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Follow the Leader?! ? How Leadership Behavior Influences Scientists? Commercialization Behavior (or not)

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Abstract

In this study we analyze the impact of organization leaders on their fellows? behavior in academia by utilizing the unique structure of the Max Planck Society. The latter is a leading research organization in Europe with autonomous institutes which center round appointed directors. Using panel data of commercialization activities and royalties received in the period 1980 ? 2007, we observe that both director engagement in disclosure activity and royalty shares received at the institute level lead to a significant increase in invention disclosure by non-directors in the following year. Yet, both effects are only significant when regarding short time lags of one year. By utilizing information based on a survey performed with Max Planck scientists in 2007 we find that perceived academic relevance of commercialization does neither relate to previous director involvement in disclosure activity nor to previous overall disclosure efforts within the institute. We conclude that directors have a short-term impact on their institute while a long-lasting impact on their institute hardly exists.

Jelcodes:O31,I23

Follow the Leader?! –

How Leadership Behavior Influences Scientists' Commercialization Behavior (or not)

Keywords: commercialization; director influence; Max Planck Society; royalties

JEL classification: I23; O31; O32

1. Introduction

Organization theory postulates that organization leaders may exert influence on the socialization of fellow employees. The actions of leaders serves as a reference point what behavior is worthwhile to be followed in order to integrate into existing corporate habits and routines (Cordes and Schwesinger, 2010; Kogut and Zander, 1996). Further, organization leaders may impact fellow workers through strategic positioning as they define the strategic goals of an organization and set the agenda. In this way, organization leaders may have a long-term influence on organizations that may outlast their own affiliation with the organization (Beckman and Burton, 2008; Johnson, 2007).

Yet, the impact of leaders' behavior has largely been investigated in private firms while surprisingly few studies analyze such organizational influence in academia. Leaders in private ventures are shown to affect employees' attitudes (Carr et al. 2003; Schneider, 1990) and employees' behavior (Cooke and Rosseau, 1988; Sila, 2007; Walumba et al. 2010). However, it is not clear whether such effects are similarly pronounced in academia as the institution of science has strong institutional norms, such that the reference group of a single scientist likely comprises the scientific community – of scientists working in related fields of research – and may neither be limited to leaders within scientists' organization nor the organization as a whole. Thus, it is less clear whether or not leaders may affect organizations in similar magnitude as in private firms. In the present study we try to shed more light on this question.

One of the rare studies examining peer effects and leadership effects in academia is Bercovitz and Feldman (2008). By tracking 1,780 faculty members across 15 matched departments of two medical schools, the latter study finds that members are more likely to participate in invention disclosure when the department head is actively involved in invention disclosure. Yet, when switching from one department in which the chair is not involved in disclosure activity to another department with a chair who is actively involved in disclosure activity, scientists often tend to engage in disclosure activity only once. Thus, Bercovitz and Feldman (2008) conclude that such adaption behavior to leadership behavior is rather *symbolic* integration than adaption to organizational focus on commercialization output.

In this study we extend the research on the influence of leadership behavior in academia by focusing on the impact of leaders' commercialization behavior in the Max Planck Society (MPS). The MPS is a research organization in Germany devoted to basic research with several important organization attributes which are beneficial for our study purpose. Most importantly, the MPS is a parent organization which comprises 80 autonomous institutes. This organizational structure allows an analysis of institute commercialization effects since external factors as organizational research outline or quality of technology transfer office are constant across institutes (since research goals set by the MPS are equally valid for all institutes and the MPS shares one central technology transfer office). Furthermore, generous public funding is provided to the MPS, accounting for 1.3 to 1.4 billion € per year – such that scientists are hardly pressured to commercialize research findings to attract external funding.

Our analysis is based on several sources. First, we rely on a dataset containing information on inventions disclosed by Max Planck researchers from the mid-1960s to 2005 in the fields of natural and life science. The second dataset considers a subset of all disclosed inventions which have been licensed to private-sector-firms including royalty payments and inventor fixed fees paid. Third, survey interviews with MPS scientists performed in 2007 capture scientists' individual perceptions on benefits and drawbacks of commercialization activities as well as socio-demographic information. By utilizing these three data sources we examine the influence of director involvement in commercialization on organization's succeeding disclosure activity. Further, we examine whether past director involvement in invention disclosures affect scientists' perception that (i) commercialization increases academic reputation and (ii) research results should be freely accessible.

Our results suggest that the number of inventions disclosed at one institute is positively related to director involvement in disclosures in the preceding year. Further, the number of invention disclosures is significantly related to commercialization success in the preceding year, indicated by royalty payments and inventor fixed fees paid to the respective institute. Yet, both effects are only significant with a lag of one year. Moreover, neither director involvement in commercialization nor overall commercialization success at the institute level does shape scientists' perceived relevance of (i) reputational reward from commercialization and (ii) open science. Both perceptions are strongly correlated with the respective perception of institute peers.

We conclude that organization leaders and financial returns signal what behavior is worthwhile to be followed and, thus, adaption to recent behavior of directors and recent financial returns is observed. Yet, in line with Bercovitz and Feldman (2008) this effect seems to be rather symbolic while a sustainable influence of directors is hardly detected. Thus, organizational change may be easier to achieve in academic organizations as in private firms as a long-term influence of leaders through persistence of organization routines seems to be less relatively less pronounced.

The remainder of the paper is structured as follows. In section 2, we review key findings of organization theory on leadership behavior. In section 3, we describe the organizational structure of the Max Planck Society, which represents the organizational context of our analysis. Our three datasets and variables of interest are introduced in section 4. Section 5 describes our empirical research methodology while results are presented in section 6. Finally, we discuss the results and conclude the study in section 7.

2. Organization Context: The Max Planck Society

In order to analyze the impact of organizational commercialization performance on individual commercialization behavior, we utilize two data sources of commercialization activities of Max Planck Society (MPS) scientists. The MPS is a German research association which was initially founded in the year 1911 as the Kaiser Wilhelm Society. In 1948 the association adopted its current name. The Society currently consists of 80 research institutes and three additional research facilities in Germany that perform basic research. The institutes are organized into three sections: (i) the biomedical section, (ii) the chemistry, physics and technology section, and (iii) the humanities and social sciences section.

Within the German public science sector, major science and research organizations - namely universities, the MPS, the Helmholtz Association, the Fraunhofer Society, and the Leibniz Science Association - serve different functions. The Helmholtz Association pursues long-term research objectives, mainly in technical and medical-biological fields with the aim of application. Even more applied research is performed by the Fraunhofer Society which undertakes applied research with direct utility to public and private enterprises. Both of these organizations generate a large amount of funding from contract research, comprising for approximately 30 percent of the total funding in case of the Helmholtz Association and roughly 75 percent of the Fraunhofer Society’s total budget. The Leibniz Association is almost completely publicly funded and is characterized by its close cooperation with universities. As a rule, each director of a Leibniz Institute is also an appointed professor at a university. Thus, universities and the Leibniz Association often perform joint research. The MPS is assigned to reach research excellence, with large research projects that require special equipment or so much funding that they cannot be managed by other higher education institutions. Research within the MPS is basic and thought to be internationally competitive.

MPS institutes are chosen as the organizational context in our study since the MPS combines four advantages for our purpose. First, the MPS is an independent, publicly funded research organization. Around 82 percent of MPS expenditure is met by public funding from the Federal Government and the German States. The remaining funding stems from donations, member contributions and from few funded projects. In the last 5 years, the total budget of the MPS accounted for 1.3 to 1.4 billion € per annum. Given the generous budget and the nature of funding, the scientists of the Max Planck Society hardly face any pressure to commercialize their research outcome in order to attract external sources of funding.

Second, MPS Institutes seek research excellence and promote academic freedom. Since research at the MPS is mostly basic and given the Society's demand for excellent research, scientists work at the frontiers of research without regard for commercial potential. Thereby, MPS research can be described as seeking ground-breaking new results, not necessarily with the goal of application. Thus, scientists' incentives to commercialization incentives are hardly affected by research agenda.

Third, Max Planck researchers share one central technology transfer office, named Max Planck Innovation GmbH, which is responsible for inventions of all institutes. Being established in 1970 Max Planck Innovation GmbH (named Garching Innovation GmbH until 1990) is co-located with the Society's central administration in Munich. Staff members of the transfer office regularly visit the individual institutes to solicit the disclosure of new inventions. Patent applications are handled in cooperation with external patent attorneys. Technologies are marketed to domestic and foreign firms, including spin-offs, which have been actively supported since the early 1990s. Max Planck Innovation has concluded more than 1,500 license agreements since 1979 (Max Planck Innovation, 2010). Accumulated returns from technology transfer activities exceed € 200 million, with most income resulting from a handful of "blockbuster" inventions. In case of successful licensing, academic inventors receive 30 percent of all revenues, and the Max Planck Institute employing the researcher gets an additional third of all income. The Max Planck Society obtains the rest of the revenues to finance the technology transfer efforts of its TTO. By German law inventors have to report their inventions to their employer if the invention is a result of work outcome.[1]

Fourth, each institute focuses on a special, specific, statutory task, be it to research the structure of matter, the function of our nervous system, or the birth and development of stars and galaxies. The Max Planck Institutes are classified by the Society in three different sections: the Biology and Medicine Section, the Chemistry, Physics and Technology Section and the Humanities Section. Although the MPS consists of many different institutes, the institutional setting is consistent throughout. All institutes select and carry out their research autonomously and independently within the aforementioned scope of the MPS. Each institute administers its own budget and is free to set their own focus within their research field.

In sum, the consistent structure of autonomous MPS institutes, which belong to one parent organization, with one central technology transfer office, allows us to analyze scientists' commercialization behavior and perception.

[1] See the changes to the German Law "Arbeitnehmererfindergesetz" (ArbEG, 2002).

3. The Impact of Leaders in Organizations

3.1. Long-term and Short-term Impact: Strategic Positioning and Role Model Effects

Leaders may exert influence on organization by both building culture and may have by serving as role models (Levy et al. 2011; Kogut and Zander, 1996). In this way, leaders may influence the organization in the short-run and in the long-run through different mechanisms. Thus, one needs to distinguish between two leadership effects which have been identified in previous literature.

First, leaders may have a lasting influence on the organization since they strategically position their organization and set the agenda. In doing so, leaders may have a lasting influence on the organization. Ecologists have operationalized the concept of “structural inertia” (Hannan and Freeman, 1984), according to which persistence results from the difficulty of changing course – once investments have been made in specific organizational technologies and routines. For example, founding team's prior functional experiences and initial organizational functional structures predict subsequent top manager backgrounds and later functional structures (Beckman and Burton, 2008). As key mechanisms by which imprinted features persist over time Stinchcombe (1965) identifies efficiency, lack of competition and institutionalization. Later research suggested that such persistence is grounded in the tendency of individuals to follow inherited organizational routines in order to integrate into organization culture (Johnson, 2007).

Second, leaders may serve as role models by signalling what kind of behavior and values are expected, and likely be rewarded (Schein, 1985). Thus, leaders’ behavior is an important reference point for fellow organization members who find actions performed by leaders as legitimate and worth to follow (Bandura 1986). In this way organizational leaders may affect commitment and attitude (Iverson and Buttigieg 1999; Carr et al. 2003) as well as behavior of employees’ (Cooke and Rosseau, 1988; Sila, 2007; Sadikoglu and Zehir, 2010). In this way, organization employees may fellow recent behavior of organization leaders. Yet, such adaption processes may not be limited to organization leaders, since individuals may adapt their behavior to the behavior of leaders or co-workers when entering an organization. Such adaption processes may be caused by (at least) two different mechanisms. On the one hand, adaption processes to peer behavior can be seen as a response to imperfect information, since individuals have insufficient knowledge on what type of behavior is requested in order to perform well in organizations. On the other hand, individuals may deliberately self-select into organizations in which the individual behavior and attitudes coincide with the orientation of the parent organization (Duflo and Saez 2000, Sorensen 2002). Because of this self-selection process individuals may have the opportunity to follow their own ambition.

3.2. The Influence of Organization Leaders in Academia

Traditionally, academic research has often been described as a public good which does not deplete when shared with others (Arrow, 1962; Scherer, 1982). The public good nature of academic research requires scientists are thought to devote their efforts to the growth of the stock of knowledge, which is freely available. Thus, academic institutions have operated under *Mertonian* norms, which emphasize the open dissemination of research discovery and disdain commercial activity (Bercovitz and Feldman, 2008; Nelson, 2001). According to Merton's studies on the sociology of science (Merton 1957, 1973), scientists are described to follow a norm of 'communalism', meaning that scientists share their discoveries with their scientific community for the common good. In doing so, a scientist yields recognition and esteem by being the first to communicate discoveries among the scientific community (Stephan and Levin, 1992).

Given the focus on the scientific community it is not clear to what extent organization effects and leadership behavior is as pronounced in academia as it is in private firms. Yet, empirical examination of the organization effects is partly a tricky business. While it is easy to argue that organizations matter, it is relatively more difficult to show how and why (Williamson, 2002). It is especially difficult to disentangle organizational effects from exogenous factors. Thus, when comparing different academic organizations – or firms – it is difficult to disentangle organization effects – meaning the influence from leaders, peers or past organization performance – from different ambition, organizational policies or quality across organizations.

Despite these difficulties to elaborate organization effects several studies have addressed the effect of organization in academia. Yet, in most studies the effect of *organization peers* has been examined in the context of publication and commercialization output. Stuart and Ding (2006) find that scientists who work with peers who are active in commercialization are more likely to engage in entrepreneurial activity. Louis et al. (1989) provide evidence that scientists' magnitude of commercialization activity and the choice of transfer channels are strongly moderated by the effect of group-level norms. Similarly, evidence on UK and German scientists indicates that researchers are more likely to consult private companies if colleagues' value of patents and awards is high, while researchers are relatively less likely to consult if peers value traditional academic most (Haeussler and Colyvas, 2011). Such results indicate that organizational culture does affect individual behavior in academia. Moreover, Tartari et al. (2010) have investigated the individual perceptions of scientists toward commercialization of research results. They examine in a sample of 1200 UK physical and engineering scientists how peers' attitudes toward commercialization and commercialization behavior influence scientists' individual attitudes and behaviors. Yet, the latter study provides evidence suggesting that peer effects of the epistemic community are strong while organizational-level effects are not detected. Moreover, organizational policies may impact scientists' likelihood to engage in commercialization. Friedman and Silberman (2003) find that greater rewards for involvement in commercialization lead to greater commercialization activity. Furthermore, several studies by Thursby and Thursby model and empirically validate that royalty shares impact the likelihood of licensing activities of scientists (Thursby and Thurby, 2003).

But what about the effect of *leadership behavior* in academic departments? In academic organizations and departments, there is typically one director who officially leads the department. In view of the aforementioned findings on role model effects in private firms it is likely that similar effects are also detected in academia. Directors of research organizations are, typically, prestigious scientists who were appointed director as result of academic merits. Observing the behavior of directors may lead scientists to behave in a similar way subsequently. Thus, if the chair pursues commercialization, such activity may be seen as legitimate and scientists may follow such paths in the future. Existing evidence on this relation is scarce. By investigating 15 matched departments from two medical schools Bercovitz and Feldman (2008) detect that own commercial activity, measured in disclosure filed, is weakly correlated with previous director involvement in disclosure.

4. Data and Variables

We utilize three sources of data in order to analyze the impact of organizational commercialization success on individual scientists' commercialization behavior and perception. As a first data source we rely on collected information of all inventions disclosed by Max Planck scientists. The second dataset covers a subset of all inventions which have been licensed. Details on how we structure this data are given in the following subsection. Thereafter, we describe our third source of data, which is a survey implementation conducted within the Max Planck Society in 2007.

4.1. Commercialization Data on the Organizational Level

Data on commercialization activities by MPS scientists are based on information provided by Max Planck Innovation GmbH. This data has also been used in previous studies conducted by Buenstorf and Schacht (2011) and Buenstorf and Geissler (2012). However, while using the same data we ask completely distinct research questions in this study as both aforementioned studies do, so that we have a clearly different approach with different dependent variables. Moreover, in the second step of analysis we combine data on disclosed inventions and commercialization activities with a survey of scientists, which further distinguishes our study from the previous ones.

The first dataset contains all inventions disclosed by Max Planck researchers from the mid-1960s to 2005. Overall, 3,012 inventions have been disclosed to the Max Planck Society. The data of disclosed inventions provides information about the date of disclosure and patent application the institute that the respective invention belongs to, invention-specific characteristics such as the involvement of a Max Planck director, as well as whether an invention has been licensed or not.[2]

The second dataset involves a subset of 864 inventions which are licensed to private-sector firms. Since a number of inventions are licensed non-exclusively to multiple licensees, there are in total 1,172 license agreements. Whether or not a licensed invention is commercial successful is not directly observable. However, as in previous studies (e.g., Agrawal, 2006) we take royalty payments as an indirect indicator for commercial success into account. The data include yearly royalty payments (and fixed fees, if any) for all individual contracts from conclusion to 2007 or prior termination. In total, 731 inventions provide royalty payments (with or without fixed fees) from which 365 (50 percent) have been successfully commercialized.

Since inventions require some development time after licensing, a right censoring problem may accrue for later disclosures. To reduce potential right censoring problems, we restrict the sample to inventions disclosed 2004 or earlier while using information about payments up to 2007. Moreover, we restrict the sample to inventions disclosed 1980 or later for two reasons: First, before 1980 Max Planck Innovation GmbH was not only responsible for inventions from Max Planck researchers, but also for other public research organizations. Thus, a clear assignment of disclosed inventions belonging to Max Planck researchers is not possible. Second, information available for the pre-1980 inventions is inferior to that related to the later inventions. These restrictions leave us with a total of 2,376 disclosed inventions.

We structured the data such that our information on royalties, invention disclosures, director involvement and fixed fees payments is given per year and institute. In doing so, we constructed a panel for the time period 1980-2004, which allows the use of time lagged variables. The annual number of accumulated invention disclosures and logged royalty payments are depicted in Figure 1 and 2.

[2] Note that only two sections are active in disclosures, namely the biomedical and the chemistry, physics and technology section.

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Insert Figure 1 about here

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Insert Figure 2 about here

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4.2. Survey Data on the Individual Level

In order to analyze scientists' motivations to commercialize research and their knowledge transfer activities a survey was implemented in the end of 2007 capturing possible stimuli and barriers to commercial science. The questionnaire contains questions with regard to scientists' knowledge transfer via engagement in research cooperation, patenting and nascent entrepreneurship. Further, scientists' attitudes toward commercialization activities as well as questions on industrial work experience, education, demographics, and time spent in research as well as risk-taking behavior are included. Questions were developed with the aim of quantitatively analyzing scientists’ individual motivation in participating in commercialization activities and experience in different knowledge transfer activities. Questions were improved during a pilot study conducted between April and September, 2007. During this pilot study we contacted randomly selected scientists at German research organizations, excluding MPS scientists.

Before interviewing scientists of the MPS, we collected the mail and phone address of all scientists within the MPS on the homepages of institutes. Further, we contacted the executive directors and heads of administration of all MPS institutes by postal service and asked for permission to survey the scientists. Most of the directors (67 out of 78) gave us the permission to interview scientists at their institute and provided the necessary contact information (phone numbers and mail addresses) of the scientists, if this information was not publicly available. Thus, the sample population for the survey consisted of 7,808 scientists working for these 67 MPS institutes. Similar to the suggestions on the procedure of online surveys denoted in Dillmann (2000) we first informed scientists about our study prior to the survey interviews. Then, phone interviews were conducted by TNS Emnid GmbH, a professional opinion research institute. Trained interviewers from TNS Emnid GmbH contacted scientists from mid-October to mid-December 2007. If scientists did not answer the first call up to three repetition calls were made within the interviewing period. With this method 2,604 interviews could be completed, denoting a response rate of 33.35 percent.

Information derived from this survey analysis complements our license data. By combining both sources of data we are able to analyze whether and to what extent institute commercialization performance affects scientists' individual commercialization behavior and its perceived relevance in academia. Our data on commercialization activities comprises data on royalties until 2007 (of inventions until 2004), while our survey analysis was implemented in the end of 2007. Since we conducted the survey analysis at the end of our commercialization period regarded we are able to examine whether and to what extent organizational commercialization performance relates to individual scientist's perception on benefits of commercialization.

4.3. Variables of Interest

Commercialization Activities at the Organizational Level

Our panel-dataset of annual invention disclosure activities at the institute level comprises five variables related to commercialization success, measured by royalty payments and fixed fees, and invention disclosures. As further measures we included institute maturity, size and research section of the respective institute. In the following our variables of interest for the panel analysis are listed.

- *LOG ROYALTIES*$_{it}$*:* Logged annual royalty payments (normalized to Deutsche Mark payments in year 2000) received by institute *i* in year *t*.
- *TOTAL DISC*$_{it}$*:* This variable captures the count of annual invention disclosures of institute *i* in year *t*.
- *DIRECTOR DISC*$_{it}$: A count of annual invention disclosures of institute *i* in year *t* with at least one director listed as inventor.
- *SCIENTIST DISC*$_{it}$: In analogy, the count of annual invention disclosures by institute with no director listed as inventor.
- *LOG FIXED FEES*$_{it}$*:* This variable identifies logged annual fixed fee payments to inventors (normalized to Deutsche Mark payments in year 2000) received by institute *i* in year *t*.
- *BIOMED*$_{i}$: In our analysis we comprise Max Planck Institutes within the biomedical section and the chemistry, physics and technology section. This binary variable indicates by a value of 1 that an institute belongs to the biomedical section and zero if an institute belongs to the other section.
- *SIZE*$_{i}$: The size of an institute *i* is measured by the number of research directors. Since each department is lead by one director the number of directors equals the number of departments, excluding temporary junior research groups. As no reliable information on the annual number of employees was available, the number of directors is the most precise information on size of institutes.
- *INST MATURITY*$_{it}$: This variable captures the 'age' of institutes measured in years.

In order to analyze the influence of organizational success on scientists' individual perceptions we also construct several variables which capture cumulated institute commercialization success. In doing so, we capture cumulated royalties by institute until 2007, which rely on invention disclosures in the period of interest, namely 1980-2004. This leaves us with the following variables:

- LOG (SUM ROYALTIES$_i$): This variable captures the logged cumulated royalties in the time period 1980-2007 of inventions disclosed in the time period 1980-2004 by institute *i*. Again, royalties are normalized to Deutsche Mark values of the year 2000.
- LOG (SUM ROYALTIES 2003-2007$_i$): This variable captures the logged cumulated royalties of inventions in the time period 2003-2007 by institute *i*. Again, royalties are normalized to Deutsche Mark values of the year 2000.

Survey Data at the Individual Level

Our third data source is the survey interviews with MPS scientists performed at the end of 2007. From this survey analysis we utilize information on scientists' perception on benefits from commercialization activities captured by two questions asked. In doing so, variables were measured with statements given to scientist *j* with the task to agree or disagree to the statements on a five-point Likert-type scale.

- *REPUTATION$_{ij}$*: Scientists were read the statement "*Commercialization activities increase the reputation of a scientist in your scientific community*". Scientists were asked to agree or disagree to this statement. In particular, prior to the statements the interviewer read to the scientist: *"[…] Please indicate to what degree you agree or disagree with the statement on a scale from 1 to 5; 1 meaning 'strongly disagree', 2 'disagree', 3 'either', 4 'agree', and 5 'strongly agree'."* Thus, the variables can take values from 1 to 5 indicating the level of agreement to the proposition.
- *OPENC SCIENCE$_{ij}$:* This variable measures scientists' attitude towards science as a public good to be freely available to anyone. The measure is based on the degree to which scientists agreed on the following statement "*Your research results should be freely accessible to any other researchers and businesses*". Scientists were asked to what degree they agree or disagree with this statement given a five-point Likert-type scale, ranging from 1: 'Strongly disagree' to 5: 'Strongly agree'.

Further variables of interest relate to demographic and job-related information of scientists which may impact scientists' commercialization behavior. These variables are used as controls in the empirical analysis as they identify join particular, we constructed the following variables.

- *COMMERCIAL ORIENTATION$_{ij}$*: This variable relies on information to the statement "*Commercialization activities are common in your scientific community". Again,* scientists were asked to what extent they agree or disagree to this statement, given the same five-point-Likert-type scale. Thus, the variable can take values from 1 to 5 indicating the level of agreement to the proposition.
- *AGE$_j$*: This variable indicates a scientist's age (in the end of 2007), measured in number of years.
- *DEGREE PhD$_j$*: This binary variable captures whether a scientist holds a doctoral degree (value of 1) or not (value of 0).

- $DIRECTOR_j$: By a value of 1 this binary variable indicates that a scientist is a research director in the MPS. Otherwise the variable is coded with a value of zero.
- $FEMALE_j$: This binary variable indicates a scientist's gender (1= female, 0=male).

Descriptive statistics are summarized in Table 1. Furthermore, correlations are reported in Table 2. The correlations indicate that commercialization activities and commercialization success at the institute level correlate in such a way that we must carefully account for the possibility of multicollinearity in our study. More precisely, in Table 2, a multitude of variables are correlated at a very high rate (r > 0.40). The highest correlation (r = 0.62) between any two independent variables is between the indicator of director involvement and the number of scientific disclosures. Thus, significantly more inventions are made when the director is involved.

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Insert Table 1 about here

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Insert Table 2 about here

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5. Econometric Approach

The empirical analysis proceeds in two steps. First, we utilize our panel data on disclosure activities between 1980 and 2004 and examine whether previous organizational success and director involvement affects the extent of subsequent disclosure activities. This analysis is implemented with a negative binominal regression model, which is used to correct for over-dispersion. We use negative binominal regressions with fixed effects to identify how disclosures of inventions are related to one-year lagged organizational performance measures. This approach is expressed in equation (1).

$$DISC_{it} = \beta_0 + \boldsymbol{X}_{it-1}\beta_1 + \boldsymbol{Z}_{it}\beta_2 + v_i + u_{it} \quad (1)$$

In equation (1), the left-hand side measures the number of disclosed inventions at institute i at time t. More precisely, we consider only disclosed inventions by non-directors to analyze the influence of leaders on non-leaders behavior. On the right-hand side of equation (1) X_{it-1} represents a vector of organizational performance measures in the previous time period -

such as royalties, fixed fees and director disclosures. Z_{it} includes time variant institute characteristics, as i.e. inventor fixed fees, and v_i stands for institutional time invariant variables, as i.e. the research section an institute belongs to.

We focus on one-year time lags in order to analyze to what extent scientists react to organization success recently observed. Invention disclosure can be done within weeks (or days) when a scientist thinks that her or his research outcome is innovative. Thus, in order to test the hypothesis that scientists adapt their behavior when observing successful commercialization outcome, we focus on short time lags. Further, since institutional settings and work force in public research change frequently, it is expected that short-term organizational performance measures have a greater influence on the public research outcome. Yet, as we acknowledge that the focus on short-term time lags may seem arbitrary, we also analyze models with different time lags as robustness checks.[3]

In a second step we study the influence of aggregated commercialization performance measures and mean perceptions of institutional peers on scientists' individual perceptions of reputational reward and open science. This leads us to the second equation.

$$PERC_{ij} = \beta_0 + \boldsymbol{K}_j\beta_1 + \boldsymbol{L}_i\beta_2 + u_{ij} \qquad (2)$$

On the left-hand side of equation (2), $PERC_{ij}$ measures either the individual perception of reputational reward or the individual perception of open science of scientist j employed at institute i. On the right-hand side, K_j accounts for scientists' characteristics such as age and gender whereas L_i includes institute specific variables such as accumulated royalties, maturity, and the scientific section. Furthermore, we include the mean institutional perception with regard to reputation and open science. Two different techniques are employed to analyze the determinants of scientists' perceptions of reputational reward and open science. First, ordered probit regressions are applied for the ordinal measure of both dependent variables. Second, the ordinal variables are reduced to a binary measure indicating whether or not scientists agreed or highly agreed to the statement of reputational reward and open science. Due to this reduction of information to binary measures we apply a probit model.

[3] For a more detailed overview, see section 6.3.

6. Results

6.1. Scientists' disclosures

The results of the negative binomial panel regressions with fixed effects are reported in Tables 3 and 4. In the first step, we analyze the impact of leadership effects and the extent of commercial successes on the total number of disclosed inventions. More precisely, Model 1a includes a one-year lagged binary variable indicating whether at least one Max Planck director is listed as an inventor. In Model 1b, additional control variables such as the size and age of the institute and the institutional section are implemented. In Models 2a and 2b, one-year lagged commercialization measures are included. Specifically, we employ the logged amount of royalties and fixed fees as indicators of commercial success. Furthermore, in Model 2b, the full range of controls is implemented. In Model 3a, both organizational performance measures are accomplished. Finally, Model 3b contains the controls for the institution-specific factors. Additionally, we implement the lagged number of scientific disclosures in all regression models to control for path dependency.[4]

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Insert Table 3 about here

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Results in Models 1a-1b (Table 3) show that the one-year lagged indicator of director involvement has a positive and significant influence on the number of disclosed inventions, which supports our conjecture of a positive leadership effect. Thus, the prior behavior of Max Planck directors who act as role models positively affects disclosure activity. This result remains robust when institute-specific controls (Model 1b) are included. In Model 2a, the lagged measures of commercialization success indicate a significant positive influence on scientific disclosures. More precisely, the significant positive influence of the lagged amount of royalties and fixed fees suggests that prior commercial successes encourage the disclosure of inventions. These results, including the institute controls in Model 2b, remain robust. The significant positive influence of organizational leaders and royalty payments on invention disclosures is confirmed in Models 3a and 3b, while fixed fees do not seem to play an important role. In models with control variables, the size of the institute has a positive impact on the number of disclosed inventions. Furthermore, in all regression models, the lagged number of disclosures significantly influences the number of subsequent disclosures, suggesting a path dependency of academic disclosure activity.

[4] In unreported regression results we abstain from the lagged number of scientific disclosures as a control for path dependency. The results of the main variables of interest do not change with regard to signs and significance levels.

To draw a comprehensive picture and reduce the correlation among covariates, we employ binary variables next to the indictor of director participation for the organizational performance measures (Table 4). More precisely, in Models 5a and 5b, two dummy variables are implemented in place of the magnitude of royalties and fixed fees indicating whether revenues have been generated. Furthermore, in all six models (Models 4a-6b), we use an indicator variable to control for precedent disclosure activity. Again, both baseline models and extended models with institutional controls are provided.

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Insert Table 4 about here

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In Models 4a and 4b (Table 4), the results reveal evidence that prior activity by Max Planck directors positively affects scientific disclosures the following year. In the following two models (Models 5a and 5b), the influence of one-year lagged organizational performance measures – royalty payments and inventor fixed fees – is analyzed. The results suggest that both indicators have a significant positive influence on the number of inventions disclosed in the subsequent year. This finding suggests that scientists are more inclined to engage in disclosures in cases of observable short-term commercialization success. Combining all organizational performance measures in Models 6a and 6b, the regression results suggest that the activity of organizational leaders and the inclusion of royalty payments significantly influence scientists' activities, while the fixed fees have no significant impact on invention disclosures. Furthermore, institute size and the existence of previous invention disclosures have a positive impact on the number of subsequent disclosed inventions.

In the prior empirical section, we employed lagged organizational performance measures to investigate their impact on the total number of disclosed inventions. To strengthen our decision to use one-year lagged variables, we experiment with different lag structures. Specifically, we use up to five-year lags to exploit their relevance on outcome performance.[5] Table 5 reports regression results for up to five-year lags of organizational performance measures. More precisely, Models 7a-7e investigate the influence of up to five-year lagged organizational performance measures on the number of disclosed inventions using negative binomial panel regressions with fixed effects. Additionally, we control for the size, age, and section of each institute.

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Insert Table 5 about here

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[5] The number of lags that can be included in the model is restricted by the size of the dataset because any additional lag comes at the cost of a decrease in the number of observations. Hence, we allow for detecting the impact of organizational performance measures on the number of disclosed inventions for up to five years later but not beyond.

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The results in Table 5 indicate that we do not have a clear lag structure. More precisely, in contrast to the one-year lagged model (Model 7a), none of the other models provide a significant influence of director participation on invention disclosure. With regard to the commercialization performance measures, only Models 7b and 7d provide evidence that the amount of logged commercial measures influences disclosure activity. In all of the other models, performance measures are insignificant. While the true lead-lag relationship is unknown and may vary among institutes, the one-year lag seems to be most appropriate for our analysis.

6.2. Determinants of the perceived value of reputational reward and open science

The second part of the analysis covers the impact of past accumulated commercialization success and director participation at the institute level as well as mean perceptions of institutional peers on scientists' individual perceptions. Results are reported in Table 6. Therein, Models 8 and 9 investigate the influence of past accumulated organizational success, role model effects and mean perceptions of institutional peers associated with academic reputation on scientists' individual perceived value of reputational reward. Models 10 and 11 in Table 6 study the impact of accumulated organizational performance measures and mean perception of peers associated with open science on scientists' perceived value of freely distributing research results. More precisely, Models 8a-8b denote the ordered probit regressions using the ordinal (five-point-Likert-scale) measure as the dependent variable whereas Models 9a-9b cover a probit model using a binary measure indicating, by a value of one, agreement to reputational reward associated with commercialization. Further, Models 10a and 10b indicate ordered probit regressions but investigate scientists' perceived value of freely distributing research results as the dependent variable. Models 11a-11b in Table 6 employ the binary measure of scientist's perceived value of freely distributing research results. In Table 6, all models indicated by an 'a' represent the baseline model. Therein, we control for institute specific characteristics such as age and size. Models indicated by a 'b' expand the analysis by including individual specific controls such as age and sex of respondents. As a further control we include in all regression models an ordinal variable of scientists' individual perception of how common commercialization activities are within their specific area of research.

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Insert Table 6 about here

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In Table 6, Models 7a-7b indicate that accumulated commercialization success at the institute level does not relate to scientists' perceived reputational benefit from commercialization. Thus, we explain the findings as evidence that scientists do not take the aggregated commercialization history into account. Furthermore, we do not find evidence that the accumulated amount of disclosed inventions with at least one director listed as an inventor has an impact on individual perception. Mean perceptions of institutional peers have a strong and significant positive influence on scientists' individual perceptions of reputational reward (Models 8a-9b). In Models 8a-9b the ordinal variable of scientists' perception of how common commercialization activities are seen in the scientific community is positive and significant. Thus, the more common commercialization is, the higher the perceived reputation.

Results of Models 10a-11b (Table 6) suggest that aggregated commercial success does not influence scientists' perceived value of freely distributing research. Moreover, accumulated director involvement in the development process of disclosed inventions does not significantly influence individual perceptions. However, the mean perception of institutional peers has a strong and significant positive influence on scientists' individual perceptions. Thus, peers have a strong and robust impact on scientists' perception of the freely availability of research results. Additionally, in Models 10a-11b scientists' perception of how common commercialization activities are seen in the scientific community significantly negative influence scientist' perceived value of freely distributing research. In other words, the more common commercialization activities are in the respective institute, the lower scientists' individual attitude towards science as a public good.

To check the robustness of the results, regression models are replicated in Table 7 employing short-term log royalties for the period 2005-2007 instead of the overall institute commercial performance. Furthermore, the short-term activity of organizational leaders for the period 2002-2004 is implemented to control for peer effects. More precisely, Models 11a and 11b denote the analysis of ordered probit models utilizing the ordinal variable of reputational reward whereas Models 12a and 12b report probit regressions of the binary variable of reputational reward. Moreover, Models 13a-13b replicate the Models 11a-11b but investigate scientists' perceived value of freely distributing research results as the dependent variable. Models 14a-14b employ a binary measure of scientists' perceived value of freely distributing research results. As before, models indicated by an 'a' correspond to our baseline whereas models labeled by a 'b' correspond to the extended models including institute-specific and individual-specific controls.

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Insert Table 7 about here

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Results in Table 7 are nearly identical to previous findings in Table 6. In models 12a-13b short-term log royalties for the period 2005-2007 do not significantly influence scientists' perceptions of reputational reward. Thus, scientists do not seem to relate short-term organizational success to reputational reward. Further, while in Models 12a-12b the short-term director involvement does not influence scientists perceptions of reputational reward, results in Models 13a and 13b show a significant negative influence which contradicts prior results.[6] Yet, mean perceptions of institutional peers have a strong and significant positive influence on scientists' individual perceptions. This result confirms that scientists' individual perception is highly correlated with the mean perception of institutional peers. Additionally, the ordinal variable of scientists' perception of how common commercialization activities are seen in the scientific community is positive and significant. Furthermore, the size of the respective institute, measured by the number of directors, positively influences scientist's perception of reputational reward. Finally, in line with prior results we find that female scientists agree more that commercialization activities increase the reputation in the scientific community.

7. Conclusion

In the present study we utilize data on commercialization activity of the Max Planck Society in order to investigate organization effects in academic settings. In doing so, we take advantage of the unique structure of the Max Planck Society with autonomous institutes which belong to one parent organization while sharing the same central technology transfer office. This specific structure allows the identification of organizational effects. Our results provide three noteworthy results.

First, leadership behavior has a short-term impact on individual behavior since the extent of director involvement in disclosure activities positively relates to an increase in subsequent disclosure activities in the following year. This finding suggests that leaders' influence on subordinates via role model effects holds not only in private firms but also in the academic contexts. With regard to lag-structure this effect mostly restricted to short-term behavior with a lag-structure. This finding coincides with Bercovitz and Feldman (2008) who find that scientists react symbolically to leaders' behavior while no sustainable effect of leaders' behavior is detected. .

[6] In unreported regressions we include log royalties of the year 2007 and director disclosures in 2004 as the short-term organizational performance measures and do not find a significant effect on scientists' perceptions of reputational reward and open science. These results are available upon request.

Second, scientists' commercialization activities are significantly related to commercialization activities and commercialization success – measured in license royalties and inventor fixed fees of distinct institutes – in preceding years. Again, this effect is only significant at the 1%-level when short-term lags of one year are included. Thus, scientists react to recently observed organization success in commercialization. This might be caused by a role model effect of successful behavior recently observed within the organization. However, we acknowledge that this effect can, alternatively, be explained by scientific opportunities. Chances for commercial success may critically depend on research agenda, since some research areas are of high relevance in the private sector. Therefore, one could argue that the correlation of disclosure activities in *year t* with disclosure activities in *year t-1* indicates that an institute follows a research program which is close to private research. As both explanations – role model effects and current research orientation – suit our finding we leave it for future research to disentangle these potential factors leading to organization effects.

Third, we detect that scientists' perception on open science and reputational reward is significantly related to the respective perceptions of institute peers. In contrast, these individual perceptions are not significantly affected by past commercialization success of the institute, strengthening the aforementioned finding that peer behavior is relevant while organizational imprinting effects are hardly detected. In line with this interpretation is the further finding that institute maturity does not affect individually perceived academic values.

In sum, we conclude that organization effects in academia are induced by short-term leadership effects and royalty payments while organization leaders' behavior hardly influences the organization in the long-run. We – cautiously – expect this key finding to hold in other academic contexts, since fluctuation in scientific organizations is rather high, such that organization imprinting of initial research outline is less relevant than present behavior in academia.

From a science policy perspective these results have important implications for leaders of scientific organizations. On the one hand, organizational change may be easier to achieve in academic organizations as in private firms as a long-term influence of leaders through persistence of organization routines seems to be less relatively less pronounced. Thus, intended shifts of research agenda may be induced at the organization level – when desired – relatively quickly as persistence of organizational routines appears to be a lesser barrier to organizational change as often detected in the context of private firms. On the other hand, organization leaders may have less power to influence their organization which might be caused by strong institutional norms in science.

However, we acknowledge that our work is limited as we focus on one organization suited for our analysis. Thus, we encourage further research in this direction to provide a comprehensive picture on this important research question.

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Table 1: Variables Overview

Variables	Obs	Mean	Min	Max
Commercialization Panel				
TOTAL DISC	929	2.140	0	25
TOTAL DISC (Binary)	929	0.560	0	1
DIRECTOR DISC (Binary)	929	0.135	0	1
LN ROYALTIES	929	3.703	0	18.729
ROYALTIES (Binary)	929	0.402	0	1
LN FIXED FEES	929	1.822	0	17.708
FIXED FEES (Binary)	929	0.169	0	1
BIOMED	929	0.493	0	1
SIZE	929	4.422	1	12
INST MATURITY	929	38.782	1	92

Table 2: Correlations between covariates

929 observations	TOTAL DISC$_{t-1}$	DIRECTOR DISC$_{t-1}$ (Binary)	*LN ROYALTIES$_{t-1}$*	LN FIXED FEES$_{t-1}$	SIZE$_i$	BIOMED$_i$	INSTITUTE MATURITY$_i$
TOTAL DISC$_{t-1}$	*1.000*						
DIRECTOR DISC$_{t-1}$ (Binary)	*0.622**	1.000					
LN ROYALTIES$_{t-1}$	*0.419**	0.278*	1.000				
LN FIXED FEES$_{t-1}$	*0.549**	0.570*	0.241*	1.000			
SIZE$_i$	*0.498**	0.288*	0.375*	0.261*	1.000		
BIOMED$_i$	*0.124**	0.165*	0.234*	0.229*	-0.038	1.000	
INSTITUTE MATURITY$_i$	*-0.024*	0.001	0.118*	-0.020	0.102*	-0.023	1.000

Note: The asterisk* denotes significance of pairwise correlation at the one percent level.

Table 3: Annual number of invention disclosures - I (negative binomial)

	Model 1a	Model 1b	Model 2a	Model 2b	Model 3a	Model 3b
			TOTAL DISC			
TOTAL DISC$_{t-1}$	0.057***	0.049***	0.055***	0.050***	0.046***	0.043***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
DIRECTOR DISC$_{t-1}$ (Binary)	0.290***	0.231***			0.258***	0.217**
	(0.092)	(0.087)			(0.095)	(0.090)
LN ROYALTIES$_{t-1}$			0.036***	0.028***	0.036***	0.029***
			(0.009)	(0.009)	(0.009)	(0.009)
LN FIXED FEES$_{t-1}$			0.016**	0.013*	0.009	0.008
			(0.008)	(0.008)	(0.008)	(0.008)
SIZE		0.201***		0.182**		0.173**
		(0.070)		(0.073)		(0.072)
BIOMED		-0.055		-0.134		-0.095
		(0.304)		(0.304)		(0.302)
INSTITUTE MATURITY		0.008**		0.005		0.004
		(0.004)		(0.004)		(0.004)
Constant	0.821***	-0.436	0.689***	-0.286	0.695***	-0.246
	(0.150)	(0.434)	(0.157)	(0.446)	0.158	(0.444)
Observations	929	929	929	929	929	929
Number of Institutes	48	48	48	48	48	48
Prob>chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses; *;**; and *** denote significance at the 0.10; 0.05; and 0.01 levels, respectively.

Table 4: Annual number of invention disclosures – II (negative binomial)

	Model 4a	Model 4b	Model 5a	Model 5b	Model 6a	Model 6b
			TOTAL DISC			
TOTAL $DISC_{t-1}$ (Binary)	0.554***	0.521***	0.532***	0.497***	0.493***	0.471***
	(0.104)	(0.104)	(0.106)	(0.107)	(0.107)	(0.107)
DIRECTOR $DISC_{t-1}$ (Binary)	0.414***	0.325***			0.380***	0.302***
	(0.084)	(0.083)			(0.089)	(0.086)
$ROYALTIES_{t-1}$ (Binary)			0.320***	0.225***	0.310***	0.231***
			(0.083)	(0.085)	(0.082)	(0.085)
FIXED $FEES_{t-1}$ (Binary)			0.215**	0.190**	0.084	0.099
			(0.084)	(0.082)	(0.088)	(0.085)
SIZE		0.182***		0.184***		0.163***
		(0.062)		(0.062)		(0.062)
BIOMED		-0.212		-0.318		-0.230
		(0.302)		(0.302)		(0.299)
INSTITUTE MATURITY		0.011***		0.010***		0.009**
		(0.004)		(0.004)		(0.004)
Constant	0.520***	-0.625	0.409**	-0.621	0.428**	-0.519
	(0.163)	(0.419)	(0.166)	(0.419)	(0.168)	(0.418)
Observations	929	929	929	929	929	929
Number of Institutes	48	48	48	48	48	48
Prob>chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses; *;**; and *** denote significance at the 0.10; 0.05; and 0.01 levels, respectively.

Table 5: The influence of different lag structures on of invention disclosures

	Model 7a	Model 7b	Model 7c *TOTAL DISC*	Model 7d	Model 7e
TOTAL DISC$_{t-1}$	0.043*** (0.009)				
DIRECTOR DISC$_{t-1}$ (Binary)	0.217** (0.090)				
LN ROYALTIES$_{t-1}$	0.029*** (0.009)				
LN FIXED FEES$_{t-1}$	0.008 (0.008)				
TOTAL DISC$_{t-2}$		0.040*** (0.009)			
DIRECTOR DISC$_{t-2}$ (Binary)		0.054 (0.088)			
LN ROYALTIES$_{t-2}$		0.010 (0.009)			
LN FIXED FEES$_{t-2}$		0.021*** (0.008)			
TOTAL DISC$_{t-3}$			0.023** (0.010)		
DIRECTOR DISC$_{t-3}$ (Binary)			0.009 (0.092)		
LN ROYALTIES$_{t-3}$			0.015 (0.010)		
LOGFIXED FEES$_{t-3}$			0.008 (0.008)		
TOTAL DISC$_{t-4}$				0.013 (0.011)	
DIRECTOR DISC$_{t-4}$ (Binary)				0.078 (0.096)	
LN ROYALTIES$_{t-4}$				0.017* (0.010)	
LN FIXED FEES$_{t-4}$				0.012 (0.008)	
TOTAL DISC$_{t-5}$					0.010 (0.012)
DIRECTOR DISC$_{t-5}$ (Binary)					0.074 (0.098)
LN ROYALTIES$_{t-5}$					0.016 (0.010)
LN FIXED FEES$_{t-5}$					0.011 (0.008)
SIZE	0.173** (0.072)	0.203*** (0.077)	0.193*** (0.069)	0.210*** (0.074)	0.215*** (0.075)
BIOMED	-0.095 (0.302)	-0.294 (0.335)	-0.433 (0.344)	-0.291 (0.361)	-0.263 (0.373)
INSTITUTE MATURITY	0.004 (0.004)	0.007 (0.005)	0.004 (0.005)	0.001 (0.005)	0.000 (0.005)
Constant	-0.246 (0.444)	-0.171 (0.481)	0.132 (0.469)	0.122 (0.506)	0.155 (0.525)
Observations	929	858	810	764	718
Number of Institutes	48	47	46	46	46
Prob>chi2	0.0000	0.0000	0.0000	0.0004	0.0053

Standard errors in parentheses; *;**; and *** denote significance at the 0.10; 0.05; and 0.01 levels, respectively.

Table 6: The impact of accumulated commercialization history and peer beliefs on scientists' individual beliefs (on the relevance of commercialization and open science)

	Model 8a	Model 8b	Model 9a	Model 9b	Model 10a	Model 10b	Model 11a	Model 11b
	REPUTATION		REPUTATION (Binary)		OPEN SCIENCE		OPEN SCIENCE (Binary)	
INSTITUTE MEAN REPUTATION	0.535***	0.549***	0.172***	0.179***				
	(0.084)	(0.085)	(0.040)	(0.041)				
INSTITUTE MEAN PUBLIC					0.519***	0.498***	0.235***	0.227***
					(0.096)	(0.096)	(0.041)	(0.040)
LOG (SUM DIRECTOR DISC)	-0.009	-0.014	-0.005	-0.007	-0.017	-0.020	-0.004	-0.005
	(0.025)	(0.025)	(0.012)	(0.012)	(0.026)	(0.027)	(0.011)	(0.011)
LOG (*SUM ROYALTIES)*	-0.003	-0.002	-0.002	-0.002	0.007	0.008	0.002	0.003
	(0.005)	(0.005)	(0.002)	(0.002)	(0.005)	(0.005)	(0.002)	(0.002)
COMM ORIENTATION	0.258***	0.260***	0.101***	0.103***	-0.127***	-0.132***	-0.026***	-0.028***
	(0.034)	(0.024)	(0.010)	(0.011)	(0.024)	(0.024)	(0.010)	(0.010)
BIOMED	0.034	0.013	-0.021	-0.031	-0.076	-0.043	-0.046**	-0.034
	(0.050)	(0.051)	(0.024)	(0.024)	(0.052)	(0.053)	(0.022)	(0.022)
INSTITUTE MATURITY	-0.000	-0.000	0.000	0.000	-0.000	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
SIZE	0.021	0.022*	0.008	0.009	-0.006	-0.006	-0.004	-0.004
	(0.013)	(0.013)	(0.006)	(0.006)	(0.013)	(0.013)	(0.005)	(0.005)
AGE		0.001		0.001		0.003		0.001
		(0.003)		(0.001)		(0.003)		(0.001)
DEGREE PHD		0.043		0.014		0.097*		0.050**
		(0.053)		(0.025)		(0.054)		(0.023)
FEMALE		0.122**		0.062**		-0.174***		-0.062***
		(0.052)		(0.025)		(0.053)		(0.023)
DIRECTOR		-0.263*		-0.111		0.140		0.005
		(0.156)		(0.067)		(0.162)		(0.070)
Observations	2109	2109	2109	2109	2109	2109	2109	2109
Prob>chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo R^2	0.039	0.040	0.053	0.056	0.018	0.022	0.029	0.036

Standard errors in parentheses; *;**; and *** denote significance at the 0.10; 0.05; and 0.01 levels, respectively.

Table 7: The impact of recen commercialization history and peer beliefs on scientists' individual beliefs (on the relevance of commercialization and open science)

	Model 12a	Model 12b	Model 13a	Model 13b	Model 14a	Model 14b	Model 15a	Model 15b
	REPUTATION		REPUTATION binary		PUBLIC SCIENCE		OPEN SCIENCE (binary)	
INSTITUTE MEAN REPUTATION	0.510***	0.522***	0.157***	0.163***				
	(0.086)	(0.087)	(0.041)	(0.042)				
INSTITUTE MEAN PUBLIC					0.553***	0.536***	0.245***	0.236***
					(0.091)	(0.091)	(0.039)	(0.039)
LOG (SUM DIRECTOR DISC 2002-2004)	-0.085	-0.084	-0.054**	-0.053**	-0.024	-0.043	0.002	-0.005
	(0.055)	(0.056)	(0.026)	(0.026)	(0.054)	(0.054)	(0.023)	(0.023)
LOG*(SUM ROYALTIES 2005-2007)*	0.001	-0.001	0.000	0.000	0.004	0.005	0.001	0.002
	(0.005)	(0.005)	(0.002)	(0.002)	(0.005)	(0.005)	(0.002)	(0.002)
COMM ORIENTATION	0.257***	0.260***	0.101***	0.102***	-0.129***	-0.134***	-0.026***	-0.029***
	(0.024)	(0.024)	(0.011)	(0.011)	(0.024)	(0.024)	(0.010)	(0.010)
BIOMED	0.040	0.018	-0.016	-0.027	-0.069	-0.032	-0.045*	-0.032
	(0.053)	(0.053)	(0.025)	(0.025)	(0.053)	(0.055)	(0.023)	(0.023)
INSTITUTE MATURITY	-0.001	-0.001	0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
SIZE	0.029**	0.028**	0.013*	0.013*	-0.005	-0.003	-0.004	-0.004
	(0.014)	(0.014)	(0.007)	(0.007)	(0.014)	(0.014)	(0.023)	(0.006)
AGE		0.001		0.001		0.003		0.001
		(0.003)		(0.001)		(0.003)		(0.001)
DEGREE PHD		0.044		0.015		0.096*		0.049**
		(0.053)		(0.025)		(0.054)		(0.023)
FEMALE		0.118**		0.060**		-0.176***		-0.063***
		(0.052)		(0.025)		(0.053)		(0.023)
DIRECTOR		-0.272*		-0.117*		0.150		0.002
		(0.156)		(0.067)		(0.162)		(0.070)
Observations	2109	2109	2109	2109	2109	2109	2109	2109
Prob>chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo R^2	0.039	0.041	0.054	0.057	0.017	0.022	0.028	0.036

Standard errors in parentheses; *;**; and *** denote significance at the 0.10; 0.05; and 0.01 levels, respectively.

Figure 1: Accumulated log royalties of 48 Max Planck Institutes

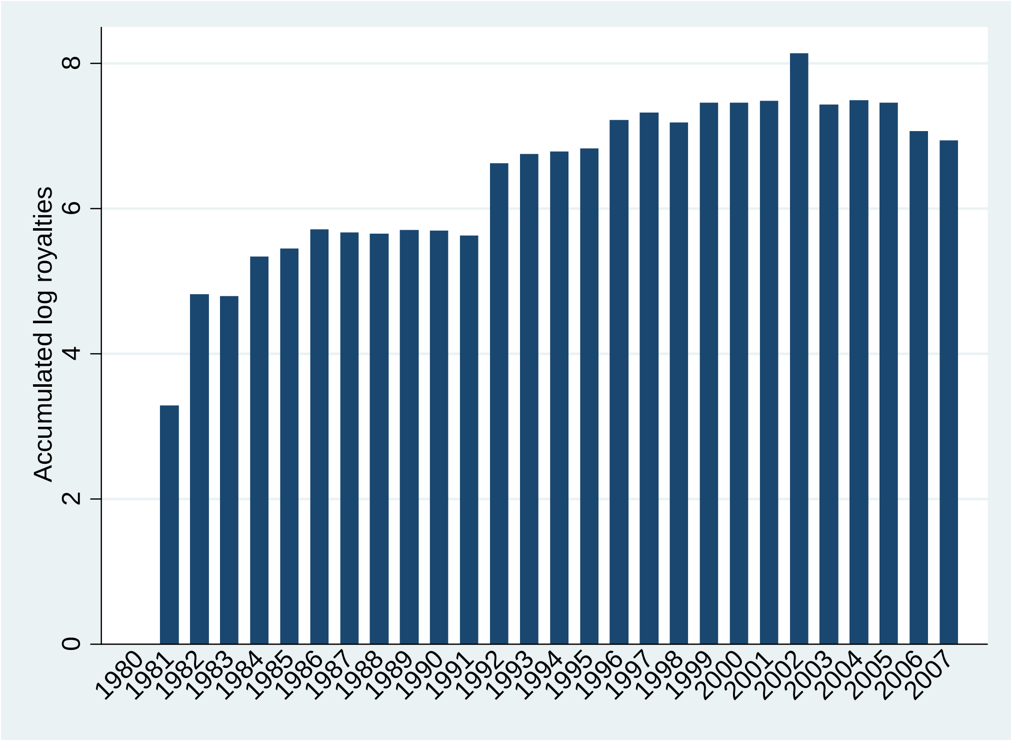

Figure 2: Accumulated disclosures of 48 Max Planck Institutes