Science, Reputation, and Organization

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INTRODUCTION

The reasons why firms undertake to do science has captured the attention of sociologists, organizational theorists, and economists for some time. Economists have examined the reasons why firms invest in basic scientific research (Nelson 1959; Arrow 1962; Rosenberg 1990; Cohen and Levinthal 1989,1990). Sociologists have explored the nature of of scientific norms and of scientific labor markets (Merton 1957, 1973; Stinchcombe 1990). Recent scholarship has focussed on the relationship between the incentive structure for science and the efficient pursuit of scientific and technical advance (Dasupta and David 1987, 1994). Despite these important and useful contributions, there is a considerable gap in our understanding of why and how scientific organizations undertake to arrange themselves. Why, for instance, do profit-seeking firms allow their employees to undertake autonomous research projects, communicate openly with their peers in other organizations, invite visitors from competing organizations into their laboratories, and publish their findings in the open scientific literature?

This article seeks to shed light on the factors that shape the organization of scientific research in profit-seeking enterpises. Drawing from organizational theory (Aiken and Hage 1968; DiMaggio and Powell 1983; Pfeffer and Salanick 1978; Weick 1979; Meyer and Rowen 1991), the theory of scientific organizations (Merton 1973; Stinchcombe 1990), and more recent contributions to the new economics of science (Rosenberg 1990; Dasgupta and David 1987, 1994; Cohen and Levinthal 1989 1990; Zucker and Darby 1996, 1998), it argues that the structure of scientific research organizations is shaped to large degree by the tastes and preferences of scientists themselves. It thus advances the rather basic claim that scientific research organizations arrange themselves in ways that enable them to attract the best available scientific and technical talent.

This article probes these issues through an empirical study of foreign-affiliated research and development (R&D) laboratories operating in the United States. Because these organizations have essentially been implanted from a foreign environment, they function as a natural experiment of sorts for examining these questions and hypotheses. The field research consisted of site visits to laboratory facilities and intensive interviews with scientists and managers. The survey research covered the entire population of foreign-affiliated laboratories in the United States and achieved a response rate of nearly 90 percent. While the transfer of organizational structures and practices associated with transplant manufacturing organizations has been extensively probed, there is little, if any research on the transfer and adoption of organizational forms and practices by scientific research and development laboratories that have been transplanted from one environment to another.

The findings lend considerable support to these conjectures. The norms of the scientific community, the incentive structure for science, and the nature of scientific labor markets are found to have significant effects on organizational structures and practices of scientific research organizations in the sample.

The research also informs three more specific findings. First, scientific research organizations are found to take on structures and practices associated with an ideal-typical model of a basic scientific research organization distinguished by the autonomous pursuit of basic research, a distancing of scientific from commercial concerns, and open publication of findings. Only a very small fraction (less than 2 percent) of sample organizations are found to be pure transplants – that is, to transfer organizational structures and practices associated with their parent firm in the home country.

Second, the findings indicate that organizational structures and practices adopted by the sample organizations are the result of three interrelated phenomena: reputation, interaction and imitation. *Reputation* requires that scientific organizations arrange themselves in ways that can attract eminent scientific researchers. *Interaction* requires that such organizations adopt structures and practices that facilitate meaningful linkages and connections to other scientific organizations. *Imitation* entails that scientific organizations seek to emulate and learn from practices associated with other, leading scientific organizations.

Third, the organizational structures and practices adopted by the scientific organizations in the sample are the result of planned, purposeful, and strategic action. This is a process of *strategic emulation or* organizational modeling which is considerably more active than the notion of "fitting into" the environment associated with a great deal of the organizational theory literature (see for example DiMaggio and Powell 1983).

The remainder of this article is organized as follows. The next section outlines the relevant concepts associated with organizational theory, the sociology of science and the new economics of science. This is followed by a description of the research design for this study. The following sections report the empirical findings with regard to the roles played by reputation, interaction, and imitation. The final section attempts to synthesize these findings and place them in the context of the broader economics and organization of science.

CONCEPTS AND THEORY

The literatures on organizational theory, the sociology of science, and the new economics of science provide a series of useful insights into the nature of scientific research organizations from which this article draws.

Organizational Theory

Organizational theory has focused on the relationships between organizations and surrounding environments. Institutional theory has noted the tendency of organizations to passively adapt to conditions in the surrounding environment (DiMaggio and Powell 1983). Resource dependency theory has questioned this view, suggesting that organizations can at times act on and shape the environment (Pfeffer and Salanick 1978; Weick 1979). Other research has noted the ability of *transplant organizations,* specifically Japanese manufacturing transplants, to transfer organizational forms to the United States (Florida and Kenney 1991). In a seminal formulation, Schumpeter (1947) distinguished between two types of organizational responses: *adaptive responses* through which organizations adapt to conditions in the environment, and *creative responses* under which organizational alter conditions in the extant environment.

While recent studies have focussed on formal, hierarchical, and highly structured organizations such as manufacturing enterprises, labor unions, and government agencies, there is a long tradition of organizational and sociological research on a less structured class of organizations which can be referred to as *knowledge-based organizations,* e.g. those concerned with creativity, innovation, and scientific research. The objectives of such knowledge-based organizations may lead them to adopt organizational practices and structures that differ considerably from those of traditional vertical organizations

Scientific research organizations are a special class of knowledge-based organization. Scientific organizations are situated in scientific communities whose professional norms center around autonomy, peer review, and priority of discovery (Merton 1957, 1973) and distinguished by labor markets which are reputational in character (Stinchcome 1990).

Institutional theory provides a potential explanation for the structure and design of scientific research organizations (Powell and DiMaggio 1983). According to this perspective, organizational adaptation to the environment is the result of three sorts of pressures. *Coercive pressures* stem from factors such as government regulations, harsh environments, or organizational interdependence. *Mimetic pressures* derive from uncertainty, as organizations minimize risk by adopting practices associated with already successful organizations. Mimetic pressures also operate through inter-organizational relationships as organizations adopt characteristics of other organizations with which the interact. Aiken and Hage (1968) note that organizations with similar organizational forms are more likely to have formalized inter-organizational relations. Adaptation also results from *normative pressures* whereby organizational structures reflect shared or implicit norms that maintain legitimacy in the environment.

DiMaggio and Powell (1983) explicitly consider the effect of professional norms on organizational structure. Professional groups depend upon shared norms that reflect members' preferences for the ways they choose to work and the environments in which they should work. Organizations reflect these norms in their efforts to attract those professionals. Professions that depend heavily on the reputations and prestige of their employees are most likely to reflect the norms of professional communities. The labor market mobility of such professionals (e.g. their abilities to transfer and utilize skills in different organizations) increases organizational incentives to retain them. Meyer and Rowan (1991) note the ways in which organizations respond to professional norms, noting that professional organizations employ external criteria of worth such as ceremonial awards e.g. scientific awards, the Nobel Prize, and so on.

An alternative explanation comes from resource dependency theory (Pfeffer and Salancik 1978; see also Weick 1979). This work suggests that organizations have resources at their disposal that enable them to effectively transfer structures and practices from one environment to another. Empirical research has found that so-called transplant organizations (e.g. Japanese manufacturing transplants in the United States) can transfer and replicate organizational structures in new environments (Florida and Kenney 1991). This body of literature views organizations as capable of transferring organizational structures and practices from one environment to the next. This is particularly likely when organizational structures and practices are associated with increased efficiency or other performance advantages.

While this literature has been mainly concerned with organizational transfer on the part of manufacturing organizations, there are reasons to believe that such transfer might be associated with foreign-affiliated research organizations. On the one hand, empirical studies indicate that foreign research, particularly Japanese R&D laboratories, are organized differently than U.S. scientific research organizations, placing considerably more emphasis on team-based organizational structures and close linkages to production operations (Nonaka and Takeuchi 1995). Other studies also suggest that there are efficiency benefits associated with such organizational structures, particularly the accelerated pace with which new project ideas are turned into products (see Mansfield 1988; Clark and Fujimoto 1991). According to this view, there may be incentives to organize offshore research organizations as pure transplants. On the other hand, the product life cycle model of foreign investment developed by Vernon (1966) suggests that firms transfer research and development functions essentially to support and interact with foreign manufacturing operations. For these reasons, one might assume that offshore laboratories will adopt organizational structures and practices which allow them to interact efficiently with manufacturing plants. Thus, there are theoretical reasons to suspect that foreign-affiliated research laboratories may take on characteristics of research organization of their parent firms or home countries.

Merton and the Sociology of Science

There is another strand of sociology and organizational theory that is principally concerned with the structure and incentives of scientific research organizations. Merton (1957, 1973) described the norms of the scientific community to include investigator autonomy in the pursuit of research, peer review, and open communication and publication of findings. These norms differ substantially from the norms of efficiency, profit, and intellectual property, which motivate business enterprises. Merton also noted that the reward system of the scientific community differs substantially from that of other organizations. The main issue, according to Merton, is that of priority of discovery (or being first to publish) which functions as the central reward and currency for the scientific community. Merton also noted that the incentive structure of science is driven by reputation, and that scientific reputations are determined by the peer ratings of other scientists as judged through their scholarly contributions, research findings, and publications. Stinchcombe (1990) later underscored the reputational nature of academic labor markets, noting that scientists are attracted to organizations which have high levels of reputation by virtue of the fact that they are home to other highly regarded scientists.

The New Economics of Science

Recent contributions from economics - frequently referred to as *the "new economics of science"* - build upon the seminal insights of Merton (see Stephan 1996 for a review). Economists have been generally been concerned with the incentives that motivate firms to undertake research and development, advancing the influential claim that investment in scientific or basic research is a public good for which social benefits outweigh private risks, thus justifying government subsidy (Nelson 1959; Arrow 1962). Following Merton, however, Dasgupta and David (1987; 1994) examine the incentive structure for science and for scientists. Their work calls attention to Merton's insights into priority and suggests that this system of discovery-driven rewards is highly efficient to the advance of science, particularly when juxtaposed to a system of monetary rewards. The discovery-driven system encourages competition for discoveries. Because the reward structure of science operates to a large degree as a "winner-take-all" system, it induces a strong element of time into this competition by engendering productive "races" for discoveries. This system further facilitates maximal knowledge diffusion and efficient advance of science as a whole as scientists rush to publish their results in the open literature so that they might be recognized and rewarded. Other economists (Rosenberg 1990; Cohen and Levinthal 1989, 1990) and Arora and Gamberdella (1994) examine the reasons why firms invest in science, arguing that firms are motivated to invest in science not simply to generate discoveries but to improve their capacity to exploit and utilize the broader pool of science and technology or bolster what Cohen and Levinthal refer to as "*absorptive capacity*." Zucker and Darby (1996, 1998) examine the effects of so-called "*star scientists"* on the performance of biotechnology firms, finding that firms which have ties to such highly regarded academic scientists tend to realize higher rates of productivity and performance. These highly regarded researchers provide a crucial source of "pre-publication" information by virtue of their standing in networks of scientific researchers. Stern (1999) examines the incentive system of scientific researchers working in industry and finds that scientists are willing to take considerably less pay (an estimated 25 percent) in order to join more highly regarded firms where they can participate in science and freely publish their work, suggesting that they are willing to tradeoff monetary rewards for the ability to engage in science.

While this research provides useful and stimulating insights into design, practices, and incentive structure of scientific research organizations, it by and large neglects the factors that shape the structure and practices of scientific organizations. Why do firms allow scientists to "*do science,"* participate in workshops and conferences, invite in visitors from other organizations, and publish their findings freely in the literature? One possible answer might be that firms are required to do science because scientists demand that they do so. In addition to simply generating useful discoveries and innovations, firms may undertake scientific research to generate reputational capital - that is to bolster their reputations so they can hire highly regarded or eminent scientists who in turn attract other scientists and so on down the line. And, these firms might also be motivated by the need for interaction - that is, they might be motivated to engage in scientific research not only to absorb outside developments but in order to interact with and establish network ties to other scientific research organizations. With this framing in hand, the paper now turns to testing these sorts of conjectures through an empirical examination of the sample of foreign-affiliated research organizations.

RESEARCH DESIGN

The research for this study consisted of two types: field research and survey research.

Field Research

The field research for this study consisted of visits to fifteen research organizations and interviews with more than two dozen senior managers and scientists from these organizations.

These site visits consisted of tours of the laboratories and interviews of one to three hours each in length with the director of the facility, other senior managers, research scientists, and technical personal. The interviews proceeded according to a semi-structured format and collected detailed information on organizational structures and practices, recruitment and hiring, inter-organizational relationships, and innovation output such as patents and research publications. Interviews were also conducted in Europe and Japan with executives and strategic planners responsible for overall planning and strategy associated with offshore research organizations. The field research provided important background for development of the survey instrument (discussed below).

The field research and interview data were analyzed using qualitative methods. Coding categories were used to identify key issues and concerns related to scientific norms and reputational labor markets. Particular attention was paid to codes that highlighted the structures and practices of these research organizations, goals and objectives, location choices, hiring and recruitment practices, and inter-organizational relationships.

Survey Research

The survey collected information on organizational structures and practices, resources, activities, sources of innovation, and innovation outputs for the entire population of foreign-affiliated R&D laboratories in the United States. The survey was done at the establishment level, meaning that each individual foreign laboratory in the United States was surveyed. The sample was constructed from government sources, including a 1993 study by the Department of Commerce (Dalton and Serapio, 1993) and directories of R&D facilities including the Directory *of American Research and Technology.* This resulted in an initial list of 393 foreign-affiliated laboratories. Screening interviews eliminated 153 organizations, because they were either not engaged in research or development or were duplicate listings. The survey was carried out by telephone by the Center for Survey Research at the University of Massachusetts, Boston. The survey was administered to the director of the facility. This individual typically had both extensive experience and training in U.S. research management (including in most cases graduate training in the United States) and significant direct experience at and training in the management system associated with the R&D units of the parent company, as well as deep and extensive knowledge of practices at the survey facility. The survey resulted in 186 completed telephone interviews, averaging approximately twenty minutes each, for a response rate of nearly 90 percent (89.9 percent) of eligible respondents.

Key characteristics of the survey respondents are presented in Table 1. Survey respondents spent an estimated average of $26.6 million in total R&D spending, employing an average of 286 people, 181 scientists and engineers, and 33 doctoral-level researchers. The sample laboratories accounted for $5.14 billion in R&D spending in 1994 (roughly 5 percent of all industry R&D in the United States), and employed an estimated 25,000 scientists and engineers, and 7,400 doctoral level researchers. More than half the respondents (53.8 percent) were affiliated with European parent companies and 45.2 percent were affiliated with Asian parents. Laboratories were concentrated in four broad areas of science and technology: biotechnology and pharmaceuticals, advanced electronics, chemical and materials, and automotive technology.

[Table 1 about here]

FINDINGS

To orient and structure the discussion which follows, Table 2 presents the survey data on what can be termed the overall *organizational style* of sample organizations. The survey asked respondents to indicate the organizational style which best described their laboratory. It identified three categories: (1) an ideal typical model of basic scientific research (e.g. discovery-driven, autonomous, open publication, etc.), (2) pure transplant, and (3) hybrid."

As Table 2 shows, 40 percent of respondents reported that their laboratories were organized according to the ideal-typical model for scientific research. An additional 52 percent reported that their laboratories were organized as "hybrids," combining elements of this ideal-typical model and structures and practices associated with scientific organizations associated with their parent firm in the home country. Less than 2 percent (1.6 percent) of respondents reported that they were organized as pure transplants. This is in striking contrast to the findings from studies of manufacturing organizations which provide evidence of a much higher level of transfer or transplanting of core organizational characteristics (see Florida and Kenney 1991).

[Table 2 about here]

The survey data further indicate that there are significant industry differences in adoption or organizational structures and practices by sample organizations. As Table 2 shows, more than half of survey respondents in the fields of biomedicine, advanced consumer electronics, materials, and computer software reported that the adoption of ideal-typical model of scientific organization. Survey respondents associated with the automotive industry (both laboratories engaged in automotive design and manufacturing-related R&D reported very low rates of adoption of this model, 16.7 percent for automotive manufacturing and zero percent for automotive design. The survey data indicate that the former group of sample organizations is more likely to rate developing connections to U.S. sources of science and technology as an important activity, while the latter group is more likely to be closely linked to production operations.

What factors account for and shape these observed patterns? To what degree are they the product of scientific labor markets, scientific norms, and/ or the incentive structure for science? Specifically, to what degree are the organizational structures and practices of sample organizations shaped by factors such as reputation, interaction, and imitation? These are the questions to which I now turn.

REPUTATION

A significant mechanism operating on the organizational structures and practices of the scientific organizations, I suggest, is reputation. Given the norms of the scientific community and the related reputational nature of scientific labor markets (Merton 1973; Stinchcombe 1990), scientific organizations may be motivated to adopt certain organizational characteristics is to effectively attract and retain scientific talent.

Table 3 provides a first approximation of this issue. As these data indicate, gaining access to scientists and engineers is the third highest ranked activity of sample organizations, with nearly three-quarters of survey respondents rating it as "very important." Furthermore, sample organizations that rated this activity as very important were significantly more likely to be organized according to the ideal-typical model of scientific research. The survey results indicate that 82 percent of respondents who rated gaining this access to scientists and engineers as very important were along these lines, more than twice the percentage of all survey respondents (noted above).

[Table 3 about here]

Scientific Norms: The scientific community, as noted earlier, is characterized by a well-defined set of norms and practices (Merton 1973). These norms include autonomous pursuit of research, freedom of scientific investigation, and a reward system of priority and individual reputation. Scientists prefer to work in university-like settings that emphasize individual curiosity, flexible working conditions, peer review, collegiality, and open publication. In fact, adherence to these norms can, and often does, outweigh monetary compensation (Stern 1999).

The survey research and field research findings shed important insight into the role of scientific norms on the adoption of organizational structures and practices. Autonomous pursuit of science is a central norm of the scientific community. Both the survey data and the field research findings indicate that organizational characteristics of sample research organizations are structured to promote autonomy. The survey findings indicate that research scientists are the principal source for both proposing and carrying out new research projects. Survey respondents reported that research scientists were the most frequent source of new research projects, with more than two thirds (68 percent) of respondents reporting that new projects were "often" initiated by research scientists. Corporate executives and R&D managers in the home country were far less likely to be involved in the initiation of new research projects, with 15.7 and 18.5 percent of respondents respectively reporting that these groups "often" initiate new projects.

The majority of interview subjects noted that organizations were explicitly designed to reflect a commitment to established scientific norms. This is reflected in the decentralized and collegial structure of decision-making of many sample organizations. In fact, almost all of the sample sites that were visited were directed by senior scientists with strong academic credentials, most of who had taught at leading universities. A majority of interview subjects explicitly noted that a central aim of their organizational structure was to "be like university settings."

Interview subjects also noted the autonomy of their sample organizations from direct management by the parent company. The survey findings confirm this to some degree. The survey findings indicate that more than three-quarters (77.8 percent) of sample organizations report to a sister R&D facility and nearly two-thirds (63.2 percent) report to a central corporate facility. The survey data indicate, however, that the primary purposes of such reporting involve overall coordination, general direction, and financial reporting rather than direction of research projects. The survey data further indicate that sample organizations have primary responsibility for proposing and carrying out research projects and for the recruitment and hiring of new technical personnel. More than 90 percent of survey respondents report that in-house scientists have significant responsibility for hiring decisions. Interview subjects noted that new hiring decisions frequently involved the input of the scientific and technical researchers.

Interview subjects went to considerable lengths to distinguish the flexible environments of sample research organizations from the more regimented organizational structures and processes associated with parent corporations. A number of subjects pointed out that sample organizations were designed to provide a relaxed work environment with flexible work hours. One interview subject explicitly noted the advantages associated with a location in the United States: “We can be much more creative here. That's because we're not lumbered with ways of working ... established for years and years. ... There are some very creative people over there [in the home country], but the process ... [stifles] creativity." Interview subjects also noted that sample research organizations were explicitly organized in a non-bureaucratic, flexible manner to emphasize the autonomous pursuits of individual researchers and research teams. Others reported that organizational structures and practices were designed to explicitly stimulate creativity.

The field research and interviews suggest that sample organizations adopt organizational practices that emphasize scientific progress and de-emphasize the pursuit of commercial profits from research. The majority of interview subjects noted that commercial profits were not the primary concern of sample organizations. The emphasis on scientific objectives (and de-emphasis of commercial objectives) was repeatedly noted as required to attract qualified scientists and engineers. One interview subject explicitly noted the need to "be more concerned with science than money." Another displayed an article, entitled *Don't Worry About Profits*, which included the following passage: "For many high-tech researchers, few sentences inspire more reverence than this. The idea of being able to do what you want to do, unfettered by company bean counters, is a scientist's dream." A third interview subject, a senior R&D manager, displayed a company memorandum which stated that the laboratory directors' "orders are to build a laboratory where scientists do their basic research, regardless of whether it leads to a saleable product, or any product at all."

Publication, as noted earlier, is the currency of scientific research. Both the field research and the survey research indicate that the sample organizations have adopted organizational structures and practices that encourage publication. The survey data indicate that sample laboratories produced a total of 1,812 published research papers in 1994 -- an average of 12.4 publications per facility. Laboratories in the sample produced an average of 16 articles per $10 million in R&D spending and 25.7 articles per 100 scientists and engineers. These rates are considerably better that of U.S. industrial R&D as a whole (1.65 articles per $10 million in R&D spending and 1.65 article per 100 scientists and engineers). The field research provided additional insight into the role of publication. The interview subjects noted that publication was required to distinguish sample organizations as places of true scientific work. Producing and publishing research papers is one way in which sample organizations can increase their prestige and facilitate interactions with universities and other R&D laboratories. Interview subjects noted the adoption organizational practices that provide incentives for publication.

Reputational Labor Markets: The survey research and field research also shed light on the role of reputational labor markets on organizational structures and practices of scientific research organizations in the sample organizations. Prestige and reputation, as noted earlier, define the labor market for scientists. Furthermore, the distribution of scientific talent is highly skewed, creating tremendous competition for prestigious scientists. In addition, recruitment of so-called "star scientists" (Zucker and Darby 1996, Zucker, Darby, and Brewer 1998) can be said to have a *magnetic effect*.[1] Organizations which attract star scientists will have advantages in attracting other scientists, particularly younger scientists and engineers who perceive benefits from association with leading scientists and from potential inclusion on joint projects or through

[1] I thank Wesley Cohen for suggesting the concept of magnetic capabilities.

mentoring and referral. This is similar to a university, where prestigious senior scientists are recruited in part to act as magnets to recruit leading junior scholars and graduate students (Merton 1973; Stinchcombe 1990). The ability to attract and retain star scientists confers broader reputational benefits and status to the organization as a whole, bolstering its prestige and credibility in general. Therefore, recruitment of key scientists can be viewed as a means of developing broader organizational capabilities and status.

For these reasons, scientific organizations face considerable pressure to adopt organizational structures and practices associated with leading scientific organizations. This entails adopting organizational structures and practices associated with the free and open pursuit of scientific discovery, similar in many respects to those of a leading university. Some of these organizational structures and practices may only be tangentially linked to the efficient utilization of scientific knowledge for the development of commercial products and others, such as open publication of key findings, may even at times comprise an organization's proprietary position in certain areas.

The field research and interview findings shed important insight on the relationships among scientific labor markets, organizational structures and practices, and the development of broader organizational capabilities. Interview subjects noted that prestigious scientists and engineers are targeted not simply for their own skill and expertise, but, moreover, for the effects their reputations can have on broader recruitment and capability development. In fact, leading scientists may be required to conduct very little, if any, directed research of immediate commercial relevance, and are instead free to pursue their own interests. The organizational benefit stems from the association of their reputation with that laboratory and by extension with the broader organization. As noted earlier, such reputational effects function as a magnet for the recruitment of capable young scientists and engineers into the R&D organization. One interview subject noted: "Seven Bell Labs' scientists have shared four Nobel Prizes, a feat coveted by [our laboratory] which has never won a Nobel Prize. … At a time when most other high-tech companies are asking their laboratories to de-emphasize basic research and direct more of their efforts to product development, [our laboratory] is taking the opposite track." Interview subjects noted that their laboratory-building and human resources strategies virtually always begin by attracting prestigious senior scientists.

The field research and interview findings further indicate that reputational effects of attracting star scientists can extend back to the home country, resulting in improved recruitment of scientists and engineers in the home country. One interview subject noted that the most important benefit his organization derived from locating scientific research organizations in the United States was an unexpected increase in successful recruitment of leading scientific and technical talent at home. Other interview subjects noted the recruitment advantages associated with having a prestigious scientific organization in the United States facility, particularly one in close proximity to a leading university, where young scientists can expect to be transferred for a period or to visit.

INTERACTION

In addition to the effects of reputation, scientific organizations may be motivated to adopt structures and practices required to interact with other similar scientific organizations. Thus, the need to interact with other research organizations creates additional pressure for the adoption of organizational characteristics associated with research organizations in order to facilitate and promotes such interaction. Organizational theory has long argued that organizations will tend to take on the characteristics of organizations with which they interact. While this is certainly the case, it may well be that the primary mechanism acting on the research organizations in the sample is not one of passive adaptation or "fitting in." Rather, it reflects planned, purposeful, and strategic actions on the part of organizations to take on structures and practices that facilitate required connections and interactions. Organizations may take on organizational traits and even copy or emulate competitors for strategic reasons - a practice I refer to as *strategic emulation.*

The combined results of the field research and survey research provide substantial support for the conjecture that sample organizations have consciously and strategically *modeled* themselves after U.S. scientific research organizations. As Table 3 (above) shows, the survey data indicate obtaining information on U.S. scientific and technical developments is the second highest ranked activity of sample organizations, with more than 70 percent of respondents rating this as “very important.” In addition, more than half of survey respondents (53.2 percent) reported establishing links to the U.S. technical community as “very important.” Furthermore, 75 percent of survey respondents who listed obtaining information on technological developments as very important were organized according to the ideal-typical scientific organizational model, compared to 39 percent overall. More than two-thirds of respondents (67.6 percent) reported that they are engaged in cooperative research arrangements with U.S. universities. Such links are an important source of personnel. More than a fifth (22 percent) of survey respondents report that they recruit senior scientific staff from U.S. universities frequently, while another 26 percent of respondents report that they sometimes do so. In addition to this, more than one quarter (26.9 percent) of respondents report that they frequently recruit senior scientific personnel from other private sector reseach organizations in the United States, while another 45 percent of respondents state that they sometimes do.

The field research and personal interviews provide additional insight into the relationship between organizational structures and linkages to outside scientific research organizations. Interview subjects noted the importance of constructing and maintaining links to other scientific organizations, both industrial laboratories and universities. In describing their specific location choices, interview subjects noted the importance of a location in close proximity to the scientific community. They noted the strategic aim to build linkages to outside institutions, attract visitors from other research organizations, and facilitate the flow of information. As one interview subject put it: “The whole intellectual atmosphere in Cambridge is definitely a draw.”

The interview subjects explicitly noted that sample organizations strategically aim to establish both formal and informal linkages and communications with other scientific organizations and the scientific community in general. Sample organizations actively seek to establish links to and relationships with outside scientific these institutions via seminars, workshops and conferences as mechanisms to interact with the outside scientific community. This has impacts on organizational structures and practices, as leading scientists tend to interact most frequently and fruitfully with organizations which reflect core scientific norms. Thus, the requirement for interaction places another constraint on organizational structure, in addition to that associated with the reputational character of scientific labor markets. As one interview subject noted: “We have many visitors from outside. ... A little bit more than half of the visitors are from American universities, and some one-fourth are from American industry.” Another subject added: “Everybody comes in and talks with us ... individual researchers can invite their peers for discussion here.” A third noted the importance of seminars: “Sometimes we have a really big crowd. They come here, sometimes we go there. So we are a part of the community.”

The interview subjects stressed the "open" or porous nature of sample organizations. As one interview subject, a senior American scientist now working in a foreign-affiliated laboratory described it: "in my own experience, I find it remarkably the most open industrial laboratory I've ever worked in." While such openness might appear to pose problems with leakage of proprietary information for commercial concerns, it is required to develop fruitful connections and linkage with outside scientific institutions, again illustrating the effects of interaction on organizational structure.

The findings here suggest that organizational structures and practices of sample organizations are strategically developed to maintain and enhance linkages to outside scientific organizations. This is in line with institutional theory which notes that organizations with similar structures are better equipped to cooperate with other similar organizations and facilitate flows of communication and information (DiMaggio and Powell, 1993; Meyer and Rowan, 1993). However, the findings extend and build upon existing theory by indicating that the effects of inter-organizational relationships on organizational structure and practices are the result of strategic action, and not simply the consequence of passive adaptation and replication of practices over time. Rather, they are the result of planned purposive and strategic behavior. What is unique about these findings is that sample organizations actively endeavor to implement an *a priori* defined set of "ideal-typical" organizational structures and practices in order to promote interaction and communication with external organizations, rather than evolving toward similar characteristics over time and through extended interaction with those organizations in the external environment.

IMITATION

In addition to the effects of reputation and interaction, scientific research organizations - particularly the "transplanted" organizations in our sample - may be motivated to emulate practices that offer efficiency advantages. This conjecture is in part informed by institutional theory which contends that organizations tend to conform to the structures and practices of successful organizations in a given environment, particularly when they are new and face considerable uncertainty (DiMaggio and Powell 1983). As noted above, however, the process of imitation or emulation may derive from planned, purposive, and strategic behavior in contrast to the more passive process of adaptation and imitation over time. In addition to being motivated by the need to interact with outside organizations, scientific organizations may seek to emulate organizational traits which offer perceived competitive or efficiency advantages - a process of *strategic emulation.*

The field research and interview data provide some support for this conjecture. The interview findings suggest that sample organizations actively seek to learn from and emulate U.S. practice, which they believe possess performance advantages in innovation and creativity. The majority of interview respondents noted that a key motivation of the decision to locate in the United State was to "learn more" about perceived advantages associated with American approaches to innovation. One interview subject reported that a laboratory was strategically located in close proximity to two leading U.S. universities in order to learn how innovation is organized in universities and in surrounding research organizations. Two additional interview subjects, directors of laboratories in the Cambridge, Massachusetts area and another in the Palo Alto, California, explicitly described their organizations as "learning environments," designed specifically to promote organizational learning on the nature and benefits associated with the style of scientific research organization in the United States.

CONCLUSIONS

This paper has explored how various organizational and economic factors effect the structure and practices of scientific research organizations. It advanced the hypothesis that organizational structures and practices of scientific organizations are shaped to a significant degree by the professional norms of the scientific community, the incentives of science, and the reputational nature of scientific labor markets. More specifically, it advanced the claim that scientific organizations arrange themselves to attract scientists and to interact with other scientific organizations. These structures and practices can be considered a *price of admission* to participate in the world of science. Thus, the nature of scientific norms and of scientific labor markets function as *hard constraints* to which organizational structures and practices are likely to conform

The findings of the field research and survey research support these conjectures: the norms of the scientific community, invective structure of science, and the reputational nature of scientific labor markets are found to have significant effects on organizational structures and practices in sample organizations. Simply put, scientific organizations organize themselves to hire scientists and attract other scientists within and outside the organization.

Both the field research and survey findings indicate that the organizations in the sample do not transfer organizational forms and practices associated with parent firms or home country. Rather, the findings indicate that sample organizations actively modeled themselves according to an ideal-typical model of scientific research, distinguished by autonomous conduct of research, a focus on fundamental science, a distancing of scientific from commercial concerns, and open publication of findings in the scientific and technical literature. More specifically, survey respondents report that they either explicitly emulate the organizational structures and practices associated with this ideal-typical model of scientific organization or adopt a "hybrid" organizational structure which combines elements of this model and practices associated with R&D organization in the home country. Furthermore, less then two percent of survey respondents report that they have are pure transplants using organizational structures and practices associated with research organizations of their parent firm at home. This stands in striking contrast to the pattern for manufacturing organizations where a high degree of transfer or transplantation has been observed.

The findings further indicate that organizational structures and practices adopted by the sample organizations are the result of three principal and interrelated phenomena. First, reputation appears to have the strongest influence on the adoption of these structures and practices. Both the norms of the scientific community and the reputational nature of scientific labor markets inform the adoption of organizational structures and practices. Simply put, sample organizations are required to adopt certain organizational characteristics in order to effectively attract and retain scientific and technical human resources. Second, interaction is important.

The adoption of organizational structures and practices is informed by the need to interact with other scientific organizations. Third, imitation is evident among sample organizations. The adoption of organizational structures and practices by the scientific research organizations in the sample is to some degree tied to a desire to imitate and learn from the practices associated with an ideal-typical model of scientific research organization in the United States.

While institutional theory (DiMaggio and Powell 1983) emphasizes the tendency of organizations to passively adapt or gradually "fit into" their environments, the survey and field research findings suggest that the organizational structures and practices adopted by the scientific organizations in this sample are the result of planned, purposeful, and strategic action. More specifically, the sample organizations appear to have consciously and strategically *modeled* themselves according to an *a priori* defined archetype of an effective scientific research organization. This paper suggests the concept of *strategic emulation* to capture this process of organizational modeling and to distinguish it from the more passive adaptation processes identified by institutional theory. This is the kind of "creative response" which Schumpeter (1947) distinguished from the more typical "passive response" of organizations and enterprises. On this score, the findings suggest that the adoption of organizational structures and practices by sample organizations are tied at bottom to the strategic efforts to develop organizational capabilities rather than the more passive adaptive mechanisms emphasized in the literature.

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Table 1

Key Characteristics of Sample Organizations

Number of Laboratories	207
R & D Spending (millions)	$5,140
Basic Research (millions)	$396
Applied Research (millions)	$1,830
Product Development (millions)	$2,976
Total Employment	65,800
Scientists and Engineers	25,000
Doctoral Level Researchers	7,400

Source: Richard Florida, *Survey of Foreign-Affiliated R & D Laboratories in the United States*, (Heinz School of Public Policy and Management, Carnegie Mellon University, 1995)

Table 2

Adoption of Organizational Approaches by Sample Organizations

Industry	Ideal-Research	Hybrid	Pure Transplant	Other
Biomedical	69.2%	30.8%	0%	0%
Advanced Consumer Electronics	66.7	33.3	0	0
Materials	60.0	20.0	0	20.0
Computer Software	54.5	27.3	0	18.2
Pharmaceuticals	42.9	50.0	7.1	0
Chemicals	40.5	48.6	0	10.8
Instruments	40.0	40.0	0	20.0
Semiconductors	38.5	53.8	0	7.7
Computers	37.5	62.5	0	0
Biotechnology	33.3	56.7	0	10.0
Telecommunications	33.3	68.7	0	0
Automotive Manufacture	16.7	77.8	5.6	0
Automotive Design	0	100.0	0	0
Total	39.5	52.4	1.6	6.5

Source: Richard Florida, *Survey of Foreign-Affiliated R & D Laboratories in the United States,* (Heinz School of Public Policy Management, Carnegie Mellon University, 1995).

Table 3

Activities of Sample Organizations

Activity	Score	Very Important	Somewhat Important	Not Important	N =
Developing New Product Ideas	2.84	86.8% (181)	11.3% (2l)	2.2% (4)	186
Obtaining Information on U.S. Scientific and Technical Developments	2.70	71.5 (133)	26.9 (50)	1.6 (3)	186
Access to Scientific and Technical Talent	2.69	73.7 (137)	22.0 (41)	4.3 (8)	186
Customize Products for U.S. Market	2.56	67.6 (125)	20.5 (38)	11.9 (22)	185
Establish Links to the U.S. Scientific and Technical Community	2.48	53.2 (99)	41.4 (77)	5.4 (10)	186
Work with Manufacturing Facility in U.S.	2.40	59.4 (107)	21.1 (38)	19.4 (35)	180
Develop New Science and Technology	2.36	44.1 (82)	47.8 189)	8.1 (15)	186

Note: Number of respondents in parentheses.

N = 186

Source- Richard Florida, Survey *of Foreign-Affiliated R & D Laboratories in the United States,* **(**Heinz School of Public Policy Management, Carnegie Mellon University, 1995).