

Higher Education

Governance & Policy

ISSN: 2717-8676

Volume: 2 Issue: 2

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Article Type: Research Article

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Funding: This research was supported by the European Commission's Horizon 2020 research and innovation programme under Marie Skłodowska-Curie Action grant agreement No. 722295, the RUNIN Project.

Cite as: Moghadam-Saman, S. (2021). Intersectoral engagements of doctoral candidates: Regime discrepancy between academic territories. *Higher Education Governance & Policy*, 2(2), 82-97.

Access: <https://dergipark.org.tr/tr/pub/hegp/issue/67725/983601>

Intersectoral Engagements of Doctoral Candidates: Regime Discrepancy between Academic Territories

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Abstract

The paper aims to analyse whether and to what extent collaborations of doctoral researchers with the non-academic sectors is determined by their disciplinary affiliation. For this purpose, the paper uses data collected from a survey of doctoral researchers at four universities from three Scandinavian countries. Relying on a critical realist research paradigm, the paper assesses the explanatory power of the Academic Tribes and Territories (ATT) thesis in terms of the relation between disciplinary groups and prevalence of intersectoral research collaborations for doctoral candidates. ATT thesis puts forward, throughout its development over time, two opposing perspectives around the degree of essentiality of disciplines in determining the professional behaviour of academic researchers. The collected survey data is analysed in the paper using a logit regression model. The results from the analysis show that different regimes can be applied to explain the essentiality of different “academic territories” in terms of influencing the intersectoral collaborations of doctoral candidates. On the one hand, for the hard-pure and soft-applied categories of disciplines in Becher-Biglan’s typology, the epistemological essentialism proves strongly capable of explaining the prevalence of intersectoral collaborations of doctoral students. On the other hand, in case of the hard-applied and soft-pure disciplines, the contextual factor represented by the country and university variables proves significant, leading to the predominance of social-practice-based understanding of intersectoral research collaboration within those fields.

Keywords: Doctoral education, intersectoral collaboration, collaborative doctorate, academic tribes and territories, epistemological essentialism, social practice

Introduction

Recent decades have seen a steep increase in the number of doctoral degrees awarded every year across most European countries (cf. OECD, 2014). This trend has led to a shrinkage in the share of doctoral graduates getting employment opportunity at the academic sector (Nerad *et al.*, 2008; McAlpine & Emmioglu, 2014; Roach & Sauermann, 2017). This is partly due to the fact that the number of academic vacancies have not been increasing at a similar rate to the number of doctoral graduations, which implies that preparing for a career outside academe is now a necessary consideration during doctoral education. Doctoral candidates’ perceived preparedness for such career paths, however, is significantly different among academic disciplines (Heflinger & Doykos, 2016). In connection to this, the patterns of employment sector of doctorate holders (cf. European Science Foundation, 2017, p. 42) shows that unlike the case for graduates of social sciences and humanities, graduates of STEM fields who are employed in the academic sector constitute considerably less than half of doctoral graduates.

Engaging in research collaborations with non-academic sectors during doctoral education is one of the most effective ways for doctoral researchers to prepare for transition to a non-academic career after graduation (Thune, 2010). Accordingly, improving the opportunities for such collaborations during doctoral studies becomes a higher education policy target (Nerad *et al.*, 2008; Bernstein *et al.*, 2014).

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(Research Article) Cite as: Moghadam-Saman, S. (2021). Intersectoral engagements of doctoral candidates: Regime discrepancy between academic territories. *Higher Education Governance & Policy*, 2(2), 82-97.

Received: August 16, 2021; **Revised:** December 13, 2021; **Accepted:** December 16, 2021; **Published:** December 31, 2021

The occurrence of such collaborations, nonetheless, is dependent on various factors, some of which are context-laden and others more inherent in the capacities existent in the academic field. Chikoore *et al.* (2016) found that there exists an association between academics' disciplinary groups and their preferred audience for public engagement. Also, when it comes to engagement with industry, previous research has indicated that disciplinary affiliation plays an important role (Franco and Haase, 2015; Ponomariov, 2008; D'Este and Patel, 2007). Hence, a question can be raised whether the same type of policy can be applied across all the academic fields to achieve an increased level of intersectoral collaboration during doctoral education. In other words, it can be questioned whether the academic discipline is such a significant factor in determining the intersectoral collaboration opportunities for doctoral researchers that would necessitate distinct policies for distinct disciplinary areas. This paper aims at finding an answer to such a question through an empirical, quantitative research based on a survey of doctoral candidates in four universities from three Scandinavian countries.

Building on the Academic Tribes and Territories (ATT) thesis, which over a couple of decades since its inception has witnessed the rise of somewhat opposing theoretical positions within it, this paper seeks to assess the explanatory power of disciplinary groups about the prevalence of intersectoral collaborations among doctoral researchers. While the initial texts on the ATT thesis attributed the disciplinary factor with a high significance in determining the professional behaviour of academics (Becher, 1989), the latest textbook following up the discussions around the same thesis has acknowledged a more important role for the social context in shaping the academics' professional practices (Trowler *et al.*, 2012). The appreciation of causal power for the epistemic core of disciplines, then, makes critical realism stand out as the research paradigmatic lens corresponding to the undertaken worldview. This is because critical realism acknowledges that some causal mechanisms emanate from unobservable real structures which are not directly experienced, but have *generative power*, and hence theories around their causal power need to be *retroduced* based on observations. The application of critical realism in the investigation of external engagement of doctoral researchers is theoretically elaborated by Moghadam-Saman (2019). The appraisal of ATT's alternative theories in terms of their capability in explaining the causality around the research behaviour of academics, conforms with the 'retroduction' step in critical realism (cf. Danermark *et al.*, 2002). Within critical realism, retroduction refers to a logical inference process in which a set of observations are used to come up with the 'most likely explanation' regarding the underlying mechanisms leading to the generation of the observed event or phenomena (cf. Danermark *et al.*, *ibid*; Zachariadis *et al.*, 2013). Accordingly, the aim in this paper is to use a set of primary data collected through a survey on intersectoral collaborations of doctoral researchers to analyse, retroductively, the relevance of two main alternative theories within ATT thesis in hinting at mechanisms underlying the occurrence of those collaborations. More specifically, it is intended to investigate whether the disciplinary factor is a significant mechanism in patterning the occurrence of doctoral researchers' intersectoral collaborations.

In order to conduct this investigation, the paper uses Becher's categorization of what became known as the *cognitive dimension* in the ATT thesis, in order to classify the departmental affiliations of the surveyed doctoral researchers. The later revision of the same thesis emphasized the role of contextual factors (as opposed to the disciplinary characteristics) in shaping the professional practices of academics. Based on this, and in order to elucidate the causal power of each of these alternative theories (known in the ATT literature as the *essentialist* versus the *social practice* view), a statistical model is used in which the contextual factor, represented by the country and university variable, is tested as the moderating variable between the disciplinary (independent) and collaboration (dependent) variables. The rest of this paper is organized as follows; the following part reviews the literature around the ATT thesis. Then the next section elaborates on the paper's hypothesis derived from the chosen theoretical framework. Then the adopted statistical methodology and the collected data are explained. The data analysis follows the methodology section, in which the results are also interpreted. A conclusion part discusses the policy implications and limitations of the study.

Theoretical Development

Taking a more general approach to the issue at stake, there has been abundance of findings in the literature emphasizing the prominence of disciplinary differences regarding the collaborative behaviour

of academics (cf. Thune, 2009; Thune *et al.*, 2016; D’Este & Iammarino, 2010; D’Este & Fontana, 2007; Perkmann *et al.*, 2011; Rentocchini *et al.*, 2014; Franco & Haase, 2015; Landry *et al.*, 2007; Chikoore *et al.*, 2016). These scholarly observations call for taking a theoretical concern on the relation between the characteristics of academic disciplines and the intersectoral interactions of academic researchers, including those of doctoral researchers. Hence, the focus in this section is on the literature that has provided background and foreground for the ATT thesis.

ATT thesis has gained significant empirical backing in the literature due to its ability to explain the professional behaviour of academic researchers across the multitude of disciplines (cf. Braxton and Hargens, 1996; Alise, 2008; Simpson, 2015). This includes both the strong and the weak essentialist view associated respectively with the earlier and later editions of the thesis. Accordingly, Moghadam-Saman (2019, p. 9) has discussed the ATT thesis as having potential in explaining some of the “real” and “contextual” mechanisms (in a critical realist meaning) underlying the intersectoral collaborations of doctoral researchers.

Becher (1987) classified disciplines in four groups including hard-pure, hard-applied, soft-pure, and soft-applied. He elaborated on each of them by further describing them in terms of the nature of knowledge – according to which the aforementioned four groups were respectively described as being cumulative, purposive, reiterative, and functional – and the nature of disciplinary culture – according to which they were respectively described as competitive, entrepreneurial, individualistic, and outward-looking.

The implication of acknowledging a relation between the nature of knowledge and disciplinary culture for the external engagements of academics would then be an area for policy contemplation. This is due to the fact that the differences in the knowledge areas’ structures would call for different policy approaches to deal with different disciplinary cultures. Becher (1994, p. 6) himself describes such discrepancies in the following paragraph:

A comparable contrast can be observed between different disciplinary groups in relation to contract research, where departments in hard applied and soft applied areas are able to earn substantial funds by undertaking sponsored work, while faculty in hard pure areas tend to see this as low-status activity, and others against in soft pure domains seldom have any opportunity to contemplate the choice. The consequences in terms of academic working lives are evident enough. Those who involve themselves in such activities necessarily have closer contacts with the outside world, which they are able to exploit in a variety of ways, including offering their graduates a wider range of job opportunities and using additional earnings to improve departmental resources.

As it reads from this excerpt, Becher considers the exposure level of each of the disciplinary groups in his model to ‘contract research’ to be substantially different. Such a discrepancy among these groups would imply significantly different level of opportunity for doctoral researchers in terms of external engagements. Therefore, the ATT thesis harbors a potential to explain the ‘real’ structure underlying the occurrence of intersectoral collaborations by doctoral researchers.

Becher’s (1989) book constituted the first edition of the ATT thesis, according to which the knowledge structure of disciplines significantly influences the behaviour of academics, and specifically their research practices. According to this original edition of the thesis, the knowledge structure (the epistemological core) of disciplines has a cognitive and a social dimension. The cognitive dimension, in accordance with earlier works by Kolb (1981) and Biglan (1973) divides disciplines into hard-pure, hard-applied, soft-pure, and soft-applied ones. These divisions are also identified respectively with natural sciences, science-based professions, humanities and social sciences, and social professions (Becher, 1994). Becher distinguished between the group identity within each discipline in terms of consensus on the definitions and research problems (questions). Accordingly, he described members of academic disciplines as *tribes* to indicate their cultural foundation. He also used the term *territories* to refer to the boundaries of disciplines to which every tribe belongs.

Becher and Trowler’s (2001) book then utilized Becher’s both 1987 and 1989 classifications, calling the former one the cognitive dimension, and the latter one the social dimension of disciplinary cultures.

Nevertheless, in this book, which became the second edition of the ATT thesis, the authors point to the changes in the higher education environment that had taken place since the publication of the first book, and its influence on the significance of disciplinary cultures. The authors posited that the disciplinary cultures had evolved to have less influence on the organizational structures, as the mode of knowledge production had started to change to the one in which problem-orientedness and transdisciplinarity are on the rise (termed as *Mode 2* knowledge by Gibbons *et al.*, 1994). Furthermore, the book highlighted the influence on the disciplinary cultures from the increasing linkages between university, industry and government in the form of ‘triple helix’ configurations. Also, contextual influence on the institutions were given more emphasis, rejecting the idea that disciplinary values trickle-down from the leading departments to the “followers” in other universities. The authors made it clear that in this book the academic communities with common intellectual interest are examined in relation to the social and cognitive *contexts* in which they operate.

Still discontent with the continued essentialist view in the second edition, later Trowler (2008) rejected the epistemological essentialist view, starting to develop an alternative approach emphasizing the significance of context and history in understanding social practices. This alternative approach was further elaborated in the third book on the ATT thesis, edited by Trowler, Saunders and Bamber (2012). In this book, the essentialist view predominating the earlier two books on the thesis, was replaced with a *social practice* approach about research practices across disciplines. In this approach, disciplines are seen as open systems susceptible to be influenced by context-specific social characteristics as well as agential and managerialist practices.

Braxton and Hargens (1996, p. 8) question whether the social dimension in Becher’s classification is “[...] associated with important scholarly phenomena independently from the associations of the phenomena with the Biglan hard-soft and pure-applied dimensions”. They conclude from their survey that the levels of scholarly consensus can explain most of the disciplinary differences. Nevertheless, the authors note that according to their preliminary evidence, the level of consensus, as well as the paradigm development concept, can be integrated with the hard/ soft dimensions. As Creamer (2003, p. 3) puts it briefly, “[r]ates of collaboration are higher in what Biglan (1973) characterized as hard-pure fields where strong agreement exists among faculty about dominant paradigms than in soft-applied fields where there is considerably less consensus about dominant paradigms.”

Nevertheless, there can be found more moderate positions taken within the literature regarding the relevance of essentialist view within the ATT thesis. For instance, Pinheiro *et al.* (2012) surveyed academics from 19 departments, which were categorized according to Becher’s 1994 four groups of disciplines, investigating their external engagement and its nature and benefits. They conclude, however, that despite the advantages of Becher’s categorization of knowledge domains in terms of general patterns of behaviour across organizational settings, the neglect of immediate context, such as national and organizational settings in which academic communities’ function, can be considered as a shortcoming. In this regard, the authors find their argument to be rather in line with Trowler *et al.*’s (2012) argument for ‘weak essentialism’.

Research Hypotheses

The review presented in the previous section indicates that, having undergone a significant revision, the ATT thesis can be considered as containing what in critical realism terms can be referred to as the alternative proto-theories about the mechanisms underlying the actual phenomena (see Moghadam-Saman, 2019, p. 9). In other words, the epistemological essentialist view and the social practice view, which constitute, respectively, the essence of the earlier and the later versions of the ATT thesis, propose two alternative understandings about the deterministic power of disciplines in shaping the research activities of academics - including the intersectoral research collaborations of doctoral candidates. The empirical corroboration of those alternative theories, aiming at retroductive inference - in a critical realist account - about the external engagement of doctoral candidates, aims at ensuring that the proposed mechanisms adequately represent the real causality (cf. Wynn and Williams, 2012).

The two alternative versions of the ATT thesis can be read through the following substitutive approaches by two of the key figures in the development of the thesis. Firstly, the earlier version of the thesis can be well understood from Becher's (1994, p. 3) held view, stating that:

Disciplinary cultures, in virtually all fields, transcend the institutional boundaries within any given system. In many, but not all, instances they also span national boundaries. That this is the case can be seen through the existence of national, and often international, subject associations which embody collective norms and exercise an informal control on undergraduate and graduate curricula, as well as providing a shared context for research.

As it can be understood from this excerpt, Becher considered the disciplinary cultures not to be much context-bound, even across *countries*. Accordingly, disciplines can be perceived as playing the role of what in critical realist accounts can be called the “real” structure underlying the mechanisms shaping the academics’ professional culture and behaviour.

As mentioned in the theoretical development section, Trowler, who pursued developing the later revision of the ATT thesis, shifted his view later, contending that the role of the disciplines is significantly influenced by the context. It can be said that according to this view, disciplines are considered as constituting a ‘transitive’ mechanism, meaning that the human ‘agency’, which is in a mutual interactive relation with its surrounding ‘structures’, significantly mediates and modifies the causal effect of disciplines. In line with this, Trowler (2008) uses the notion of teaching and learning regimes (TLRs) in order to deconstruct, among the multitude of contextual aspects, those most intimately relevant to the disciplinary practices. In his view, “[...] context is the territory in which disciplines are performed” (Trowler, *ibid*, p. 8).

These two alternative understandings of the ATT thesis provide us with a basis for starting what in Danermark *et al.*'s six-step Explanatory Model of Social Science is referred to as the *retroduction* step (the fourth step), during which the candidate mechanisms underlying the concerned event – here, the intersectoral collaboration of doctoral researchers - are identified¹. Consequent to this step comes the comparison of the relative explanatory power of the alternative theories and their respective constituent mechanisms (the fifth step in Danermark *et al.*'s model). What will follow this step, i.e. Danermark *et al.* model's sixth step, termed as *concretization and contextualization*, will complete the empirical corroboration to “[...] enhance our descriptions and understanding of the specific contextual conditions under which these mechanisms were enacted.” (Wynn and Williams, 2012, p. 15). However, this last step is out of the scope of this paper, as this paper aims only to enquire on whether the epistemological essentialist understanding of academic disciplines, as conceived within the earlier version of the ATT thesis, can explain the patterns of intersectoral engagement for doctoral researchers across different disciplinary groups from different university and country contexts (see again the aforementioned quote from Becher, 1994). This approach, i.e. testing the presence of a specific, retroductively-inferred mechanism, is also in accordance with Miller and Tsang's (2010) approach in theory testing within critical realism. These authors suggest a four-step approach in a CR-based theory testing (in the field of management), which includes *specifying the hypothesized mechanisms, testing for the presence of these mechanisms, determining whether they function as hypothesized, and testing the full theoretical system*. Accordingly, here we address the second and third step in Miller and Tsang's approach by testing for the presence of disciplinary mechanism at the level of “real structures” underlying the mechanisms causing the “event” of intersectoral research collaboration by doctoral researchers, in order to determine whether it functions as hypothesized by the earlier or later versions of the ATT thesis. Accordingly, the following hypotheses are put forward for verification by the empirical data:

Proposition: The cognitive dimension of academic disciplines, as defined in the Becher-Biglan typology, function as a significant influencer of the prevalence of intersectoral engagement by doctoral researchers, and remains significant across countries and universities.

¹ The three steps preceding this step, which include 1- *description of events*, 2- *identification of key components or dimensions*, 3- *theoretical redescription (abduction) of components or dimensions*, are elaborated in Moghadam-saman (2019).

Accordingly, the null hypotheses and the alternative hypotheses to be tested by the empirical data are formulated as the followings:

Null hypothesis 1: The nature of the cognitive dimension of disciplines does not significantly affect the prevalence of intersectoral engagements by doctoral researchers.

Alternative hypothesis 1: The prevalence of intersectoral engagement by doctoral researchers is significantly affected by the nature of the cognitive dimension of their academic disciplines.

Null hypothesis 2: The country or university context does not significantly mediate the extent to which the nature of academic disciplines affects the prevalence of intersectoral engagements by doctoral researchers.

Alternative hypothesis 2: The impact of academic disciplines on the prevalence of intersectoral engagement by doctoral researchers is significantly mediated by the country or university where the collaboration takes place.

It is necessary to note that, under the critical realist paradigm, an explanation would be complete when it addresses all the three points of a) structures underlying the generative mechanism; b) the outcome these mechanisms tend to generate; and c) the contextual elements that influence the actualization of those generative mechanisms (Cartwright, 2003). The above hypotheses, however, are defined to test one theory regarding only the first of these explanation parts. The way the contextual elements interact with the generative mechanism (the disciplinary effect), and the outcome of these for doctoral researchers, is left out of the scope of this paper, as within critical realism it is arguably preferred to address the complex issue of interaction between contextual and intransitive mechanisms to qualitative studies (Danermark *et al.*, 2002).

Methodology and Data

Following the hypotheses developed in the previous section for testing, hereunder the variables of interest, the data analysis method corresponding to the questions emanating from the hypotheses, and some descriptive features of the data attained through the survey of doctoral researchers in the four Scandinavian universities will be presented. It is noteworthy to mention that, under the critical realist paradigm, the econometric models are deemed as able to reveal only some stylized facts, known as *demi-regularities*, as suggested by Lawson (1997). This means that the hypotheses tested mainly concern the context from which the data are derived, rather than providing a basis for positivist-style generalizations of the findings.

The dependent variable

The dependent variable in this study is to indicate whether doctoral researchers in the sample are – or will be – engaged with the non-academic sectors during their doctoral education. Therefore, the dependent variable is a dummy variable.

Alise (2008) chose to use data on what affiliates of academic disciplines actually *do* (research), rather than *say*, in validating ‘Biglan classification’. Similarly, this paper uses the actual occurrence of intersectoral collaborations for the studied doctoral researchers (the empirical layer in the CR ontology) to validate the explanatory power of the ATT thesis (in the form of either of its two versions) regarding the causality potential between disciplines (the layer of real in the CR ontology) and the intersectoral collaborations of doctoral researchers. This will in fact enable the retroductive logic to assess, and if necessary, refine the theories around the underlying mechanisms (the layer of ‘real’ in the critical realist ontology) which lead to the generation of the actual events (here, the occurrence of intersectoral collaborations for the doctoral researchers). Bozeman and Gaughan (2007) show that grants and contracts from industry and government have a significant effect on academic researchers’ propensity to work with industry, albeit the effect from the latter is more moderate. In this paper, collaborations with both private and public sector industry have been included under the overall title of intersectoral collaboration between the academic and non-academic sectors.

The independent variables

Corresponding to the queries raised in the two hypotheses, the two explanatory variables include the disciplinary group to which the doctoral candidates in the sample belong to, and the country and university in which they conduct their doctoral studies. Similar to Robles (1998) and Roy (1979) who equates disciplines with departments in campuses, and Pinheiro *et al.* (2012) who categorize departmental units of a university into the four quadrants of Becher's typology, the disciplinary affiliations of doctoral candidates are here coded into one of the four categories in Becher-Biglan's Typology (see also Neuman *et al.*, 2002) based on their departmental affiliation. This coding was done by using the following definitions used by Neuman *et al.* (*ibid*, p. 406) regarding each of the categories in the cognitive dimension of disciplines:

- *Hard Pure*: The nature of knowledge in these disciplines has “cumulative, atomistic structure, concerned with universals, simplification and quantitative emphasis.” Examples: physics, chemistry, mathematics, biology.
- *Hard Applied*: The nature of knowledge in these disciplines is “concerned with mastery of physical environment and geared towards products and techniques.” Examples: technology, engineering, medicine, design.
- *Soft Pure*: The nature of knowledge in these disciplines has “reiterative, holistic, concerned with particulars and having a qualitative bias.” Examples: history, literature, art theory, sociology.
- *Soft Applied*: The nature of knowledge in these disciplines is “concerned with the enhancement of professional practice and aiming to yield protocols and procedures.” Examples: education, business studies, law, information management.

Then, in order to investigate the second hypothesis, the country and university in which the doctoral candidates are conducting their studies are coded in the form of a categorical variable.

All in all, from a population of 4213 doctoral researchers in the four universities, a total of 587 responses were received, resulting in a response rate of 13.93%. Per university, the response rates ranged from 8.65% in the case of Gothenburg University to 24.24% in the case of University of Stavanger. Table 1 shows the response rate from each university.

Table 1. Response rate from each of the four universities participating in the survey

University*	UiS	LiU	GU	AAU
Total number of doctoral researchers	425	1219	1710	859
Total number of responses	103	140	148	196
Response rate	24.24%	11.48%	8.65%	22.28%

*UiS: University of Stavanger, LiU: Linköping University, GU: Gothenburg University, AAU: Aalborg University

Not only in sum, but also in each individual university, the highest number of responses came from doctoral researchers affiliated with hard-applied (HA) category of disciplines. Table 2 shows the number of responses from doctoral researchers in each university under each category of disciplines.

Table 2. Total number of responses from doctoral researchers affiliated with each of the four disciplinary groups at each university

the name of the university	cognitive dimension				Total
	HA	HP	SA	SP	
Linköping University	52	21	32	35	140
University of Aalborg	141	13	12	30	196
University of Gothenb	80	15	20	33	148
University of Stavang	35	14	24	30	103
Total	308	63	88	128	587

Pearson $\chi^2(9) = 61.5089$ Pr = 0.000

The total number of observations for either situation of the dependent variable in terms of the frequencies under each category of disciplines are demonstrated in Table 3. It shows that for all the disciplinary groups, *not* being involved in an intersectoral collaboration is more prevalent, although such a difference

is much more pronounced in the case of ‘pure’ groups of disciplines compared to the ‘applied’ groups (in both hard and soft disciplines).

Table 3. Total number of responses from doctoral researchers affiliated with each of the four disciplinary groups at each university, in terms of having or not having intersectoral collaboration*

intersectoral collaboration	cognitive dimension				Total
	HA	HP	SA	SP	
0	185	47	49	93	374
N	123	16	39	35	213
Total	308	63	88	128	587

Pearson chi2(3) = 11.8880 Pr = 0.008

* 0: with no intersectoral collaboration, N: with intersectoral collaboration

If we distinguish between the co-funded and not-co-funded intersectoral collaborations, we see that in all the disciplinary categories, not-co-funded collaborations outnumber the co-funded ones, although such a difference seems to be more pronounced in the ‘soft’ group of disciplines compared to the ‘hard’ groups (for both pure and applied disciplines).

Table 4. Total number of responses from doctoral researchers affiliated with each of the four disciplinary groups at each university, in terms of having or not having their collaboration co-funded*

collaboration and funding	cognitive dimension				Total
	HA	HP	SA	SP	
NN	185	47	49	93	374
YN	79	10	31	26	146
YY	44	6	8	9	67
Total	308	63	88	128	587

Pearson chi2(6) = 16.2963 Pr = 0.012

* NN: no collaboration and no funding, YN: collaboration with no (co)funding from the collaborating non-academic entity, YY: collaboration with (co)funding from the collaborating non-academic entity

While these descriptive statistics indicated in the Table 3 and 4 already hint at a potentially significant “patterning effect” of disciplinary groups, the data analysis in the next section aims at providing a more robust (although not *strict*) regularities in the occurrence of collaborations. In other words, the aim is to identify important demi-regularities which can help direct the overall research process in its quest for identification of causal mechanisms later in the qualitative (intensive) study (Lawson, 1997).

Data Analysis and Interpretation of Results

Stata software was used in order to conduct the data analysis for this research paper. The data from the survey of doctoral researchers was stored in spreadsheet format and after coding the data according to the afore-mentioned categorizations - based on departmental affiliations - was transferred (imported) to Stata. All the independent variables were then “encoded” as categorical variables. The dependent variable, i.e., the existence of intersectoral collaboration, was coded as a dummy variable.

Model specification

To run the logistic regression, Stata’s *logit* command was used. Since the dependent variable is a dummy (indicating existence or non-existence of intersectoral collaboration) and the independent variables are of indicator (categorical) type, and the moderation effect is also included, the Stata command was specified as in the Tables 5 and 6.

In these tables, the variable *cllb* denotes the outcome variable which indicates whether the doctoral researcher has a collaboration with non-academic sectors (could be with public sector, with private sector, or both). The variable *i.ctry* denotes the categorical variable of country where the doctoral student

is based, and the variable *i.cogn* refers to the category of cognitive dimension of academic discipline according to Becher-Biglan's categorization. The variable *i.ctry#i.cogn* denotes the moderation effect of country on the pattern-giving effect of disciplinary groups being tested by the analysis.

In order to check whether the case of two Swedish universities makes a difference in the results, the analysis was done once more with using university as the mediating variable (see Table 6). Here, the variable *ib2.univ* includes the variable denoting the categorical variable of university (*i.univ*), in which *b2* was used to change the base (reference) category into Aalborg University in order to make the results comparable with the previous analysis, where Denmark was the base category for the country variable (which in this case also represented the single university from Denmark).

Model identification and parameter estimation

Table 5 depicts the results gained from Stata after running the aforementioned logit command for specifying the analysis model. As it can be seen from the initial part of the results, the model has merged after four iterations. The likelihood ratio chi-square of 38.86 with a p-value = 0.0001 tells us that our model as a whole fits significantly better than an empty model (i.e., a model with no predictors), or in other words, at least one of the regression coefficients in the model is not equal to zero. The results also showed McFadden's pseudo R-squared value equal to 0.0479, indicating a good fit (Hemmer *et al.*, 2018).

Table 5. The results attained from the logit model with country as moderating variable.

cllb	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
cogn						
HP	-1.07	0.68	-1.58	0.113	-2.41	0.26
SA	-0.21	0.61	-0.34	0.732	-1.40	0.99
SP	0.13	0.40	0.32	0.751	-0.66	0.92
ctry#cogn						
Norway#HA	-0.40	0.39	-1.03	0.305	-1.16	0.36
Norway#HP	0.92	0.85	1.08	0.282	-0.75	2.59
Norway#SA	-0.76	0.75	1.76	0.311	-2.24	0.71
Norway#SP	-1.87	0.65	1.55	0.004**	-3.14	-0.60
Sweden#HA	-0.57	0.25	-2.26	0.024*	-1.06	-0.08
Sweden#HP	-0.22	0.78	-0.28	0.781	-1.75	1.31
Sweden#SA	0.49	0.65	0.76	0.449	-0.78	1.76
Sweden#SP	-1.18	0.46	-2.54	0.011*	-2.09	-0.27
cons.	-0.13	0.17	-0.76	0.449	-0.46	0.20

The output of the two logit models compares respectively two and three groups of the doctoral students with the reference group. In the top section of the both of the output tables, the reference group comprises those doctoral researchers who are affiliated with the hard-applied group of disciplines. By default, Stata chooses the most frequently occurring group to be the reference group, which as indicated earlier, in our sample comprises of hard-applied group. The top section of the output table compares with the base group the other disciplinary groups, i.e., those who are affiliated with hard-pure, soft-applied, and soft-pure disciplines. What matters in the case of this research are the p-values in order to see whether the disciplinary groups matter regarding the probability of having intersectoral collaborations. The coefficients are hence reported solely for the sake of transparency.

In the bottom section of both tables, the reference group comprises those doctoral researchers who are affiliated with the Aalborg University in Denmark. Hence, the bottom part of the first output table, compares with the base group the doctoral researchers from other two countries, i.e., those who are conducting their doctoral studies in the two universities in Sweden and the University of Stavanger in Norway. In the second table, the bottom section makes a distinction in the Swedish sample between the observations at the GU and LiU.

Arguing about the view of critical realism to regression analysis, Ron (2002, p. 3) holds the position that “[t]he gist of successful regression analysis is not to be able to offer a law-like statement, but to bring forth evidence of an otherwise hidden mechanism”. In line with this, he posits that unlike the empiricist interpretation of regression analysis, which uses this method for identifying law-like *regularities* in the observed phenomena, the critical realist interpretation of regression analysis assumes the role of isolating the *mechanism* emanating from the real *tendencies* of underlying structures (here, the epistemic core of disciplines).

Table 6. The results attained from the logit model with university as moderating variable.

c1lb		Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
cogn							
	HP	-1.07	0.68	-1.58	0.113	-2.41	0.26
	SA	-0.21	0.61	-0.34	0.732	-1.40	0.99
	SP	0.13	0.40	0.32	0.751	-0.66	0.92
univ#cogn							
	Linköping University#HA	-0.26	0.33	-0.79	0.427	-0.91	0.38
	Linköping University#HP	0.04	0.83	0.05	0.961	-1.59	1.68
	Linköping University#SA	1.27	0.71	1.81	0.071	-0.11	2.66
	Linköping University#SP	-1.06	0.53	-1.99	0.046*	-2.10	-0.02
	University of Gothenburg#HA	-0.78	0.30	-2.61	0.009**	-1.37	-0.19
	University of Gothenburg#HP	-0.67	1.01	-0.66	0.506	-2.64	1.30
	University of Gothenburg#SA	0.76	0.78	-0.98	0.329	-2.29	0.77
	University of Gothenburg#SP	-1.31	0.56	-2.34	0.019*	-2.41	-0.21
	University of Stavanger#HA	-0.40	0.39	-1.03	0.305	-1.15	0.36
	University of Stavanger#HP	0.92	0.85	1.08	0.282	-0.75	2.59
	University of Stavanger#SA	-0.76	0.75	-1.01	0.311	-2.24	0.71
	University of Stavanger#SP	-1.87	0.65	-2.88	0.004**	-3.14	-0.60
cons.		-0.13	0.17	-0.76	0.449	-0.46	0.20

This means that the causal influence of underlying unobservable structures only *tends* to lead to certain patterns, but this might not always actualize as other, contextual mechanisms can hinder that influence. In agreement with this view, the findings from the data analysis in this paper can be interpreted as follows.

- *Essentiality of disciplines’ cognitive dimension for doctoral researchers’ intersectoral engagements*

The results from the logit model shows that in general, for comparing intersectoral collaboration opportunities of doctoral researchers affiliated with hard-pure, soft-applied, and soft-pure disciplines relative to those affiliated with hard-applied disciplines, the essentialist view cannot explain the differences. The outputs of the logit model shows that the z test statistic for the predictor hard-pure (-1.08/0.68) is -1.58 with an associated p-value of 0.113. If we set the alpha level to 0.05, we would not be able to reject the null hypothesis 1, and hence conclude that the difference between doctoral researchers affiliated with hard-applied and hard-pure disciplines has been found not to be statistically significantly different. Similarly, since the p-values for the soft-applied and soft-pure disciplines are 0.732 and 0.751 respectively, the difference between the intersectoral collaborations of doctoral researchers affiliated with these groups of disciplinary cognitive dimension and the hard-applied group is not significant. Hence, the cognitive dimension of disciplines proves not to be an important factor in determining the pattern of intersectoral collaborations of doctoral researchers.

- *Intersectoral engagements of doctoral researchers in LiU, GU and UiS, relative to AAU*

Despite the general findings regarding the non-suitability of essentialist view of disciplines in describing the intersectoral collaboration opportunities of doctoral researchers in the sample, further breakdown of the sample to doctoral researchers from each of the countries and universities provides a further nuance to the above-mentioned general finding.

For those doctoral researchers in Norway whose academic discipline is in the hard-applied category, compared to the respective reference group, i.e., those affiliated with hard-applied disciplines in the Danish sample, the z test statistic for the predictor Norway#HA (or University of Stavanger#HA in the second table) is -1.03, with an associated p-value of 0.305. By setting the alpha level to 0.05, we fail to reject the null hypothesis 2. In other words, we cannot reject that compared to the base country (Denmark), the prevalence of intersectoral engagement of doctoral researchers from hard-applied disciplines is not significantly different in Norway. However, the same argument does not apply to the case of doctoral students from hard-applied disciplines in Sweden, according to the respective p-value (0.024). Therefore, the results of the logit model imply that when it comes to the hard-applied disciplines, the contextual factors implicit in the country variable do matter in determining the intersectoral collaboration opportunities of doctoral researchers.

Then, according to the output of the logit model in the first table, the prevalence of engagement with non-academic sectors for doctoral researchers from hard-pure and soft-applied disciplines in Norway and Sweden is significantly different from that of their peers in Denmark. Concerning HP disciplines, doctoral researchers' intersectoral collaboration opportunities in Norway and Sweden are not significantly different from those in Denmark (given $p=0.282$, $p=0.781$, respectively), thus we cannot reject the null hypothesis 2. Similarly, according to the second table too, the p-values for the SA and HP disciplines for all the three universities compared to the base university are greater than 0.05.

And when it comes to the doctoral researchers from soft-pure disciplines, in the first table for both Norway and Sweden the prevalence of intersectoral engagement is significantly different from Denmark (indicated by p-values of 0.004 and 0.011). Also in the second table, all the p-values for the three universities compared to the AAU, are smaller than 0.05 (0.046, 0.019 and 0.004). Therefore, in the case of doctoral students affiliated to soft-pure disciplines, the null hypothesis can be rejected, implying that the prevalence of intersectoral collaborations, even in the relatively similar context of Nordic countries, varies by the country and university context. This result implies that soft-pure disciplines are - specifically concerning the issue of intersectoral collaborations - (socially) practiced differently, making the opportunities for intersectoral collaboration significantly influenced by the contextual factors.

Here it is worth to mention briefly some background information about collaborative doctorates in the three countries from which the four surveyed universities were selected. Denmark introduced industrial PhD in 1980s, while in Sweden and Norway this type of collaborative doctorate was recognized and regulated during 1990s and 2000s respectively. However, the structure of doctoral education in Norway more closely resembles that of Denmark rather than Sweden (e.g. the initial length of doctoral contracts is usually three years in Norway and Denmark and four years in Sweden). Previous investigations have shown that compared to Sweden, benefitting from the industrial PhD scheme in Norway are less limited to the technical faculties (cf. Kihlander *et al.*, 2011; Schlegel & Keitsch, 2016). Accordingly, some of the differences between the level of external engagement by doctoral researchers in the three countries (more specifically the case of hard-applied sciences) can be ascribed to the differences in implementing collaborative doctorate schemes.

Conclusion and Implications

Citing the example of grant-getting and student recruitment, Trowler (2008, p. 6) notes that being able to make distinctions among disciplines regarding their power to condition policy and practice "[...] is important for institutional management, particularly at a time when managerialist approaches are predominant". In agreement with this view, it was the aim of this paper to assess whether the academic disciplinary specifics can explain the differences in prevalence of intersectoral research collaborations

among doctoral candidates. In doing so, the two alternative versions of ATT thesis were considered as substitutive views in terms of the extent of importance attached to the pattern-giving power of disciplines. While the earlier version of the ATT thesis implies that the intersectoral collaborations of doctoral researchers are highly determined by their disciplinary category (or more precisely, its cognitive dimension), the latter version of the ATT thesis implies that the disciplinary effect on those collaborations is mediated by the context in which those disciplines are practiced. The results gained from a survey of doctoral researchers from the four universities in three Nordic countries, however, demonstrates that the answer to the above-mentioned question depends on the specific categories of the disciplinary groups. In other words, each of the essentialist- and social practice-based interpretations of the ATT thesis prove to have more explanatory power for some of the four disciplinary groups.

Based on the above, and similar to the notion of Teaching and Learning Regimes (TLRs) used by Trowler (2002), in this paper the notion of 'regimes of intersectoral engagement' is proposed, based on the attained results, to denote the witnessed difference between the theories applicable to the disciplinary groups. Accordingly, while the *essentialist regime* of intersectoral engagements better corresponds to hard-pure and soft-applied disciplines, the *social practice regime* of intersectoral engagement seems to better explain the engagement opportunities of doctoral candidates within hard-applied and soft-pure disciplines. Hence, HA and SP disciplines are more susceptible to be influenced by getting combined with causal tendencies that emerge as a result of interaction between the disciplinary and contextual factors around the external engagements of doctoral researchers.

A research implication of this approach would be that, in determining the factors important in improving the intersectoral collaborations by doctoral candidates affiliated with HA and SP disciplines, scrutiny is needed in uncovering the contextual mechanisms able to affect the causal power of the epistemic core of these disciplines. For instance, further research should investigate how doctoral programmes defined around specific academic disciplines from these disciplinary groups interact differently in different country- or university contexts with regulatory or policy elements around the issue of intersectoral collaboration.

On the other hand, according to the findings of the paper, for those doctoral candidates affiliated with the soft-applied and hard-pure disciplines, disciplinary characteristics are strong determinants, as the contextual variation seems not to be significantly changing the collaboration opportunity. Accordingly, it can be argued that, for improving the intersectoral collaboration opportunities of those affiliated with these disciplines, it is of higher relevance to introduce interdisciplinarity within the research and education curricula, as the epistemic core of these disciplines seem to be specifically crucial in shaping their potential for providing engagement opportunities. For instance, improving intersectoral collaboration opportunity for doctoral candidates within the field of business administration or mathematics can be achieved through strengthening their knowledge communicability with engineering fields.

A policy implication of the findings of this paper is that, when it comes to the measures aiming at promoting the intersectoral collaborations of doctoral researchers, a distinction shall be made between the disciplinary groups regarding the extent to which their potential for providing opportunity for collaborations are affected by the contextual elements. The results from this study implies that, even in a relatively homogeneous higher education context like the Scandinavian countries of Norway, Denmark and Sweden, the propensity of soft-pure disciplines for intersectoral collaborations of doctoral researchers varies significantly across country and university contexts. Similarly, but to a lesser extent, hard-applied disciplines are also showing a sensitivity to contextual conditions for providing intersectoral collaboration opportunities. Hence, policies aiming at the increase in the level of intersectoral collaborations during doctoral education in these categories of academic disciplines need to be tailored in accordance with the way such disciplines are "practiced" in those contexts.

Following the critical realist epistemology, the findings of this paper need to be understood as ideal-typical middle-range hypotheses (Smith, 2010). This consideration is specifically related to the data sources which were confined within the Nordic context. This means that the proposition that regimes of

engagement are disciplinary-group-driven, and their specific types of regime (essentialist or social practice based) can be further refined through research with data from other contexts. Nevertheless, concerning the studied contexts, as indicated by the results, the HA and SP disciplines appear to be more prone to the influence of contextual specificities, implying that the attained data regarding the intersectoral collaborations of doctoral candidates affiliated with these disciplines can be subject to the specifics of Nordic higher education systems and their industry collaboration traditions. More specifically, the higher prevalence of triple helix collaborations in some of these countries can indicate that university-industry collaborations have higher probability to provide opportunities for doctoral candidates' engagement with industry. Furthermore, the collaboration policies of universities represented by the data in this study add another contextual conditioning layer (or contextual mechanism, in CR terms), as within the national systems, a variety of third mission policies can be applied by universities, affecting the intersectoral engagement opportunities of doctoral researchers.

Availability of Data and Material

The data used for the analysis in this paper are available upon request.

Acknowledgement

I am grateful to Eliel Cohen, Bjørn Asheim and two anonymous reviewers for their valuable comments on the earlier versions of this article. I remain, nevertheless, solely responsible for the content of the article.

Funding

This research was supported by the European Commission's Horizon 2020 research and innovation programme under Marie Skłodowska-Curie Action grant agreement No. 722295, the RUNIN Project.

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