Universities and external engagement activities: Particular profiles for particular universities?

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Abstract

Studies of universities' external engagement have found that individual and discipline-level characteristics explain most of the participation in different kinds of external engagement activities, but characteristics at the institutional level are often not studied explicitly. In this paper, we analyze how five different forms of external engagement are influenced by a range of factors, using a multilevel regression approach on a complex combined dataset including a survey to 4400 Norwegian academics and detailed data on the 31 higher education institutions where the academics are employed. The goal is to test whether university-level characteristics matter for participation in different kinds of external engagement, when we also control for the influence of individual and discipline level factors. We find that university-level variables explain few of the differences in external engagement among academic staff in general. Still, there are important nuances, and the multi-level analysis has revealed a complex picture of influences on forms of external engagement among academics. Participation in consultancy and commercialization among academics is in particular influenced by university-level factors.

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1. Introduction

This paper explores how different kinds of universities interact with external actors, depending on the particularities of both the universities and the individual academics that carry out these interaction activities. The paper seeks to contribute to the extensive literature on academic engagement and external interaction by studying empirically whether university-level characteristics influence how academic staff interact with external organizations. Institutional factors – by which we mean characteristics of higher education institutions – have been less explored when it comes to interaction between universities and external organizations (Perkmann et al. 2013). This is largely because individual and scientific discipline variables have been found to account for a substantial part of variance in the level and kinds of external engagement of academic staff (Perkmann et al 2013, Abreu & Grinevich 2013, Bekkers & Freitas 2008, Boardman & Ponomarinov 2009, Schartinger et al 2002). However, institutional level profile, specialization and strategies have been found to influence academics' external orientation in some studies (e.g. Laursen et al. 2011, D'Este et al. 2013, Audretsch & Lehmann 2005, Perkmann et al. 2013, Bishop et al. 2011, Wright et al. 2008, Abreu & Grinevich 2013). These characteristics include dimensions such as applied/professionally oriented versus general academic institutions, research universities versus polytechnics/regional colleges – but also location, age, quality, R&D expenditures, and commercialization policy. Some studies indicate that the effect of institutional level characteristics (such as the scientific quality of the institution) on academics external engagements differs systematically by fields of science (Perkmann et al. 2011, Bishop et al. 2011). As a consequence, it is important to account for the relative importance of institutional variables when controlling for differences between the scientific fields and profile of academic staff. A methodological problem is, however, that samples of higher education institutions in many countries are small and that one would need a range of variables to distinguish subject field, individual and institutional level characteristics in the same analysis.

This paper contributes to the literature by investigating institutional-level differences in terms of how academic staff interacts with external organizations in their environment, when we control for individual and disciplinary characteristics. Our paper addresses this issue by investigating whether institutions – when represented by their academic staff –behave relatively similarly (convergence hypothesis), or whether we see distinct institutional profiles in academic engagement activities (distinction hypothesis).

In this study we do not rely upon institutional taxonomies established for legal or administrative purposes, and we do not assume that institutions within different "institutional categories" such as

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"university" or "regional college" are similar, or that different categories are significantly different from each other. We operationalize and measure institutional differences using multiple variables, and perform a multilevel analysis combining individual level and institutional level data. The study was carried out within the context of the Norwegian higher education system, and included data from 4400 academics employed in 31 public higher education institutions.

The paper is structured as follows: In Section 2 we provide a review of existing research on the issue of academic engagement and the individual, discipline and institution level variables that have been used to explain differences between level of activity and modes of external interaction among academic staff. The review does not do justice to the broad research field of university-industry interaction but focuses on a set of empirical studies that have attempted to measure systematically the heterogeneity and patterns in how academics interact with external users. We emphasize studies that have looked into institutional differences, and identify the main variables and results from these studies. Based on the review, we formulate a main assumption that there are no or limited institutional characteristics that can significantly explain patterns of academic engagement. We then operationalize a set of institutional variables that do not take as an assumption that higher education institutions in the same institutional categories (university, college, specialized university college etc.) are very similar. Section 3 presents the variables, data and methods of the study, and the results of the analyses are found in section 4. In section 5, we discuss the results in light of prior research and policy relevance.

2. Universities' external interaction activities and factors that explain variance

Many studies of academics' interaction with private and public partners have emerged the last decades, often based on survey data yielding a nuanced picture of these external engagement activities and factors that explain variance in such engagement. Early studies tended to focus on a limited number of knowledge transfer activities – particularly connected to commercialization of university research – or on explanations for firms' use of universities as a source of knowledge. In studies of these "empirical objects" knowledge transfer is a relatively marginal phenomenon in terms of the volume of firms, academics and universities that participate. It is carried out by a limited number of firms, universities, or individuals with special characteristics: R&D intensive and fairly large firms, technical universities and universities with a particular commercialization focus, and star scientists that are able to combine high research productivity with commercial activities (see Rothaermel et al. 2007).

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The last five to ten years have seen a growth in the number of micro-level studies of academics and also a broadening of the kinds of activities that are seen as part of the phenomenon of university knowledge transfer to external users. The resulting image is that of heterogeneity (Gulbrandsen et al. 2011). The following definition of "academic engagement" presented in a recent review of the literature in this field is symptomatic: "Knowledge-related collaboration by academic researchers with non-academic organizations. These interactions include formal activities, such as collaborative research, contract research, and consulting, as well as informal activities like providing ad hoc advice and networking with practitioners" (Perkmann et al. 2013, p.2). With a broadening of the definition of knowledge transfer and a broadening of the relevant partners, knowledge transfer has moved from a relatively marginal phenomenon to one that the majority of academics and universities are involved in. Empirical studies have as a consequence shifted from explaining participation in narrowly defined knowledge transfer to participation in different types or modes of external engagement activities, usually measured across a number of academic fields and institutions.

Recent surveys have therefore asked academics about their participation in many interaction and engagement activities. Based on data reduction methods, patterns of interaction among academics emerge. Hughes & Kitson (2012) distinguish between four types of engagement they call "people based", "community based", "problem solving" and "commercialization" activities. Relatively similar categories are found in Abreu & Grinevich (2013) and Ramos-Vielba & Fernandez-Esquinas (2012). The most important distinction is between activities that are geared towards the commercialization of research-based knowledge (usually the smallest group), research collaboration (contract-based and involving resource exchange), informal cooperation (consultancy, counselling etc.) and education and dissemination activities.

2.1 Discipline and individual level factors

A key finding is that there are discipline-specific ways to collaborate with external partners (Abreu & Grinevich 2013, Schartinger et al. 2002, Perkman et al. 2013, Ramos- Veilba & Fernandez-Esquinas 2012, Boardman & Ponomariov 2009, Bekkers & Bodas-Freitas 2008). Hughes & Kitson (2012) and Abreu & Grinevich (2013) show that commercialization activities and research collaboration are common among academics in the hard sciences (often defined as natural science, technology, engineering and mathematics, STEM subjects). Researchers in these fields also cooperate mainly with the private sector. Collaborative research is also common in the social sciences, but to a greater extent with the public sector. Health disciplines have the highest proportion of education and competence oriented cooperation with external organizations and work mostly with the public sector and the voluntary sector. Academics in the humanities participate in dissemination activities and cooperation with the public and voluntary sectors. Informal networking activities are common in

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all disciplines. Hughes & Kitson (2012) show that the percentage of academics who report having collaborated with external users in each field of science does not differ that much; what differs is who they interact with and the way the interaction occurs.

Disciplinary affiliation thus explains a relatively large part of the variation in patterns of academic collaboration with external users. Some have however treated disciplinary differences explicitly rather than given, and have investigated issues such as level of funding, size (no. of employees), scientific status and academic norms (Schartinger et al. 2002, Ponomarinov & Boardman 2010, Perkmann et al. 2011) in terms of impact on academics' external engagement and collaboration behaviour.

There is also great variation between individuals in terms of range of external cooperation and the ways collaboration happens. Individual level factors like age, position, scientific productivity, gender, and prior work experience are important for explaining academics' participation in external engagement – particularly in formal, commercially oriented collaboration. Here the pattern seems to be that established male academic staff with substantial research production and externally funded research projects are most likely to participate in external cooperation, particularly in collaborative research and commercialization of own research (Perkmann et al. 2013, Abreu & Grinevich 2013, Bekkers & Freitas 2008, Boardman & Ponomarinov 2009, Schartinger et al. 2002). These characteristics are also significant in explaining participation in informal but commercially oriented forms of cooperation (networking, consulting), but they do not seem to be significant in explaining participation in education-oriented and non-commercial informal contexts (Abreu & Grinevich 2013 , Perkmann et al. 2013).

Academic staff who express that their research has an applied objective or that it is basic research with long-term application possibilities, are more likely to be involved in external cooperation than scientists who believe that their research can best be characterized as basic research (Hughes & Kitson 2012). Work experience outside academia or commercial experience in particular are also significant (Perkmann et al. 2013), while participation in specific training related to the commercialization or entrepreneurship has no significance (Abreu & Grinevich 2013). Academic staff with many PhD and other students involved in their research, also have a more cooperative activities of all types than other researchers (Boardman & Ponomarinov 2009).

2.2 Do institutional factors matter for academics' external engagement?

Since individual level variables and disciplinary affiliation explain a lot of the variation in range and types of external engagement, institutional-level variables have been seen as less significant and are

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primarily used as control variables (Perkmann et al. 2013, Abreu & Grinevich 2013, D'Este & Patel 2007). According to D'Este & Patel (2007) and Perkmann et al. (2013), institutional variables have been less explored within a broader external engagement perspective, and have primarily been systematically assessed for their impact on research commercialization activities. There are, however, a number of studies that use institutional level variables to explain differences in external engagement. Table 1 provides an overview of characteristics of higher education institutions that have been used as explanatory or control variables in empirical analyses of universities' external engagement activities. The table indicates the main result found as well as unit of analysis. There are three main sets of independent variables used in these studies: 1) Scientific quality of the institution measured by reputational data, assessment scores, overall R&D funding and bibliometric data; 2) localization of the university, and 3) institutional policy for supporting external engagement and commercialization. Most of the other variables such as ize, degree of scientific specialization, institutional status and institutional legacy/origin are treated as control variables.

There are also three sets of indicators used to measure the dependent variable: universities' external engagement. Several studies that include institutional level data have used industry funding as a measure for external engagement (Perkmann et al 2011, D'Este et al. 2013, Hewitt-Dundas 2012, D'Este & Iammarino 2010, Mansfield & Lee 1996). Secondly, a few studies distinguish between different modes of engagement relying on survey data from academic staff (D'Este & Patel 2007, Abreu & Grinevich 2013, Hughes & Kitson 2012). Thirdly, some studies use firms' assessment of the relevance and benefit of collaborating with universities to measure university-industry partnerships (Bishop et al. 2011, Laursen et al. 2011, D'Este et al. 2013, Bodas-Freitas et al. 2014).

The review summarized in Table 1 shows that not all of the institutional variables are equally important for the three different measures of universities' external engagement. Most of the studies have relied on funding data, and these studies have also tested the largest numbers of independent variables. However, the evidence for a relationship between institutional characteristics and funding from industry is mixed. *Scientific quality* measured by rating or scoring systems is found to be associated with higher levels of industry funding, but this varies by scientific fields (Perkmann et al. 2011, D'Este et al. 2013) and kinds of engagement activities (D'Este & Iammarino 2010, Hewitt-Dundas 2012).

< Insert table 1 about here>

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Institutional policies for supporting external engagement and commercialization have been found to have a weak association with external engagement measured by funding data, but studies that look at variance in academics' external engagement find a positive association with commercialization activities (Abreu & Grinevich 2013). Research intensity (total R&D expenditure), size of institution, high degree of specialization and presence of technical disciplines are all variables found to have a positive association with industry funding in universities (Hewitt-Dundas 2012, Perkmann 2011).

Turning to individual-level engagement, institutional characteristics such as research intensity (total R&D resources) and an institutional policy to support commercialization and external engagement have been found to influence the number of academics that report participation in certain types of engagement activities, in particular commercialization of research and research collaboration with industry (Hewitt-Dundas 2012, Abreu & Grinevich 2013). Also the external orientation of the university measured by the share of industry funding in relation to total R&D funding as well as the institutional origin and mission (former polytechnics, regional institutions) have been found to influence individual-level external engagement (D'Este & Patel 2007, Wright et al. 2008), but this association also seem to differ by fields of science and is typically found in studies with UK data only.

Finally, studies that use firms' assessment of partnerships with universities (or their investment behavior) have largely used two institutional variables – localization and scientific quality – as explanatory alternatives. These studies find that the decision to collaborate with a local university or a university which is a leading scientific institution is not an either-or decision. Rather, firms collaborate with local or distant universities for different purposes. Also, the decision is to a large extent influenced by characteristic of the firms, particularly size and R&D intensity. Several authors find that large and R&D intensive firms develop strong collaborative ties with local universities when the local university has a good scientific standing (Laursen et al. 2011,Bodas-Freitas et al. 2014, Bishop et al. 2011, D'Este et al. 2013b).

To summarize, the evidence for an association between institution level characteristics and academic engagement and collaboration with industry is quite mixed and far from clear. A few studies find that institutional variables matter for academic engagement and industry collaboration, particularly the overall scientific standing of the institution as well as an institution-wide policy for supporting academic engagement, but that the association is mainly positive for certain fields of science and for particular forms of academic engagement. A few institutional control variables seem to have an overall effect on multiple forms of engagement, particularly degree of specialization, research/teaching in technological disciplines, institutional legacy (former/present status in binary systems) and size of the institution.

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The current state-of-the art thus offers little support for the assumption that institutional characteristics are important for explaining the extent to which and how academics collaborate and engage with external users. Institutional characteristics are primarily associated with disciplinary differences. There are, however, problems with this conclusion: First, most of the studies are based on data about investments by firms in university R&D, which is a rare and limited channel of collaboration between universities and firms. Second, most studies focus on either institutional level analyses or individual level analyses, where institutional level characteristics is used as control variables. The relationship between subject field characteristics and institutional characteristics is not explored explicitly. We therefore cannot say that institution-level strategies and institutional characteristics matter a lot (as assumed in the "one size does not fit all"-hypothesis) or not at all in explaining variance in academic engagement and external collaboration.

The literature review therefore primarily seems to support the convergence hypothesis – that differences between higher education institutions in their external engagement can best be explained by characteristics not found at the institutional level, with the possible exception for commercialization activities. We have formulated this as the following two hypotheses:

- H1: Individual characteristics to a larger extent than institutional level factors explain variance in academics' external engagement activities.
- H2: Institutional characteristics influence only certain kinds of academic engagement activities, particularly commercialization of research.

2. Variables, data sources and methods

The empirical study reported in this paper has been carried out in Norway, and thus reflects the experiences of Norwegian academics that are employed in public higher education institutions in this particular context. Norway is a small and relatively well-endowed country. The public higher education institutions are owned by the Ministry of Science and Education and are subject to similar requirements and policies, and there is limited competition among institutions for students or research funding. But Norway has also had a two-pronged policy towards higher education institutions. The main distinction has been between large "research universities" and regional and vocationally oriented "university colleges", with e.g. a stronger emphasis on bachelor level teaching and less emphasis on basic research. The picture is complicated by a number of specialized scientific colleges related to specific sectors (such as agriculture) or particular professions (such as architecture). In the last decades, the higher education landscape has been changing, however. The

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number of universities has increased from four to eight in a decade, and mergers have created larger and more scientifically ambitious regional colleges and specialized university colleges.

Substantial data on higher education institutions, the academic population and research production are publicly available in Norway, which represents a unique opportunity for carrying out multilevel analyses of academic behavior with the context of disciplinary and institutional landscapes. We make use of several data sources to test the impact of multiple independent variables at individual (including disciplinary affiliation) and institutional level on academic engagement (Table 2 contains an overview of the variables).

As the *dependent variable*, we operationalize "academic engagement" in a wide sense akin to Abreu & Grinevich (2013), Hughes & Kitson (2012) and Ramos-Vielba & Fernandez-Esquinas (2012). Relying on survey data from academic staff, different modes of engagement are distinguished based on factor analysis of survey responses to multiple items connected to different modes of contact with external audiences/stakeholders. Data on modes of interaction by academic staff were collected through a survey[1] administered to 8500 tenured/permanently employed academic staff in all public higher education institutions in Norway in 2013. The survey received 4440 useable responses, 52.5 percent response rate. We have excluded two higher education institutions (the Oslo School of Architecture and Design and the Sámi University College) since the survey only contains 13 and 10 respondent, the rest of the 31 institutions have all above 25 respondents. Hence the total number of respondent in the survey is 4417.

We use the following *individual level independent variables*: subject field (in which the academic employee has a PhD), academic rank, gender, age, scientific productivity and scientific merit. Aside from the two latter variables, all the other variables have been collected from a national registry of academic staff (the R&D personnel registry in Norway).

Data on the two variables scientific productivity and scientific merit are based on analysis of the publication output of academic staff from a national bibliographic database. The database (CRISTiN) is a complete documentation system for all peer-reviewed publications that have been published by academic staff employed in Norwegian research organisations, including journal articles, monographs, book chapters and conference series in all fields of research (Sivertsen 2010). Different publications yield different publication points based on type of publication and a two-tiered assessment of quality. Level 1 contains the "regular" scientific publication channels, while Level 2 is confined to the 20 percent most prestigious journals and publishers. Articles give a higher score than

[1] A copy of the full questionnaire used can be obtained by contacting the corresponding author.

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book chapters, and scores are split between multiple authors. We use the total number of publication points in the three-year period 2011-2013 as an indicator of research productivity, and the percentage of publications at Level 2 in this period as an indicator of research quality.

Institutional level independent variables are based on different data sources. We have collected data about the variables previously found to have an impact in empirical research (Table 1) for the 33 public higher education institutions in Norway (excluding private institutions and arts colleges). We have computed a Herfindahl specialization score (the breadth of academic fields within each institution), research intensity (volume of R&D in each institution), research output (number of scientific articles published in a three year period), external orientation (ratio of external funding to all R&D funding), scientific merit (ratio of high quality publications to all publications over a three year period), and have also included a score of the emphasis each institution puts on external engagement (measured by existence of strategies and institutional investments in resources for commercialization and external engagement). Data on the latter variable was collected from an institutional mapping of policy and resources for commercialization in Norwegian higher education institutions (Spilling et al. 2015).

We also include three variables frequently used as control variables – the size of each institution (number of academic employees), the location of the institution (major city or not), as well as whether or not the institution offers education in technical subjects/engineering subjects. Urban location is measured by whether the institution is located (or location of main campus) in a major city region. An urban area is by Norwegian convention defined as a city region with more than 50 000 inhabitants. Data on this variable was collected from the Norwegian statistical agency's webpage. For the variable "technical subjects", we use information on whether the institution has a technical faculty/department or an engineering school. Data on all the other institutional variables were collected from two publicly available databases on higher education: the Norwegian R&D Statistics[2] and the Database for Higher Education in Norway (DBH)[3].

< Insert table 2 about here>

We investigate the effect of both individual and institutional factors on external relations through a multilevel analysis which allows us to investigate factors at different levels simultaneously.. Such an analysis takes into account that the dataset is hierarchically structured; in this case, between academic staff (level 1) at separate higher education institutions (level 2). Multilevel analysis gives a

[2] http://www.foustatistikkbanken.no/nifu/
[3] http://dbh.nsd.uib.no/statistikk/

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precise estimation of the level of significance, since it takes into account that institutional variables are based on fewer observations than individual variables. The variance at level 2 is smaller than recommended for a multilevel analysis, but since not using this model will underestimate the level of significance (Christophersen 2009), we use a multilevel analysis for not getting too many significant results because of underestimating.

There are different models in multilevel analysis. Fixed-effect models investigate the variation within the level 2 groups (Allison 2009), while a random effect model investigates both the variation within and between the groups of individuals (Snijders & Bosker 1999, Rabe-Hesketh & Skrondal 2010). Akaike's information criterion (AIC) can be used to select the best-suited model. The test shows that a multilevel analysis is preferable to ordinary logistic regression, and hence confirms our choice of multilevel analysis. The test also shows that a fixed effects model is preferable to a random effect model. Since a fixed-effect model does not give us significantly different results of the effects of the individual variables, and also omits the institutional variables since they are the same for all individual in one group, we nevertheless use a random effect model (Akaike 1973). .

Since many of the institutional variables are highly correlated, namely Policy, Average Publication Points, Scientific Merit and R&D, with a Pearson's R above 0.7 we had to take these variables in separate regressions to avoid multicollinearity (Skog 2009). However, all regressions include the individual variables and technical subjects, location, size and the Herfindahl specialization index as institutional variables.

The dependent variables, the external relation indexes, are highly skewed and hence transformed into dichotomous variables. We thus use logistic regressions for our multilevel analysis, using the xlogit-function in STATA. Since the xlogit function does not show how much variance is to be found at both levels, we will use a linear multilevel regression model, xtreg in STATA, where the Rho-coefficient will provide an indication, although we are aware that the linear regression is not perfectly suited for our dependent variables.

3. Results

4.1 Different modes of external engagement

As seen, academics are involved in multiple knowledge related interaction activities with external stakeholders, but the modes of interactions vary by field of science (Abreu et al. 2009, Abreu & Grinevich 2013, Hughes & Kitson 2012). To capture the breadth of external engagement, we use multiple indicators for different activities, and asked academics to indicate which of these they had

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been involved in over the last three-year period (similar to Abreu et al. 2009). We then performed a factor analysis to extract different modes of interaction (Table 3). The output of the factor analyses was assessed in light of previous research findings (Abreu & Grinevich 2013, Hughes & Kitson 2012) to make sure that the constructed variables were meaningful for our analytical model. Since the factors that represent the modes of interaction are too skewed to be used as dependent variables in regression, we converted them into dichotomous variables.

< Insert table 3 about here>

The factor analysis revealed five main modes, as described in Table 3: **Dissemination** of research to user groups and the general public (78 per cent of the informants has contributed to at least one activity in this group), **Training** (59 per cent), **Research Collaboration** (32 per cent) and **Commercialization** (13 per cent). The final factor (**joint positions/consultancy** activities) had a relatively low factor loading, but since it was quite common among the informants in the sample (37 per cent) we have retained it in the analyses. The latter factor concerns activities where academics exploit their competence commercially (in the form of consultancy tasks or additional positions to their permanent academic position). This has been highlighted in prior studies (Abreu & Grinevich 2013) which also underpins our decision to retain it as a factor even though it has low factor loadings. These results are largely in correspondence with prior research, which indicates that participating in academic engagement activities is common among academic employees, and that the most common forms of engagement are connected to informal activities that focus on creating and disseminating knowledge to a range of different users, and the least common mode among academics is commercialization of research.

Participation in different kinds of external engagement varies across academic fields, rank, gender and age. Figure 1 describes the participation in five different modes of interaction by fields of science.

<Insert figure 1 about here>

While 84 per cent in social science have been active in dissemination, 71 per cent of academics in natural sciences have done the same. In training academic employees in the social sciences (66 per cent) and in health and medicine (71 percent) are the most active. Professors (49 per cent) and men (43 per cent) are the most active in consultancy. Academic employees in technology (49 percent) and male academics (36 per cent) are the most active in research collaboration. Academics in technology (30 per cent), professors (19 per cent) and male academics (18 per cent) are the most active in commercialization activities. Hence, we see that the factors that influence the level of participation in

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external engagement activities vary between the different types of engagement. However, generally speaking, it looks like academic fields and academic rank are the most decisive factors for involvement, which is in line with prior research. The question we pursue in this study is, however, whether there are also significant institutional differences in participation in external engagement activities, having in mind the strong impact of academic disciplines and individual characteristics.

4.2 Multilevel analysis

Intraclass correlation is a measure of the variance at level 2 and could be found by looking at Rho in a multivariate analysis without independent variables (empty-model) using the xtreg-function in STATA (Christophersen 2013). However this estimation in a logistic multilevel analysis is difficult since the level 1 residuals are fixed and will always be 3,29 (Christensen et al. 2013). Lacking a more suited alternative, we therefore use the skewed variables in a linear regression to get an estimation of the variance at level 2.

Table 4 displays both the Rho for the modes of engagement with non-independent variables. A very small part of the variation in modes of external interaction is between the institutions, from zero to seven percent. Hence, this analysis confirms that most of the variance is between individuals, and not between the institutions. This does not imply that institutional factors do not have a significant effect on external engagement, but shows that most of the variance is between the staff and not between the institutions. Since we are interested in investigating these effects, we use a multilevel analysis even though the variance at level 2 is small.

<Insert table 4 about here>

Table 5 displays the results from the logistic multivariate analysis using random effects models. Since many of the institutional factors are highly correlated, we were not able to integrate them in one analysis. Hence, the separating lines in Table 5 indicate that the coefficients are drawn from different analyses. All individual variables are included in all regressions and do not differ significantly between the different analyses (for the specific coefficients see Appendix). Since the coefficients from a random effect model are based both on between and within variation, they are a bit tricky to interpret. However, they estimate the effect of the different independent variables on the dependent variables, as the independent variables changes with one unit, and are based both on the between and within variation.

< Insert table 5 about here>

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Gender only has significant effect on "consultancy activities" and "commercialization". Both effects are negative, meaning that the propensity to be involved in these activities is greater for men than women. While 36 percent of men take part in consultancy activities and 17 percent in commercialization, just 25 and 9 percent respectively of women take part in these activities.[4] The youngest academic staff members, individuals under the age of 40, are the least involved in dissemination, training and consultancy activities. However, staff over 60 years of age is less frequently involved in commercialization than academic staff below 40.

Being a professor or associated professor instead of a lecturer increases the propensity to be involved in dissemination, consultancy and research collaboration, but not in training. Being a leader instead of a lecturer decreases the possibility of being active in "training" with 10 percentage points for employees in science between 40 and 49 years old, with the average of publication points and elite level publications, at an urban institution with 1000-3000 employees.

Academic fields also influence participation in different kinds of external engagement. The possibility to be involved in dissemination is highest for the staff in humanities and social science, as we have seen already. For training, the social scientists and the staff in medicine are the most active, while the academic in humanities are the least active in research collaboration. The possibility of being involved in commercialization increases from 8 percent to 45 percent going from the male employees in humanities to male employees in technology.

In terms of scientific productivity and quality, we find that productivity (number of publication points) has a limited relation to external engagement. Personal publication points increases the possibility for being involved in dissemination and research collaboration, and personal scientific merit decreases the possibility of being involved in training and increases the possibility of research collaboration. However, the effects are small. For associated professors in science at an institution with 1000 – 3000 employees with the average of publication points and the average of elite level publications, the possibility of being involved in research increases from 36 to 44 percent if the same person has the double amount of publication points and scientific merit.

We have already shown (Table 4) that most of the variation in external engagement is found between the individuals and not between the institutions. However, this does not imply that institutional factors are not related to modes of interaction. The multivariate analysis shows that being employed at an institution in urban areas decreases the possibility for being active in

[4] The group we analysis is associated professor in science between 40 and 49 years old, with the average of publication points and publication at level 2 at an urban institution with 1000 – 3000 employees.

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dissemination from 72 percent to 67 percentages and increases the possibility for being active in training from 23 percent to 48 percent[5].

Size of the institution also seems to matter. Bigger institutions are more prone to be active in consultancy, while smaller institutions are more active in training. Having a Technology Transfer Office (TTO) and an active policy towards commercialization has a positive effect on both consultancy and commercialization.

Controlling for individual publication points and personal scientific merit, the level of scientific productivity and scientific merit at the institutional level has a positive effect on research collaboration, not so surprisingly since scientific merit is an indicator of research activity. Higher level of average publication points decreases the possibility to being active in dissemination. Whether the institutions contain technological disciplines, the degree of specialization (measured by the Herfindahl index), and the total expenses on R&D have no significant effect on any of the indicators for external engagement.

4. Discussion and concluding remarks

We started out noticing the great variety in academics' external engagement, documented in an increasing number of sophisticated empirical investigations with rich micro-level data. It is assumed that this variety also reflects different roles for different types of higher education institutions, and warnings have been raised against pushing all institutions into the same template under the framework of a "one size fits all" policy leading to inefficient "convergence". There is some indication that the institutional level is important for external engagement, i.e. a picture of "distinct" universities, but much evidence that other aspects (disciplinary mix and individual-level characteristics) matter a lot more (Perkmann et al. 2013, Abreu & Grinevich 2013, Bekkers & Freitas 2008, Boardman & Ponomarinov 2009, Schartinger et al. 2002). However, few investigations have looked explicitly at multiple levels simultaneously; often crude measures of external engagement and the type or quality of universities have been used as variables in institution-level studies of academic engagement (Perkmann et al 2011, D'Este et al. 2013, Hewitt-Dundas 2012, D'Este & Iammarino 2010, Mansfield & Lee 199).

In the paper we have aimed to fill this gap and asked whether characteristics of the higher education institution influence the ways in which individual academics engage with industry and other external bodies. We have carried out a multi-level regression utilizing multiple data sources: a large-scale

[5] For Associated professor between 40 and 49 years old in science, with the average of publication points.

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individual-level survey with 4417 respondents combined with information about 31 public higher education institutions in Norway. Rather than assuming that existing categories of higher education institutions (universities, regional colleges, and scientific colleges) represent significant institutional differences, we have collected information on scientific specialization, size, scientific quality, research funding, commercialization policy and localization on all Norwegian higher education institutions to look at the impact of different institutional characteristics.

Based on a review of recent literature on this topic, we hypothesized that institutional characteristics would be less important than individual-level characteristics for explaining variance in academics' participation in external engagement activities, apart from a possible effect on academics' participation in specific linkage mechanisms such as commercialization of research. By and large, our empirical study supports the current knowledge and the hypotheses have been confirmed – individual-level aspects including disciplinary affiliation matter a lot more than the institutional-level characteristics. Many of the latter are not significantly related to any of the five different forms of external engagement that we have looked at: dissemination, (external) training, consultancy, commercialization and research collaboration. When we control for differences between individual academics (which includes their disciplinary affiliation), institutional factors do not matter much for how academics interact with external audiences.

Still, there are some nuances to be added from the multi-level analysis. Particularly consultancy is influenced by university-level factors: it is found more often at leading institutions, less frequently at the smallest ones (measured both in number of employees and volume of research funding) and at universities with explicit strategies for commercialization including having technology transfer offices. The latter is, as expected, also important for commercialization. Why it is important for consultancy is not clear, but it could be that also this form of interaction benefits from a certain infrastructure and as such may be less "individualistic" than often assumed. It is also interesting to see that an urban location is only positively related to participation in external training activities (maybe because this is common in medicine and health and the larger hospitals typically are found in urban areas), and negatively related only to dissemination.

It nevertheless seems relevant to ask why we find so few differences between higher education institutions, as external engagement and research activities are two areas where one would expect universities to make an attempt at creating distinct profiles. While the higher education institutions in this study might in fact actually be doing just that, these efforts seem to have limited impact on the activities performed by their employees. The academic staff we have observed seem to behave in relatively similar ways regardless of what kind of higher education institution they are employed

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by. This might be regarded as a form of inertia or as a typical organic or incremental change process in universities (Stensaker 2015). In the latter perspective, understanding change in universities requires attention to individuals and groups within the institutions and their behavior, interests, motives etc. Stensaker (2015) refers to these two perspectives as a strategic and essentialist perspective on change in universities.

In this light our findings can be interpreted as a failure to create distinct institutional profiles that are manifest at the individual level (at least for the time being). For instance, there might be a lack of incentives or a mismatch in the incentive systems for academic staff which means that they prioritize other tasks than external engagement (research activities, publication). We do not, however, observe a low level of external engagement activities in general; rather what is striking is the limited degree of variance between institutions because there is a relatively high level of activities in all institutions. This might be due to limited differences in policies and strategies at the institutional level, or that policies and strategies have limited effect on the behavior of academic staff. Interpreted with an essentialist perspective, our results indicate that engaging in interaction with external constituencies is a key element of academics' behavior and identities. The majority of academic staff are interested in communicating and putting results of their work to use; and they do so largely irrespective of policies and incentive schemes. Our results do seem to indicate that external engagement activities to a great extent are bottom-up processes intimately tied to individual-level aspects such as position, interests and competence.

This study have offered a new look on determinants of academics' behavior by looking at individual behavior within the organizational-institutional context. We believe multi-level analyses are a fruitful avenue for further research. For instance, we find that certain forms of behaviors (dissemination, collaboration) occur regardless of special institutional support, whereas other kinds of behavior (commercialization and consultancy) are more common in institutions that have developed policies and resources to support such behavior.

It can therefore be valuable to disentangle multiple factors in order to identify areas where policy intervention might make an impact on academic behavior. Further research could for instance look at other areas of academic behavior and performance (in research, teaching) seen in light of particular institutional characteristics, as well as disciplinary and individual level factors. Broad labels such as "social science" and "medicine and health" probably hide large variances between different sub-fields. Also, we have not explicitly looked into how institutional goals are reflected in institutional strategies (for instance recruitment, incentives and career structures); and whether or not the latter influence behavior that over time lead to the accomplishment of institutional goals.

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Moreover, in our study there seems to be a relatively high degree of congruence between individual level goals and institutional goals. In other areas of activities, institutional and individual goals might not be very well aligned or even in conflict. The multi-level approach is therefore central in studies of change and stability in universities, among other things, as it can explore the complexities of change that underlie the perspective that universities appear to change very little and a great deal simultaneously. There are multiple research questions that can be explored with this approach, but it is also important to mention that analyses across multiple levels require substantial amounts of data, and that it is perhaps most feasible in either relatively small higher education systems or a subset of institutions in larger countries. Finally, an important caveat is that this study took place within the context of one national higher education system, which obviously influences the generalizability of the results. Further research should therefore establish a comparative basis for exploring these questions.

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Tables and figures to paper "Universities and external engagement activities: Particular profiles for particular universities?" submitted to SPP august 2015

Table 1: Overview of variables and results in empirical research on institutional differences and academic engagement

	Independent variables (or control variables)	Dependent variables	Relationship found[1]	Unit of analysis for dep. variable	References
Studies of the relationship between scientific quality of the institution and academic engagement	*Quality of institution* (measured by RAE scores in UK, other rating/grouping systems of institutions, US)	Income from external engagement activities	+ (but only in certain scientific fields) 0	University	Perkmann et al 2011 D'Este et al 2013
		Benefits of collaborating with universities (reported by firms)	+ (but only for certain uses of universities)	Firms	Bishop et al 2011
		Decision to collaborate with universities (by firms)	+ (particularly for R&D intensive firms)	Firms	Laursen et al 2011
		Industry support/funding to Universities (R&D)	+ (but only for industry support to some forms of university R&D)	Firms	Mansfield & Lee 1996, D'Este & Iammarino 2010,
	Research intensity of institution (measured by reputation, level of R&D funding)	Engagement profile (funding for different kinds of external engagement activity)	+ across all forms of engagement	Universities	Wright et al 2008, Hewitt-Dundas 2012
		Income from industry	0 (control variable, but significant relationship reported I table)	Universities	D'Este et al 2013
Studies of institutional policy for commercialization and engagement	*Commercialisation policy/resources* supporting industry collaboration and commercialization (Having a commercialization plan, presence of Technology transfer office , no. of staff working with commercialisation.)	Modes of collaboration (by academic staff)	+ for commercialization - For other forms of engagement	Academics	Abreu & Grinevich 2013
		Industry funding	+/0 depending on kinds of income	Universities	Hewitt-Dundas 2012 Perkmann et al 2011
	Maturity of commercialization policy (age of TTO)	Industry funding	0	Universities	Perkmann et al 2011
	External orientation of university (industry funding relative to total income)	Variety in modes of collaboration with industry	+	Academics	D'Este & Patel 2007

[1] **+= positive relationship, - = negative relationship, 0= no relationship/pattern found**

Studies of the impact of geographic location and engagement	*Regional mission* of university («former poly»)	Variety in modes of collaboration with industry	+ (dep on scientific field)	Academics	D'Este & Patel 2007
	Localization of university (relative geo closeness of university to industry partners)	Industry support/funding, decision to collaborate with universities	+ (but only for certain kinds of firms and certain uses of knowledge) - For large and R&D intensive firms 0 depend on the quality of the regional university	Firms	Laursen et al 2011, Mansfield & Lee 1996, Bodas-Freitas et al 2014, Bishop et al 2011, D'Este et al 2013b
Other independent and control variables	*Academic specialization* of university (measured by Herfindhal index))	Income from industry	+	Universities	Perkmann et al 2011,
	Size of institution (nr of full time equivalent staff)	Industry support/funding to different kinds of collaborative arrangements with universities	+/0 (depend on engagement form and partner)	Universities	Perkmann et al 2011
	Technical subjects (Presence of disciplines with high prevalence of industry relations such as engineering vs general academic institutions)	Firm growth	+	Firms	Audrech & Lehmann 2005
		Industry funding to universities	+	Universities	Perkmann et al 2011

Table 2: Variables used in the multilevel regression analysis

Name	Description	Values (N; number of respondents in each category)
Dependent variable		
External engagement	Indexes based on factor analysis; each index is treated as a dichotomous variable. Read more about the variables in part 4.1.	
Independent variables at individual level		
Gender	Gender is a dichotomous variable.	0 - Men (2615) 1 - Women (1802)
Age	Age is a dummyvariable with <40 as the reference group.	< 40 (502) 40 - 49 (1063) 50 - 59 (1634) 60 < (1218)
Rank	Rank is a dummy variable with assistant professors as reference category.	Professor (1286) Associate professor/Senior lecturer/lecturer (1614) Assistant (1362) Leaders (155)
Academic field	Academic field is a dummy variable with humanities as reference category	Humanities (709) Social sciences (1589) Natural sciences (529) Technology (684) Medicine and health (906)
Personal scientific productivity	The staff's personal publication points in the period 2011-2013	Min: 0, Max: 23.4 Mean: 1.64. 36 % have zero publication points.
Personal Scientific merit	The percentage of the staff's publication at Level 2	Min: 0, Max: 100%, Mean: 14%. 71 % have zero Level 2 publications
Variables at institutional level		
Technological disciplines	Dummy variable; presence of technological subjects or not	0 – No (1653) 1 – Yes (2764)
Location	Dummy variable; location in major urban center or not	0 – Non-urban (1359) 1 – Urban (3058)
Size	Size consist of four dichotomous variables (number of employees): < 500, 500-1000, 1000-3000, 3000 <	< 500 (1615) 500-1000 (761) 1000-3000 (959) 3000 < (1082)
Specialization	Herfindahl index (0-1; higher number means more specialized)	Min: 0.22, Max: 1, Mean: 0.32
Policy	Policy consist of four dichotomous variables: No policy for commercialization, technology transfer office (TTO), internal resources for commercialization and TTO, internal resources plus TTO plus other initiatives	No policy (1320) TTO (1159) Internal resources/TTO (661) Internal resources TTO and other (1277)
Average publication points	Average publications points is the institutions' total amount of publication points per employee	Min: 0.69, Max: 5.70, Mean: 2.68
Scientific merit	Average publication at Level 2 is the institution total share of publications at level 2	Min: 0.02%, Max: 0.34%, Mean: 0.19%
Total R&D expenses	Total R&D expenses consist of four dichotomous variables (numbers in million NOK): 0-100, 100-500, 500-2000, >2000	0-100 (1467) 100-500 (972) 500-2000 (819) > 2000 (1082)

Table 3: Factor analysis of modes of interaction among academic staff

	Disseminatio n	Training links	Commerci alisation	Research collaborati	Consultanc y

				on	
Published contributions in popular press	0,623				
Published contributions to public open debate	0,540				
Lectures/talks to users/practitioners	0,531				
Participating in meetings/conferences with users/ practitioners	0,397				
Training employees outside campus		0,592			0,335
Training/continuing education offerings at campus		0,487			
Applied for a patent			0,618		
Developed/tested a new prototype			0,399		
Licensed results to users outside HE			0,397		
Started a company			0,379		
Participated in a research project with firms				0,469	
Participated in commissioned research for a public or private user				0,467	
Participated in a research project with a public sector agency				0,374	
Acted as consultant/advisor based on academic expertise					0,378
Holding an adjunct position outside HE-sector (hospital, research institute, firm)					0,326
Percent of variance explained by each factor	12,7	10,8	10,3	9,1	6,4
Extraction Method: Principal Axis Factoring. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 5 iterations.					

Table 4: The variance of the dependent variables between the higher education institutions

	Type of dependent variable	Dissemination	Training links	Commer-cialization	Research collaboration	Consultancy
Rho	The indexes	0,03	0,01	0,02	0,07	0,01

Table 5: Multilevel analysis

Dependent variable:		Dissemi-nation	Training links	Consultancy activities	Research collabo-ration	Commercia-lization
1	Gender (0-men, 1-women)	-0.02	0.14	-0.52***	-0.03	-0.76***
		(0.08)	(0.07)	(0.07)	(0.07)	(0.11)
	Age (<40 as reference category)					
	- 40 and 49	0.32*	0.43***	0.31*	0.17	-0.04
		(0.13)	(0.11)	(0.12)	(0.13)	(0.16)

	- 50 and 59	0.30*	0.36***	0.44***	0.11	-0.10
		(0.12)	(0.11)	(0.12)	(0.12)	(0.16)
	- 60 <	-0.03	0.36***	0.22	-0.22	-0.37*
		(0.13)	(0.12)	(0.13)	(0.13)	(0.17)
	Rank (assistant as as reference category)					
	- Associated professor	0.63***	0.10	0.44***	0.93***	0.13
		(0.09)	(0.08)	(0.09)	(0.10)	(0.13)
	- Leader	0.86***	-0.43*	0.32	0.93***	0.06
		(0.23)	(0.18)	(0.18)	(0.19)	(0.28)
	- Professor	0.92***	-0.03	0.77***	1.39***	0.40**
		(0.13)	(0.11)	(0.11)	(0.12)	(0.16)
	Academic field (humanities as reference category)					
	- Health	0.04	0.82***	0.50***	1.33***	1.04***
		(0.13)	(0.11)	(0.11)	(0.14)	(0.19)
	- Technology	-0.46***	-0.26*	0.22	1.72***	1.74***
		(0.14)	(0.12)	(0.12)	(0.15)	(0.19)
	- Science	-0.58***	-0.07	-0.08	1.20***	0.90***
		(0.14)	(0.12)	(0.13)	(0.15)	(0.20)
	- Social Science	0.39***	0.60***	0.46***	1.19***	0.38*
		(0.12)	(0.10)	(0.13)	(0.13)	(0.18)
	Personal scientific merit	0.07	-0.39**	0.01	0.33*	0.01
		(0.19)	(0.15)	(0.15)	(0.16)	(0.22)
	Personal publication points	0.07**	0.00	0.00	0.05**	-0.03
		(0.02)	(0.02)	(0.01)	(0.04)	(0.03)
	Institutional factors					
	Technical subject	0.17	0.05	0.06	0.04	-0.19
		(0.09)	(0.08)	(0.08)	(0.16)	(0.11)
	Location (0 – Nonurban, 1 – urban)	-0.33**	0.25*	-0.03	-0.07	-0.11
		(0.20)	(0.10)	(0.11)	(0.18)	(0.15)
	Size (<500 as reference category)					
	- 500-1000	0.20	-0.00	0.33*	-0.11	0.44*
		(0.14)	(0.12)	(0.12)	(0.22)	(0.22)
	- 1000-3000	0.14	-0.26*	0.46***	-0.61*	0.35
		(0.14)	(0.12)	(0.13)	(0.26)	(0.30)
	- 3000 <	-0.06	-0.32*	0.49***	-0.44	0.53**
		(0.15)	(0.13)	(0.13)	(0.30)	(0.20)
	Herfindahl index	0.43	0.22	0.43	-0.64	-0.09
		(0.30)	(0.25)	(0.26)	(0.44)	(0.37)
2	Commercialization policy (no as reference category)					
	- TTO	0.18	0.04	0.10	-0.09	0.38*
		(0.13)	(0.11)	(0.11)	(0.18)	(0.14)
	- internal resources/TTO	-0.03	-0.17	-0.19	0.11	0.20
		(0.24)	(0.21)	(0.12)	(0.45)	(0.17)
	- internal resources, TTO, and other	-0.14	-0.28	0.35**	0.02	0.96***
		(0.23)	(0.19)	(0.19)	(0.40)	(0.13)
3	Institutions number of publication points/size	-0.13*	-0.05	0.03	0.02	-0.05
		(0.05)	(0.05)	(0.04)	(0.08)	(0.06)
4	Institution's scientific merit	0.88	-0.77	0.96	3.14*	-0.86
		(1.09)	(0.92)	(0.93)	(1.26)	(1.21)
5	Total R&D expenses(0-100 as reference category)					
	- 100-500	0.0	-0.0	0.0	0.0	0.0
		(.)	(.)	(.)	(.)	(.)
	- 500-2000	0.17	-0.05	0.10	0.52	-0.24
		(0.21)	(0.17)	(0.18)	(0.32)	(0.20)
	- > 2000	0.15	0.09	0.15	0.18	0.02
		(0.14)	(0.12)	(0.12)	(0.20)	(0.18)
1	Constant	0.43***	-0.44**	-1.77***	-2.39***	-2.54***
		(0.21)	(0.18)	(0.20)	(0.30)	(0.29)

	Observations	4417	4417	4417	4417	4417
	Log Likelihood	2220	2861	2775	2509	1581

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

**The null hypothesis is that there is no significant difference between the two models. If Prob>chi2 <0.05

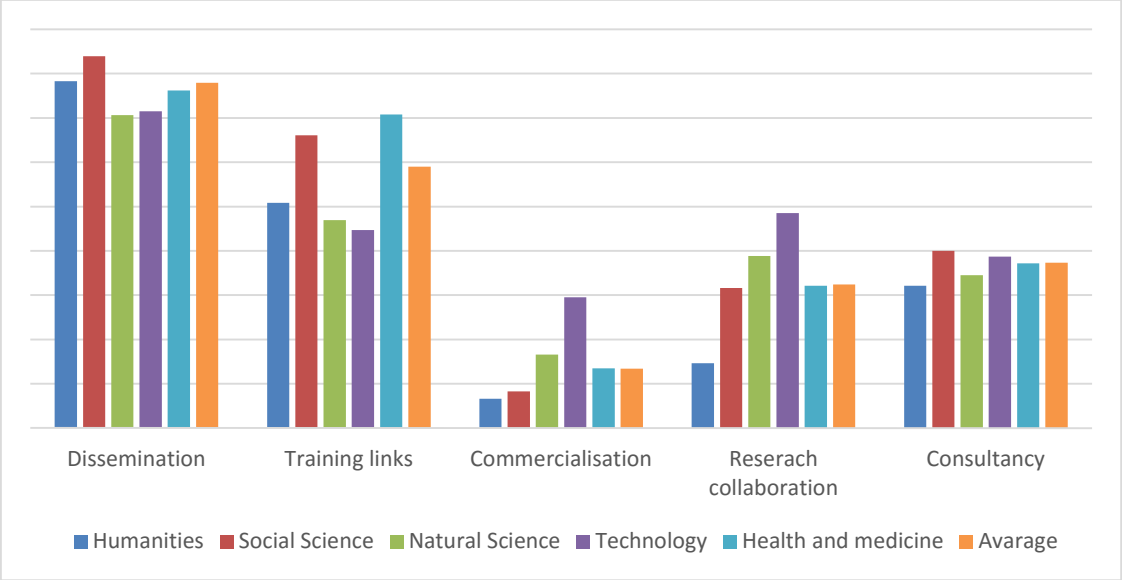

Figure 1: Modes of interaction by fields of science