | Public Policy and Administration |
| Lavenex, S. | 36 | Uni-LU | International Relations |
| Widmer, T. | 34 | Uni-ZH | Public Policy and Administration |
| Cederman, L. | 34 | ETH-ZH | International Relations |
| Kübler, D. | 33 | Uni-ZH | Public Policy and Administration |
| Schwok, R. | 32 | Uni-GE | International Relations |
| Graz, J. | 30 | Uni-LS | International Relations |
| Bonoli, G. | 29 | IDHEAP-LS | Comparative Politics |
| Pflieger, G. | 28 | Uni-GE | Public Policy and Administration |
| Leresche, J. | 28 | Uni-LS | Public Policy and Administration |
| Steenbergen, M. | 27 | Uni-ZH | Political Methodology |
| Koubi, V. | 26 | ETH-ZH | International Relations |

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