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The Influence of Leadership on Academic Scientists' Propensity to Commercialize Research Findings[a]

Stefan Krabel[*], Alexander Schacht[†]

Abstract:

Previous studies of organizations have highlighted that leadership and organizational performance have a strong and long-term impact on employee behavior in private firms. In this study, we analyze whether similar effects can also be observed in academia by examining the commercialization behavior of academic scientists. The empirical analysis is based on panel data of commercialization for the period of 1980 – 2004 within the Max Planck Society, a leading research organization in Europe. The results suggest that director engagement in disclosure activity and the amount of royalties received lead to a significant increase in invention disclosure the following year. However, we do not find the same results when modeling longer time lags. Thus, academic scientists mimic successful behavior, while leadership behavior does not have long-lasting effects on commercialization behavior within the institute. We conclude that existing organizational theories need to be modified for academic organizations.

Key words: leadership effect, technology commercialization
JEL codes: L24, O33, O39

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1. Introduction

To what extent is individual behavior influenced by past behavior within the organization? This question has long been the focus of a scholarly debate in various disciplines. Previous literature has highlighted that individuals tend to mimic successful behavior observed within the organization in order to perform well themselves. In doing so, individuals tend to follow the behavior of organization leaders and adapt to peers whose behavior is observed to be rewarded. Organizational theory postulates that leadership behavior and organizational routines have a long-term impact on subsequent behavior because role model effects persist over time, leading to a long-term path dependency on organizational routines. Existing empirical evidence largely supports this theory by showing that organizational leaders or founders influence individual behavior (see, e.g., Johnson, 2007; Beckman and Burton, 2008; Levy et al. 2011).

The effects of leadership behavior have been empirically investigated largely in the context of private firms, while surprisingly few studies deal with organizational influences in academia. The discipline of science has strong institutional norms, which guide scientists' behavior (Merton, 1973; Mitroff, 1974). These norms are independent of the organization. For example, "open science" demands that scientists and scholars share their results with the global scientific community as soon as possible after discovery (Stephan and Levin, 1992). Scientific careers depend upon peer recognition (i.e., scientists working in the same field of research worldwide). Thus, in academic institutes, the effects of leaders' and organizational peers' behavior on individual scientists and whether academic scientists adapt to past organizational behavior are less clear.

One of the rare studies that examined peer and leadership effects in academia was conducted by Bercovitz and Feldman (2008). By tracking 1,780 faculty members across 15 matched departments in two medical schools, the study found that department members are more likely to participate in invention disclosures when the department head is also actively involved in the process. Yet, when the scientists switched from one department where the chair was not involved in disclosure activities to another department where the chair was actively involved in disclosure activities, the department members tended to engage in disclosure activities only once. Thus, the study concludes that adaptation to leadership behavior is primarily *symbolic.*

In this study, we extend the research on the effect of leadership in academia. By utilizing panel data of invention disclosure activities within the Max Planck Society (MPS), a research organization in Germany devoted to basic research, we examine the influence of director involvement in disclosures on subsequent disclosure activity. In so doing, we utilize the unique structure of the MPS, which has independent research institutes that belong to one

parent organization. Thus, our study is able to analyze leadership (and peer) influence and measure its impact in the organizational context. This research is of interest to economists for (at least) two reasons. First, from a behavioral economics perspective, this analysis improves our understanding of the influence of leadership in academia, and it addresses the question of to what extent existing research in organizational theory applies to academic institutions. Second, from an innovation economics perspective, our study contributes to the understanding of the extent to which organizational behavior may impact an individual scientist's participation in technology transfer.

For the organizational portion of our study, we chose to examine the (MPS) because the MPS has several attributes that are beneficial to the purpose of our study. Most importantly, the MPS is a parent organization, which comprises 80 autonomous institutes. This organizational structure allows for an analysis of institutional commercialization effects because external factors, such as organizational research structure or the quality of the technology transfer office, are constant across all of the institutes (because research goals set by the MPS apply to all of the institutes who share one central technology transfer office). Furthermore, the Max Planck Institutes follow the so-called "Harnack principle," where institutes are built solely around the world's leading researchers who are appointed as directors of research units. The directors determine their own research subjects, are provided with the best working conditions and have free reign in selecting their staff. Thus, the Max Planck Society is structured as a person-centered research organization. This unique structure allows us to analyze the effects of leadership because directors at the Max Planck Institutes have similar powers as leading managers in private firms. Moreover, generous public funding is provided to the MPS, accounting for 1.3 to 1.4 billion € per year, so that scientists are not pressured to obtain external funding.

Our analysis is based on several sources. First, we rely on a dataset containing information on inventions disclosed by Max Planck researchers in the natural and life sciences from the mid-1960s through 2005. The second dataset considers a subset of all disclosed inventions, which have been licensed to private-sector-firms.

Our results suggest that director engagement in disclosure activities and the amount of royalties received lead to a significant increase in invention disclosures the following year. However, these effects disappear when modeling longer time lags. Thus, academic scientists mimic successful behavior, but leadership behavior does not have long-lasting effects on commercialization behavior in the institute. These results are roughly in line with the findings of Bercovitz and Feldman (2008), who suggest that adaptation to leadership behavior is opportunistic and symbolic but does not have any sustainable effects. We conclude that existing organizational theories need to be modified for academic organizations.

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

2. The Role of Leadership in Organization

2.1. Leadership Behavior and its Influence on Individual Behavior

When individuals join an organization, they often imitate the behavior of their leaders or co-workers. This behavior may, in part, be due to a selection process. Individuals may deliberately self-select into organizations where individual behaviors and attitudes match the orientation of the parent organization (Duflo and Saez, 2000; Sorensen, 2002). Behavioral adaptation to leadership and peer behavior is often observed over time; therefore, organizational theory explains that individual behavior is influenced by organizations without excluding the potential self-selection mechanism. Adaptations due to peer behavior can be seen as a response to imperfect information because individuals have insufficient knowledge of the type of behavior required to succeed in the organization. Thus, individuals imitate the behavior of their more experienced peers (March and Simon, 1958; Williamson, 1999).

Leaders influence behavior in organizations by serving both as role models and by fostering a particular culture (Kogut and Zander, 1996; Levy et al. 2011). By serving as role models, organizational leaders signal what type of behavior is expected and likely to be rewarded (Schein, 1985; Beckman and Burton, 2008). A finding often stressed in experimental psychology in support of the theory that leadership behavior serves as a benchmark for individual behavior is that learning through identification and induced beliefs is more powerful than attempts to teach individuals via incentives or propaganda (Wood and Bandura, 1989). Furthermore, given that individual behavior is shaped by the observation and imitation of others in social contexts, organization members may find that actions performed by their leaders are legitimate and worthy of imitation (Bandura, 1986). Several studies have identified adaptation processes for individual behavior empirically. In the context of entrepreneurship, Wagner (2004) provides evidence that small, young firms have a pronounced share of nascent entrepreneurs, meaning that workers within such firms are relatively more likely to become involved in start-up endeavors themselves. When observing entrepreneurs in young firms at work, the likelihood that the employee later becomes an entrepreneur increases significantly. Thus, individuals tend to mimic behaviors that have been shown to be successful in the past. When individuals recognize what past behaviors

were successful, they orient their own behavior in past organization routines in order to perform well themselves.

Moreover, leaders or founders of firms may have a long-lasting *imprinting* effect on organizational behavior. Sociological organizational theory emphasizes that an organization's initial structures and routines tend to persist over time because the founding team's prior functional experiences and initial organizational and functional structures predict subsequent top manager backgrounds and later functional structures (Stinchcombe, 1965; Beckman and Burton, 2008). This persistence is grounded in the tendency of individuals in organizations to follow inherited organizational scripts and routines (Johnson, 2007). Ecologists have operationalized the concept of "structural inertia" (Hannan and Freeman, 1984) in which persistence is a function of the difficulty of changing course once investments have been made in specific organizational technologies and routines. Because of the difficulty in changing existing behavioral routines, it is likely that routines will persist over time.

2.2. Leadership in Academia

Traditionally, academic research has often been described as a public good that does not deplete when shared with others (Arrow, 1962; Scherer, 1982). The public good nature of academic research requires scientists 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 the disdain for commercial activity (Nelson, 2001; Bercovitz and Feldman, 2008). According to Merton's studies on the sociology of science (Merton, 1957; 1973), scientists are described as following a norm of "communalism," meaning that scientists share their discoveries with the scientific community for the common good. In doing so, a scientist gains recognition and esteem by being the first to communicate discoveries to peers (Stephan and Levin, 1992).

Despite the potential change in academic values and norms, it is often acknowledged that scientific recognition in the academy is determined by international standards of research evaluation instead of by organization-specific routines. Through comparative statistics of research output, such as the Tinbergen list of AA, A and B journal rankings of publications in economics, academic scientists are evaluated using comparable, international standards. Moreover, the relevance of commercializing research output and academic reputation through commercialization may depend more on the degree of peer recognition within the particular research community than upon institutional colleagues. Therefore, it is unclear whether the impact of organizational behavior described above applies to academic organizations.

In universities or public research institutes, the impact of an organization on individual behavior usually is measured with regard to peer effects in publication and commercialization output. Azoulay et al. (2007) find that scientists are more likely to patent their research when their coauthors have patent experience. Further, Stuart and Ding (2006) find that scientists who work with peers who are active in the commercialization process are more likely to engage in entrepreneurial activity than other scientists. Furthermore, several studies validate that royalty shares impact the likelihood of disclosure and the licensing activities of scientists (Thursby et al., 2001; Jensen et al., 2003; Siegel et al., 2003).

In academic organizations and departments, there is typically one director who officially leads the department. In light of the aforementioned findings on role model effects in private firms, it is likely that similar effects will also be detected in academia. Typically, directors of research organizations are prestigious scientists who are appointed to be directors as a result of their academic merit. Observing the behavior of directors may lead scientists to behave in a similar way. Thus, if the chair pursues commercialization, such activity may be seen as legitimate, and scientists may follow such paths in the future. Existing evidence of this relationship, however, is scarce. By investigating 15 matched departments from two medical schools, Bercovitz and Feldman (2008) found that commercial activity, measured by disclosures filed, is weakly correlated to previous director involvement with commercial disclosures.

Even though existing evidence hints that an organization's influence in academia is slightly different than its influence in private firms, a comprehensive picture of organizational effects does not yet exist. To fill this gap, we analyze the extent to which leadership behavior and past organizational performance influence individual behavior by examining the commercialization of research results via invention disclosures. In so doing, we analyze disclosure behavior at different research institutes over time.

3. Organizational Context: The Max Planck Society

The MPS is a German research association that was initially founded in the year 1911 as the Kaiser Wilhelm Society. In 1948, the association adopted its current name. The MPS 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, applied research objectives, which are based primarily in the technical and medical-biological fields with the aim of application. The Fraunhofer Society, which undertakes applied research with direct utility to public and private enterprises, conducts even more applied research than the Helmholtz Association. Both of these organizations generate a large amount of funding from contract research, comprising approximately 30 percent of the Helmholtz Association's total funding and approximately 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 goal of the MPS is to achieve research excellence, with large research projects that require special equipment or such high levels of 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 for our study because the MPS has four advantages for our purposes. First, the MPS is an independent, publicly funded research organization. Approximately 82 percent of the MPS's expenditures are publically funded by the federal government and the German states. The remaining funding comes from donations, member contributions, and from a few funded projects. Over 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 the funding, the scientists at the MPS hardly face any pressure to commercialize their research to attract external sources of funding.

Second, the MPS Institutes seek research excellence and promote academic freedom. Because 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 to commercial potential. Therefore, MPS research can be described as seeking ground-breaking new results, though not necessarily with the goal of application. Thus, scientists' commercialization incentives are hardly affected by the research agenda.

Third, Max Planck researchers share one central technology transfer office, the Max Planck Innovation GmbH, which is responsible for the inventions of all the institutes. 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 entered into more than 1,500

license agreements since 1979 (Max Planck Innovation, 2007). Accumulated returns from technology transfer activities exceed € 200 million, with most income resulting from a handful of "blockbuster" inventions. In the case of successful licensing, academic inventors receive 30 per cent of all revenue, and the particular Max Planck institute employing the researcher gets an additional third of all the income. The Max Planck Society obtains the rest of the revenue to finance the technology transfer efforts of its TTO. According to German law, inventors must 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, such as researching the structure of matter, the function of the nervous system, or the birth and development of stars and galaxies. 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 the focus of its own research.

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

4. Data and Variables

We utilize two sources of data to analyze the impact of organizational commercialization successes on individual scientists' commercialization behavior. 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 that have been licensed. Details on how we structure this data are provided in the following subsection.

4.1. Commercialization Data at 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).

The first dataset contains all inventions disclosed by Max Planck researchers from the mid-1960s through 2005. Overall, 3,012 inventions have been disclosed by the MPS. The data provide information regarding the date of disclosure and patent application, the institute the

[1] See Arbeitnehmererfindergesetz (2002)

invention belongs to, invention-specific characteristics, such as the involvement of a Max Planck director, and whether an invention has been licensed.[2]

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

For the empirical analysis, we restrict the sample to inventions disclosed in 2004 or earlier. Moreover, we restrict the sample to inventions disclosed in 1980 or later for two reasons: First, before 1980, Max Planck Innovation GmbH was not only responsible for inventions from Max Planck researchers, but it also offered its services to other public research organizations. Thus, a clear assessment of disclosed inventions belonging to Max Planck researchers is not possible. Second, information available for the pre-1980 inventions is inferior to the information available for later inventions. These restrictions leave us with a total of 2,376 disclosed inventions.

We structured the data such that information on royalties, invention disclosures, director involvement and fixed fees payments is provided by year and by institute. Information on royalty payments and fixed fees are credited to the year in which they were paid. In so doing, we constructed a panel for the years 1980-2004, which allows for the use of time lagged variables. The annual number of accumulated invention disclosures and logged royalty payments are depicted in Figures 1 and 2.

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Insert Figure 1 about here

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Insert Figure 2 about here

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

4.2. Variables of Interest

Our panel-dataset at the institute level comprises annual variables related to commercialization success, measured by royalty payments and fixed fees, and invention disclosures. As additional measures, we included institute maturity, size and the research section of the respective institute. Below, we provide our variables of interest for the panel analysis.

- *TOTAL DISC$_{it}$:* This variable captures the number of annual invention disclosures of institute *i* in year *t*.
- *DIRECTOR DISC$_{it}$ (Binary)*: A binary variable that denotes whether inventions have a Max Planck director among their inventors.
- *LN ROYALTIES$_{it}$:* The annual royalty payments (normalized to Deutsche Mark payments in year 2000) received by institute *i* in year *t*. As the distribution is highly skewed we employ the natural logarithm of this variable
- *LN FIXED FEES$_{it}$:* This variable identifies annual fixed fee payments to inventors (normalized to Deutsche Mark payments in year 2000) received by institute *i* in year *t*. As the distribution is highly skewed we employ the natural logarithm of this variable
- *BIOMED$_i$*: In our analysis, we comprise Max Planck Institutes within the biomedical section and the chemistry, physics and technology section. This binary variable has a value of 1 to indicate that an institute belongs to the biomedical section and zero to indicate that an institute belongs to the other section.
- *SIZE$_i$*: The size of an institute *i* is measured by the number of research directors. Because each department is led by one director, the number of directors equals the number of departments, excluding temporary junior research groups. Because no reliable information on the annual number of employees was available, the number of directors is the most precise information on the size of the institutes.
- *INST MATURITY$_{it}$*: This variable captures the age of institutes measured in years.

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

We utilize our panel data on disclosure activities between 1980 and 2004 to examine whether previous director involvement and the magnitude of commercial success affect the extent of subsequent disclosure activities. This analysis is implemented with a negative binominal regression model, which is used to correct for overdispersion. We use negative binominal regressions with fixed effects to identify how invention disclosures are related to one-year lagged organizational performance measures. This approach is expressed in equation (1).

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

In equation (1), the left-hand side measures the total number of disclosed inventions at the institute i at time t. On the right-hand side of equation (1), X_{it-1} represents a matrix of organizational performance measures in the previous time period, such as log royalties, fixed fees and an indicator variable for director disclosures. Z_{it} includes institute characteristics such as the research section an institute belongs to. v_i is the unobserved time-invariant individual effect, and u_{it} is the error term.

We focus on one-year time lags to analyze the extent to which scientists react to recently observed organizational success. Invention disclosures can be completed within weeks (or days) when a scientist thinks that his or her research outcome is innovative. Thus, to test whether disclosure behavior is related to peer effects and commercialization measures, we focus on short time lags. Further, because institutional settings and the work force in public research change frequently, it is expected that short-term organizational performance measures will have a greater influence on the public research outcome. Yet, because we acknowledge that the focus on short-term time lags may seem arbitrary, we also analyze models with different time lags as robustness checks.

6. Results

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.[3]

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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.

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

[3] 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.

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 previous regressions, 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.[4] 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.

[4] 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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Insert Table 5 about here

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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.

7. Conclusion

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

First, leadership behavior has an impact on individual behavior. Director involvement in disclosure activities positively relates to subsequent disclosure activity the following year. However, this effect disappears when time lags of two or more years are used. This finding suggests that academic scientists' adaptation of leadership behavior is rather *symbolic.* When directors are involved in invention disclosures, academic scientists' disclosure activities increase in the short run, but long-term effects are not found. This finding is roughly in line with the finding of Bercovitz and Feldmann (2008), who reported evidence that scientists are more likely to disclose inventions if the director is involved in invention disclosure, but scientists often do so only once.

Second, scientists' commercialization activities are significantly related to previous commercialization activities and successes - measured in license royalties and inventor fixed fees of distinct institutes. However, this effect is only significant at the 1 percent level when short-term lags of one year are included. Thus, we conclude that scientists react to recently observed organizational success in commercialization, which serves as a financial incentive

for disclosure activities. Moreover, scientists tend to be more inclined to commercialize research when peers were successful in commercializing their research in recent years. However, we acknowledge that this effect can also be explained by scientific opportunities. Chances for commercial success may critically depend on the research agenda as some research areas are of high relevance to the private sector. Therefore, one could argue that the correlation of disclosure activities of scientists with the same indicator in previous years indicates that an institute follows a research program that is close to private research. Because both explanations suit our data, we leave the question of how to disentangle these potential factors of organizational effects for future research.

In sum, we conclude that the influence of organizations on individual behavior in academia can only partially be explained by existing organizational theory. Short-term effects of leadership behavior and past organizational performance can be explained by role model effects and financial incentives, respectively. This is in line with existing organizational theory addressing how individuals tend to adapt to behavior that appears worthy of following. The finding that these effects disappear when modeling time lags of more than one year are considered suggests, however, that long-lasting leadership effects are barely detected. Directors in the MPS have a central role in shaping the research agenda. If directors do not have a long-lasting effect on scientists' behavior in the Max Planck Society, it is likely that such effects are also not found in other academic settings. Thus, we conclude that the absence of persistent effects of leadership disclosure activities and performance measures address the question of the effectiveness of organizational theory to explain the behavior of academic organizations.

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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	Model 7d	Model 7e
			TOTAL DISC		
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**	0.203***	0.193***	0.210***	0.215***
	(0.072)	(0.077)	(0.069)	(0.074)	(0.075)
BIOMED	-0.095	-0.294	-0.433	-0.291	-0.263
	(0.302)	(0.335)	(0.344)	(0.361)	(0.373)
INSTITUTE MATURITY	0.004	0.007	0.004	0.001	0.000
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
Constant	-0.246	-0.171	0.132	0.122	0.155
	(0.444)	(0.481)	(0.469)	(0.506)	(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.

Figure 1: Accumulated log royalties of 48 Max Planck Institutes

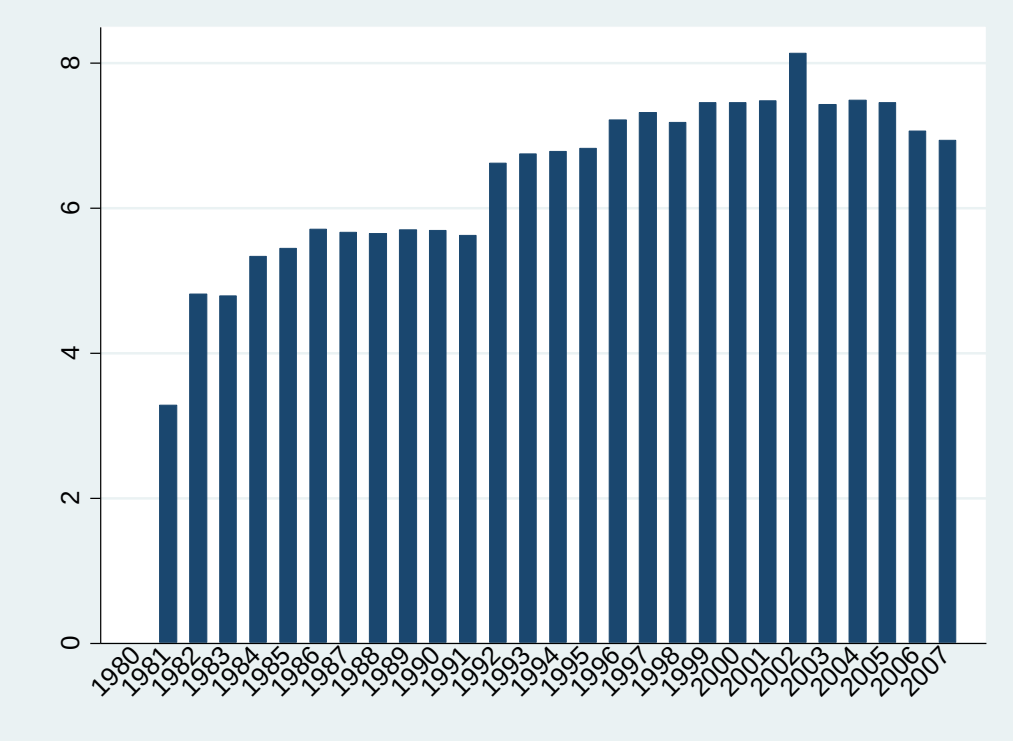


Figure 2: Accumulated disclosures of 48 Max Planck Institutes

