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The political shaping of scientific fields in Argentina's Pesticide Conflict: Evidence from domain-topic model analysis

Preliminary paper submitted for inclusion in the 2023 ASA Annual Meeting

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SUMMARY

Part of a larger, ethnographic and interview-based study of experts and expert networks in the Argentina's pesticide conflict, this paper investigates the relationship between two processes that unfolded simultaneously during 2000-2020: the development of the anti-spraying movement and the emergence of a new national scientific field on the health and environmental effects of pesticides. To understand how mobilized experts have shaped the scope and direction of Argentine pesticide research we employ domain-topic models to analyze a bibliographic corpus of scientific publications of Argentine researchers collected from the Web of Science Core Collection (1990-2023). We describe the thematic and relational structure of Argentine pesticide research and, subsequently, locate those research domains aligned with the interests of the anti-spraying movement to follow and characterize the participation of previously identified scientists allied with the movement. Our theoretical goal is to advance two novel theories within the Political Sociology of Science that propose a network based, symmetrical institutional analysis of the dynamics and impacts of expert activism.

Introduction

Beginning around 2000, a people's movement began to emerge from GMO soy-producing regions of Argentina. Intensive application of glyphosate and other pesticides was contaminating air, waterways and nearby communities, raising serious health and ecological concerns. In this context, activists demanded that national, state and municipal governments more strictly regulate pesticide use, especially spraying of transgenic crops. Since 2000, the anti-spraying movement has grown in size and scope and has attracted many experts, including doctors and nurses, teachers, journalists, agronomic engineers and lawyers, as well as academic faculty and graduate students from a range of disciplines, from environmental sciences to genetic toxicology to sociology (Arancibia, 2013).

Over the same period, a new field of Argentine pesticide research surged into existence in parallel to the anti-spraying movement, centered in university laboratories in the capital Buenos Aires and in some of the regional universities in the country's rural and peri-urban soy-producing regions. According to Clarivate's *Web of Science* database, Argentinian researchers' participation in published studies relating to the production, characterization, use, and diverse impacts of pesticides grew from 25 articles per year between 1990-1999 to 167 per year during 2010-2019; total publications in the Argentinian pesticide research field rose from 40 publications at the start of 1990 to 3,304 articles by 2023.

Part of a larger, ethnographic and interview-based study of experts and expert networks in the anti-spraying movement that we initiated in 2019 (Arancibia *et al.*, 2022; Frickel and Arancibia, 2022), this paper investigates the relationship

between two emergent fields caught up in the struggle – one political and one scientific (Sosa *et al.*, 2019). Our prior research has identified more than 130 experts who have contributed their expertise to the movement, including more than 60 academic scientists. To understand how mobilized experts have shaped the scope and direction of Argentine pesticide research here we employ domain-topic models and corresponding network analysis and co-word analysis (Hannud Abdo *et al.*, 2022). We work with a bibliographic corpus starting from a large sample of scientific publications collected from the *Web of Science Core Collection* (1990-2023), to describe the thematic and relational structure of Argentine pesticide research. Subsequently, we locate those research domains aligned with the interests of the anti-spraying movement and follow and characterize the participation of our previously identified academic experts. Our theoretical goal is to advance political sociology of science (Frickel and Moore, 2006) by studying how experts allied with the anti-spraying movement have embedded the pesticide research field and promoted the production of science that was critical to advancing the movement's goals (Arancibia and Motta, 2019).

Theoretical Motivation

Both social movement and STS scholars have long paid attention to the complex relationship between experts, science and social movements. Extant studies show how social movements have enhanced public participation in scientific and technical decision-making, encouraged inclusion of popular perspectives in expert fields, and contributed to changes in policy making processes that favor democracy. However, the current understanding of this phenomenon remains limited, as most studies have emphasized localized episodes of protest or the

activities of specific social movement organizations, following those experts whose involvement in particular episodes of struggle render them visible to case study researchers. In this way, these studies have ignored the collective, heterogeneous, and complex nature of expert activism, as well as the symmetrical and productive character of expert-movement interactions (Frickel, 2011; Arancibia, 2016).

Frickel's and Eyal's theories of expert activism and expertise can help to study these underexplored topics. Addressing different research questions, Frickel and Eyal both recognize the importance of networks and institutions. Frickel argues that experts are mobilized into heterogeneous, boundary-spanning networks embedded in specific disciplinary and professional structures (Frickel, Torcasso and Anderson, 2015; Frickel *et al.*, 2022). Eyal looks at the production of new expertise and argues for a relational conceptualization of expertise as something carried out by heterogeneous networks (and which include “non-experts” in the traditional sense) (Eyal, 2010; Eyal *et al.*, 2010). Synthesizing the two frameworks allows observation of not only how networks of expert-activists interpenetrate social movements, but also how new expertise is produced and carried through these networks and is shaped by institutional variables.

Networks that link community and activists with academic, government and clinical researchers and other professionals can alter the social structure of knowledge formations and can inspire epistemic innovation (Eyal, 2013). This is very important: it is known that the capacity of producing new knowledge is critical for challenging political-scientific consensus that perpetuate environmental injustice, as the idea of “undone science” (Hess, 2007; Woodhouse, Hess, Breyman, & Martin, 2002) suggests. This paper intends to contribute towards the two theories by empirically analyzing how new scientific domains have developed from a

network that connects experts and activists of the anti-spraying movement in Argentina.

Context

Argentina is the world's third largest producer and exporter of genetically modified (GM) soy. The rapid adoption of Ready Roundup Soy®, a biotechnology developed by Monsanto that pairs GM soy seeds with intensive use of glyphosate-based pesticides, spurred radical changes in the domestic agrarian system and gave rise to a new GMO agribusiness regime (Gras and Hernández, 2013). The rise of crop yields and subsequent increase of exports during the 2000s "commodities boom" softened traditional balance-of-payment constraints (Teubal, 2008), and encouraged broad political support for the emerging regime from right- and left-wing governments alike. Aided by the absence of federal laws regulating pesticides (Paz Belada, 2017), the new regime also has had growing ecological and public health consequences for rural and peri-urban communities of GM crops producing provinces (Leguizamón, 2014).

In response, since the early 2000s communities have organized protests claiming that pesticide spraying was linked to the growing prevalence of multiple pathologies (developmental abnormalities, cancers, miscarriages, among others). Identifying themselves as Pueblos Fumigados (Sprayed Villages), the movement spread across the country (Arancibia, 2013) and gained traction as a public issue. Still, the movement has encountered substantial obstacles as has yet to inspire concrete regulatory change at the national level. One of the main challenges has been the absence of "scientific proof", which government officials use as justification for regulatory and legislative inaction.

In the movement's early stages, few Argentinian scientists were studying the environmental and health effects of pesticides; effectively, an Argentinian field of pesticide effects research did not exist. Facing conditions of "undone science" (Arancibia and Motta, 2019), activists from the *Sprayed Villages* movement have allied with scientists and health experts to conduct environmental, clinical or epidemiological studies to support their claims. Many of these studies were successfully used by the movement to promote change at the local (municipal or provincial) level: endorsing ordinances or laws restricting the use of pesticides, pursuing lawsuits to protect public health, and promoting agroecology.

As we document elsewhere (Frickel and Arancibia, 2022) a significant outcome of the anti-spraying movement has been the growing production and mobilization of scientific, medical and public health expertise alongside legal expertise across the Academia, courts, legislatures, public offices, and the mass media. A steadily increasing roster of lawyers, scientists, physicians and other health experts represents incipient nodes in an expanding network of experts mobilized by the struggle. Other studies using more traditional bibliometric approaches confirm that Argentina is now a major world producer of glyphosate science (Zyoud *et al.*, 2017) and since the 2000s, has become the second leading producer articles on two critical and underrepresented topics on glyphosate: human health and the environment (Sosa *et al.*, 2019). The present study uses topic-domain modeling techniques to chart the anti-spraying movement's role in shaping a new field of Argentine science focused on agricultural pesticides.

Data and Methods

We collect our data from the Web of Science Core Collection through their API service, using a broad query based on the key terms “pesticide”, “herbicide”, “insecticide” and “fungicide”, enriched with the specific names of certain substances pointed to us by a domain expert, and restricted to articles with Argentinian participation/authorship. This main corpus contains 3,304 documents, of which the 109 in Spanish and 18 in Portuguese provide English abstracts. Over 8,000 authors contribute to the corpus, representing more than 2,000 academic, government, and commercial organizations and publishing in close to 900 different journals.

To make sense of this volume and diversity of information, we employ domain-topic models with chained dimensions (Hannud Abdo *et al.*, 2022). This method is useful because, on the one hand, it allows us to perform multi-scale, simultaneous grouping of similar documents (document clustering) and similarly used words (topic modeling), according to a robust statistical criterion capable of inferring from the data both the number of groups and of levels (scales). On the other hand, the same method offers a series of interactive interfaces to navigate the inferred domains (document clusters) and topics to render network visualizations that describe the corpus across multiple scales and foci. In the following section, Figure 1 shows our entire corpus split into 13 level-4 domains connected through their thematic structure, while Figure 2 displays the breakdown of domain “L4D4” — shown magnified at the top-left of Figure 1 — into 12 more granular (level-2) sub-domains.

Since our goal is to characterize the embedding and role of individual researchers in this corpus, we proceeded with modeling author participation in publications as a chained dimension to our previous model, thus translating the

inferred domains into multi-scale author clusters. These author clusters correspond to statistically meaningful profiles of participation in domains (e.g., authors that “publish only in domain D1”, or that “publish a third of their papers in D1 and two thirds in D2”). As shown in Figure 4, together with an understanding of the domains, these profiles describe the diverse forms of participation shaping the scientific field, allowing us to attribute meaningful qualities in the analysis of the mobilized experts in the sample. We can also formulate more general observations about larger groups of researchers who occupy similar positions in the corpus network. Using this strategy, we can identify those researchers who more closely resemble each other, and how so, and incidentally provide, for each of them, a list of new peers with similar profiles: a potential source of guidance for future fieldwork.

In sequence, we investigate whether our group of researchers can be considered “domain builders”, that is, whether their papers appear among the first published in the domains in which they’ve been clustered. Depending on the nature of such domains, this could point to an active agenda of transformation of scientific subjects and priorities. As shown in Table 1, we consider a paper to be suggestive of domain-building if no more than one-fifth (0.2), but preferentially less than one-tenth (0.1), of the papers in the domain it belongs to an earlier year of publication, and that such condition holds for both its level-1 domain and its broader level-2 domain. This exercise will later be followed by fieldwork to contextualize these developments within the researcher’s careers and movement participation, and may include some form of citation analysis.

As a first stage of analysis, here we focus our attention on a group of 10 expert activists who, according to our fieldwork, have been most influential in the cooperation between social movements and academic science. An implicit goal

being the replication of this analysis for a larger group of experts, including those we might encounter from conducting it.

Preliminary Findings

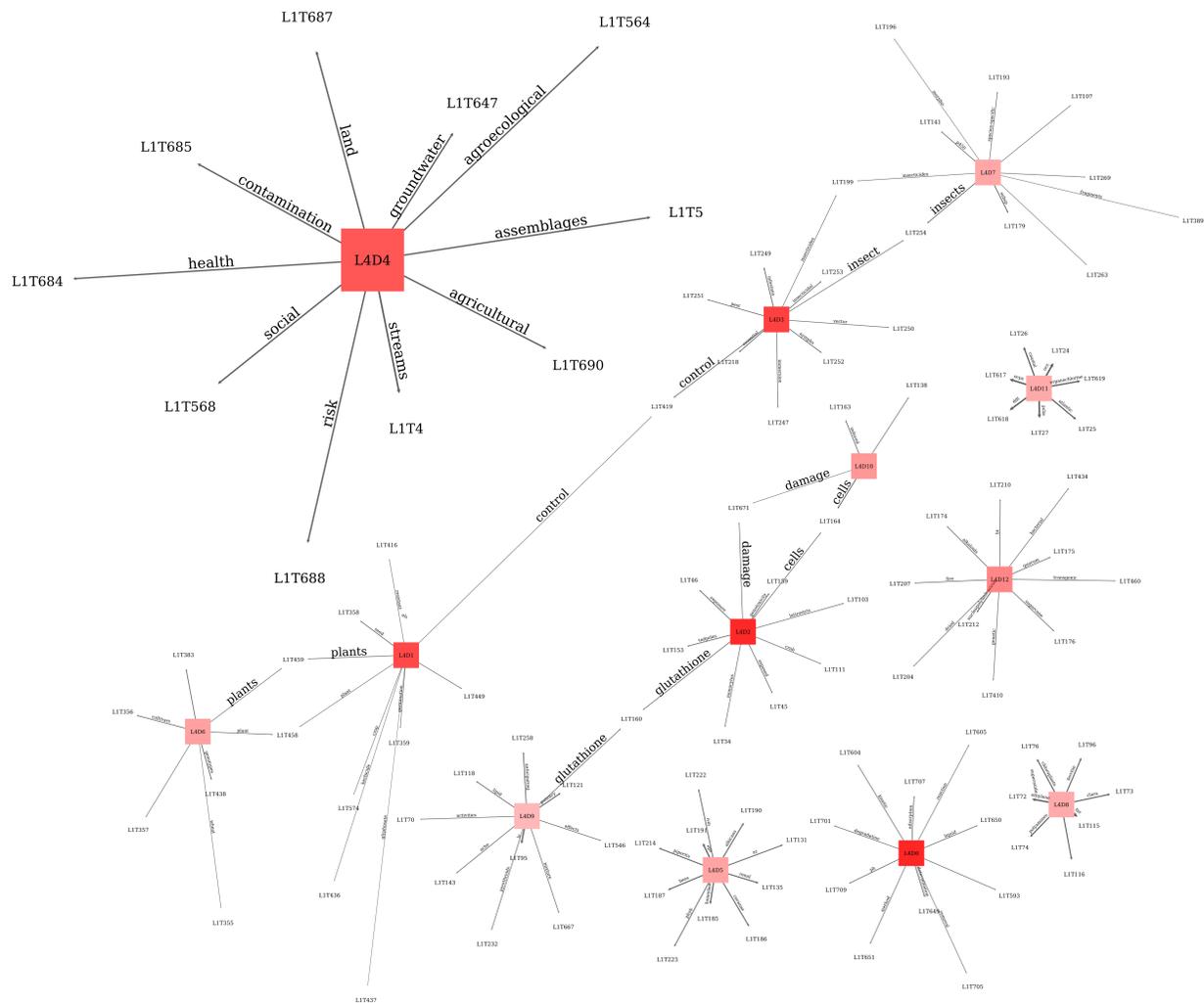


Figure 1 presents a domain map of the Argentine pesticide research field at level 4. Articles populating the field clusters into 12 distinct domains, with each domain representing a large set of papers (at this level, from 66 to 593 papers depending

on the domain) that share a common vocabulary and thus tell us, at a relatively high level of abstraction, what topical themes are developed by papers in the set. For example, L4D4, seen magnified on the top-left, appears connected to the words “risk”, “agricultural”, “social”, etc. (because its level-3 child domains share the topics that contain such words). The network map also makes it evident how different domains establish thematic relationships through shared topics, such as the theme of “control” connecting two domains (L4D1 and L4D3) at the center of the figure. We’ve magnified domain L4D4 because, already at this scale, it carries strong themes that directly share knowledge interests with the anti-spraying movement (health, risk, farm workers, agroecology), but we should also comment on domain L4D2, which attracted our attention as its main topics represented by their most characteristic words for the domain are “exposure”, “exposed”, “damage”, “genotoxicity”, a domain that at this level, and unlike L4D4, also shares common topics with other domains, connecting two other sets of articles that seem to deal with different biological aspects of exposure to pesticides as manifested in L4D2 (“molecular” and “cellular” for L4D9 and L4D10, respectively).

in each domain) are discussed as they relate to health and farming, or agricultural practice.

Thus, broadly speaking, L4D4, but also L4D2, appear to be critical sources of expertise to social movements (although probably not the only sources, as further analysis may reveal). This is further confirmed by navigating a hierarchical “sashimi” map view, where we find that at level 4 these domains figure as the strongest signals for health and risk, together with L4D11, a domain populated by more technical monitoring activities and disconnected from discussions of effects and exposure, or agricultural practices.

Figure 3 depicts the temporal evolution of domain L4D4. As indicated by the red line in Figure 3, the domain L4D4, which as we’ll see is heavily populated by expert activists, has grown rapidly since 2018, not only in absolute terms, but in terms relative to the size of other domains, and has thus been “displacing” other research as a proportion of the field of pesticide research. This suggests that the domain with potentially the most direct connections to the anti-spraying movement has been occupying more and more space, and thus gaining significance, over time within the larger field.

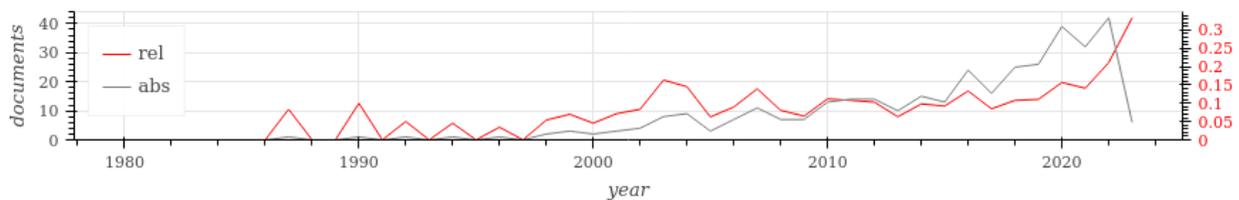


Figure 3: relative (in red, scale on the right) and absolute (in grey, scale on the left) values for the temporal evolution of the domain L4D4.

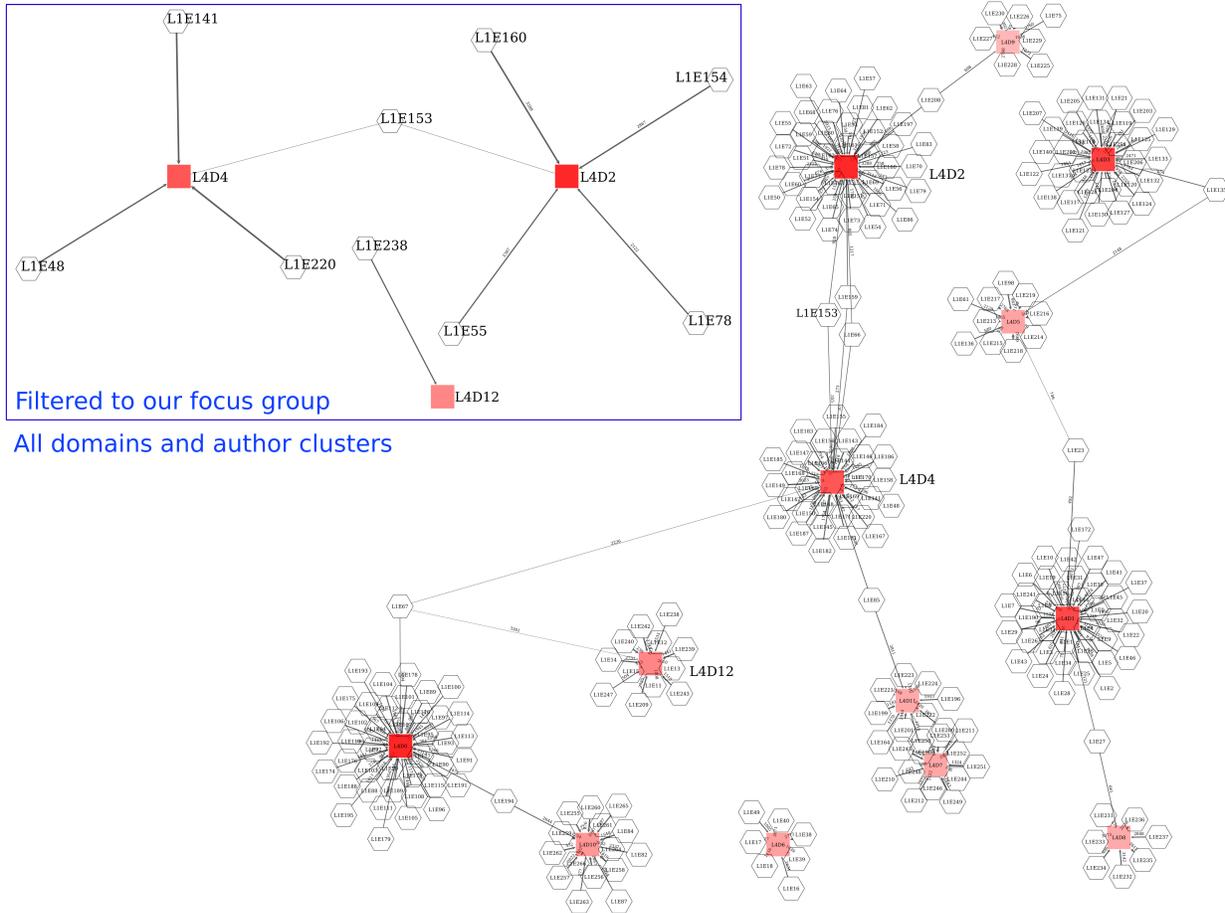


Figure 4 displays the full network of clusters of authors (profiles), and the domains they most significantly publish in, using the most granular level (level-1) for authors and level-4 for documents, in continuity with our previous discussion of level-4 domains. At this domain level, we can see most authors publish in a single major domain, although several bridge two domains, and only one author profile (L1E67) connects to three different level-4 domains. The inset image, in turn, filters the larger image by showing only the profiles where we find the 10 scientists that our prior research indicates are among the more outspoken movement advocates, and their corresponding domains.

As we can see, L4D4 and L4D2 have a privileged place in their participation in the field, which is consistent with our previous suggestions. Moreover, one profile, to which belongs one of the ten researchers, is strongly related to both domains. At more detailed levels, we also find that several other of these outspoken movement advocates also publish in multiple domains, although with less frequency (analysis not shown).

Now that we've established some understanding of the context in which these 10 mobilized researchers work, we can look for evidence that their production has been instrumental in the development of such domains that more directly relate to social movement issues.

Together, our group of 10 researchers published 120 articles contained in our corpus between 1998 and 2023. As seen in Table 1, we find that 24 of these articles (20%) pass the criteria for precocity, as they are chronologically early publications in their domain for both level 1 and level 2. We also find that all but one of the researchers in our group appear as an author in at least one early or pioneering article. In addition, the columns to the right show the domains these articles belong to, at different levels. We note that they correspond to domains we identify as relevant to the anti-spraying movement, suggesting an active and significant role of this group of movement-engaged researchers in establishing such lines of research.

Year	Level 1 precocity		Level 2 precocity		Level 3 precocity		Domain			
	Domain Size	Fraction Before Article	Domain Size	Fraction Before Article	Domain Size	Fraction Before Article	L1D	L2D	L3D	L4D
1998	5	0.20	39	0.10	335	0.08	L1D186	L2D26	L3D8	L4D2
2000	3	0.00	18	0.06	106	0.08	L1D538	L2D89	L3D29	L4D12
2001	8	0.00	54	0.06	245	0.13	L1D168	L2D24	L3D7	L4D2
2002	8	0.13	54	0.07	245	0.15	L1D168	L2D24	L3D7	L4D2
2003	5	0.00	39	0.18	335	0.11	L1D188	L2D26	L3D8	L4D2

2003	6	0.00	29	0.00	335	0.11	L1D199	L2D28	L3D8	L4D2
2003	6	0.00	29	0.00	335	0.11	L1D199	L2D28	L3D8	L4D2
2004	6	0.00	25	0.00	216	0.06	L1D374	L2D54	L3D13	L4D4
2004	6	0.00	25	0.00	216	0.06	L1D374	L2D54	L3D13	L4D4
2005	8	0.00	39	0.00	216	0.08	L1D363	L2D52	L3D13	L4D4
2006	9	0.11	62	0.03	245	0.21	L1D159	L2D22	L3D7	L4D2
2007	2	0.00	26	0.19	144	0.15	L1D351	L2D50	L3D12	L4D4
2007	4	0.00	40	0.03	335	0.15	L1D235	L2D33	L3D8	L4D2
2008	5	0.00	54	0.11	245	0.24	L1D173	L2D24	L3D7	L4D2
2008	5	0.00	54	0.11	245	0.24	L1D173	L2D24	L3D7	L4D2
2008	11	0.18	54	0.11	245	0.24	L1D170	L2D24	L3D7	L4D2
2009	5	0.00	40	0.13	335	0.20	L1D231	L2D33	L3D8	L4D2
2009	6	0.00	33	0.12	335	0.20	L1D223	L2D32	L3D8	L4D2
2010	6	0.17	33	0.18	335	0.23	L1D223	L2D32	L3D8	L4D2
2010	3	0.00	29	0.07	335	0.23	L1D200	L2D28	L3D8	L4D2
2012	4	0.00	35	0.20	144	0.28	L1D335	L2D48	L3D12	L4D4
2012	5	0.20	27	0.19	335	0.30	L1D218	L2D31	L3D8	L4D2
2013	7	0.00	39	0.05	216	0.31	L1D369	L2D52	L3D13	L4D4
2016	7	0.14	39	0.15	216	0.44	L1D369	L2D52	L3D13	L4D4

Table 1: articles published by the 10 activist researchers our fieldwork identified, showing the domains they belong to (right side) and, for levels 1 and 2, the number of documents in the domain containing the article and the article’s precocity within, defined as the fraction of articles published in the same domain in years previous to the article’s.

Plans for Further Analysis

We conclude with our plans for further analysis, which can be summarized in five points.

1. We began our preliminary analysis searching for the contribution of 10 selected expert-activists that we considered the most relevant. The next step will be to replicate the analysis for the other 50 academic scientists allied with the movement. This will give us an idea of how many contributed to the movement with new published articles or in some other way, as well as which

is the role of discipline and professional profile in determining the type of contribution experts can make (developing and publishing new research or otherwise) and the level of their contribution in the scientific realm (central or marginal).

2. Despite our inclusive strategy and the corpus' important size, we need to later extend our data with more Spanish language publications, particularly as a number of relevant Argentinian journals do not feed into the Core Collection nor into Web Of Science. We think that we are leaving outside our corpus mainly articles from the Social Sciences, which more often publish in domestic or regional Spanish-speaking journals.
3. In order to investigate whether pioneering papers from experts allied with the movement are more heavily cited (and thus more influential) than other domain-specific papers, we will pursue further analysis including bibliometric citation and co-citation analysis.
4. By processing the articles' metadata, we will know the geographic location and institutional affiliation of the authors of domain-specific papers and their changes over time. In this way, we will be able to trace connections between the authors and different local branches of the movement, as well as the role of universities and other research institutions in mediating this relationship. In other words, we will be able to draft important connections of the network of expertise involved with the movement.
5. Finally, we intend to conduct follow up interviews with authors that we had already identified (present in the list of more than 60 activist-scientists) as well as new authors or co-authors or domain peers that we have yet to identify, in order to confirm the hypothesis derived from preliminary analysis.

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