The Halo Effect and Technology Licensing: The Influence of Institutional Prestige on the Licensing of University Inventions

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Sociologists and organizational theorists have long claimed that the processes of knowledge creation and distribution are fundamentally social. Following in this tradition, we explore the effect of institutional prestige on university technology licensing. Empirically, we examine the influence of university prestige on the annual rate of technology licensing by 102 universities from 1991–1998. We show that institutional prestige increases a university's licensing rate over and above the rate that is explained by the university's past licensing performance. Because licensing success positively impacts future invention production, we argue that institutional prestige leads to stratification in the creation and distribution of university-generated knowledge.

(*Prestige; Status; Licensing; Technology*)

Introduction

Sociologists and organizational theorists have long claimed that the processes of knowledge creation and distribution are fundamentally social. For example, Merton's (1968) seminal work on the Matthew effect demonstrated that, for the same quality of scientific research, more prestigious scientists receive more citations than less prestigious scientists. In this paper, we extend the concept of prestige to the domain of university technology licensing. We examine the proposition that universities' institutional prestige will influence their ability to license inventions.

Prior research on the licensing of university inventions does not pay much attention to questions of institutional prestige (Henderson et al. 1998, Rosenberg and Nelson 1994, Mowery et al. 2001). Drawing primarily from an economic paradigm, this research has argued that a university's ability to license its inventions is largely influenced by its current and past invention quality. Past licensing performance enhances current licensing performance because past performance provides a signal of future invention quality to potential buyers (Allen 1984). While providing useful insights into university technology licensing, this research stream fails to incorporate sociological findings that an institution's prestige is influenced by organizational traits other than past performance, and that general university prestige influences both the production (Allison and Long 1990) and diffusion of academic knowledge (Crane 1965, Merton 1968). As a result, to date, no research investigates the effects of institutional prestige on the ability of a university to license its inventions.

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Examining the influence of institutional prestige on university technology licensing is important for at least four reasons. First, from a theoretical perspective, disentangling the effects of prestige from past performance is important. Some researchers have argued that these perceptions emerge directly from past performance and influence exchange transactions by providing signals of quality. In contrast, other researchers have argued that these perceptions are not only tied to an organization's past performance, but are also strongly associated with the organization's general prestige relative to peer institutions. Moreover, the construct of prestige holds that external perceptions of an organization influence exchange transactions, not only by signaling the quality of an organization's goods, but also because positive external perceptions about the general organization influence external perceptions of its goods (Shenkar and Yuchtman-Yaar 1997, Perrow 1961). Therefore, understanding the roles that university prestige and past performance play in university licensing transactions will help increase our understanding of the relationship between an organization's general prestige, its past performance, and exchange transactions.

Second, much of the prior research has used indirect proxies of performance, such as past market presence (Podolny 1993) and occurrence dependence (Podolny and Stuart 1995), or has inferred prestige from organizational affiliations, arguing that actors prefer to associate with other actors of the same status (Benjamin and Podolny 1999). However, because past performance and prestige are positively correlated (Podolny 1993), the use of indirect measures has limited the ability of researchers to claim that prestige effects are not solely due to the signaling effect of past performance or unobserved dimensions of organizational capability. Similarly, because prestige and affiliation are positively correlated, the use of social ties to measure prestige confounds the effects of these two constructs.

Third, prior studies of prestige effects do not look at markets for knowledge, but instead look at hybrid interfirm relationships or markets for physical goods. For example, Stuart (1998) examines the formation of hybrid interfirm relationships (strategic alliances) in the semiconductor industry. While this paper provides useful evidence of prestige effects, questions remain about the generalizability of its findings to the purchase and sale of knowledge assets through markets. Knowledge differs from physical goods (such as semiconductors) because it is indivisible, uncertain, and difficult to appropriate, making its purchase and sale quite different from the purchase and sale of physical goods (Arrow 1962). Moreover, market-based transactions, such as licensing, differ from hybrid interfirm relationships, such as strategic alliances, on a variety of dimensions that prestige could impact, including modes of communication, organizational commitment, organizational preferences, approach to conflict resolution, climate, and flexibility (Powell 1990). If prestige is more important for facilitating market-based transactions than for interfirm relationships and is more important for knowledge assets than for physical assets (Podolny 1993), the licensing of knowledge may depend more on prestige than other types of business activity. Consequently, empirical examination of the effects of prestige on markets for knowledge provides an important test of the scope of prestige-based arguments.

Fourth, the specific focus of our investigation on the effect of prestige on university technology licensing is important because university technology plays an important role in economic growth and technical advance in this country (Adams 1990, Jaffe 1989, Rosenberg and Nelson 1994). United States (U.S.) universities generate thousands of patents each year, accounting for approximately 8% of the total patents issued. Moreover, the licensing of university-generated intellectual property accounted for $40 billion of economic activity last year (AUTM 1999). Therefore, explaining the effects of prestige on university technology licensing is important to understanding the knowledge economy.

Unfortunately, prior studies, even those that consider technology (e.g., Stuart 1998, Podolny and Stuart 1995), do not explore the potential for prestige to create large inefficiencies in the university technology licensing market. Licensees of university technology may exhibit risk-averse behavior by preferring to transact with more prestigious universities. In addition, licensees may be drawn to more prestigious universities because the university's prestige will help them attract additional resources to commercialize technology. These behavioral patterns may create significant inefficiencies in markets for university technology, as more prestigious universities may license more technology than their past performance at technology licensing suggests that they should.

In this paper, we examine the rate at which 102 universities license their inventions during the period 1991–1998. We find that institutional prestige influences the number of licenses that a university annually generates, even after controlling for the university's past licensing performance, its staffing policies, its magnitude of technology production, the density of high-technology firms and other universities in its region, and its sources of research funds.

The Setting: University Technology Licensing

The specific setting we examine is the market for university technology. Many universities retain the rights to inventions developed by faculty, staff, and students that make material use of university resources in their development. As a result, those universities, not the inventors themselves, make decisions about the disposition of inventions made with university resources.

University policies often require faculty, staff, and students to file invention disclosures when they believe that they have invented new technologies. University personnel, located in offices of technology transfer, review these disclosures. Technology transfer office personnel determine whether the disclosures represent actual inventions, because university personnel sometimes believe that they have invented new technology, when, in fact, they have not.

In addition to determining whether a disclosure represents an invention, the technology licensing office personnel determine whether or not to patent the invention. Because of the legal monopoly that patents provide, they are the preferred mechanism for protecting universities' intellectual property. However, not all inventions can be patented. To be patented, an invention must be novel, nonobvious to a person trained in the prior art, and valuable. Thus, only a portion of disclosures made by university inventors will result in new patents.

Many universities seek to earn financial returns from their inventions. Because universities are in the business of conducting research and educating students, they do not develop products and services directly from their inventions. Rather, they generally seek to license these inventions to private-sector firms that use this technology to create new products and services in return for a fee.

To license their inventions, universities must market them; and technology licensing personnel are in charge of this marketing effort. Along with the inventors, licensing officers identify and target those private-sector entities most likely to be interested in the new technologies. The licensing officers contact those parties to invite them to examine the technology.

The licensing officers also manage the interaction with potential licensees. Licensing officers interact with individuals who come to the university in search of valuable technology, directing them to technologies that might be available for license, arranging for meetings with inventors, and coordinating visits to university labs. In addition, licensing officers help to arrange future research and development work on the technology through contract research at the university, or for external financing through contacts with venture capitalists and other financial institutions. Furthermore, when a potential licensee is interested in contracting for a technology, the licensing officer negotiates the terms of the contract.

University technology licensing contracts typically involve two components, an up-front cash payment and an ongoing royalty that is generally specified as a percentage of sales (Feldman et al. 2002). Up-front fees generally range from $10,000 to $250,000 and ongoing royalties between 2% to 15% of sales (Bray and Lee 2000). Often, with small and startup firms, and increasingly with other firms as well, universities capitalize the up-front fees and take their payments in equity (Feldman et al. 2002).

The licensing of university-generated intellectual property is an important economic phenomenon. University patents account for more than 8% of total patents in the United States (Henderson et al. 1998).

Moreover, these institutions generated 12,324 new invention disclosures, 5,545 patent applications, and 3,900 new licensing agreements in 1998 (AUTM 1999).

University technology licenses generate significant economic value. Roughly, 8,308 of them yielded income in 1998, and 25% led to a product that had sales in the marketplace. As a result, U.S. and Canadian educational institutions received $862 million in licensing income in 1998 (AUTM 1999). Furthermore, the Association of University Technology Managers estimates that this licensing activity generated 270,000 jobs, $5 billion in tax revenues, and $40 billion in total economic activity.

Just Past Performance or Something More?

According to both economic and sociologically inspired theories, external perceptions of an organization influence the likelihood that buyers will undertake exchange transactions with that organization. However, typical economic and sociological explanations for the mechanisms behind these influences substantially differ.

Reputation for Past Performance

Rational choice theorists, drawing from an economic paradigm, typically argue that buyers form rational expectations of the quality of goods and services offered by sellers by observing the sellers' past products and actions, and that these reputations influence subsequent purchasing decisions (Wilson 1985). Reputation for past performance serves as (an imperfect) substitute for direct knowledge that is particularly influential in situations where it is difficult to ascertain quality (Shenkar and Yuchtman-Yaar 1997). Given uncertainty, buyers are more willing to transact with organizations that have better past performance because past performance signals future performance. Thus, in economic models of reputation, past performance, future expectations, and the likelihood of transactions are tightly coupled (Weigelt and Camerer 1988). In the context of university licensing, reputation arguments suggest that universities that have better past licensing performance should be more likely to license their current inventions than universities that have worse past licensing performance.

Prestige

Sociological theories of prestige argue that buyers' decisions are more loosely linked to past performance than economics-based theories would suggest (Perrow 1961). Sociological theories suggest that buyers are influenced by an organization's general prestige; that is, the relative esteem in which an organization is held in an "ordered total system of differentiated evaluation" (Parsons 1951, p. 132). Prestige arguments claim that, while the organization's past performance influences external perceptions of the value of its current outputs, other organizational attributes (Perrow 1961), such as organizational size, age, network position (Young and Larson 1965, Shrum and Wuthnow 1988), members' social status (Minnis 1953), structure, and the status of its exchange partners (Podolny 1993) also influence these perceptions.

Organizational prestige influences exchange transactions by making a high-prestige producer more likely than a low-prestige producer to consummate a deal to sell a product or service of equal quality. Four mechanisms underlie this effect. First, buyers attribute their positive perceptions of a high-prestige organization to its outputs, thereby increasing the outputs' perceived value through a "halo effect" (Crane 1965, Perrow 1961). For example, Perrow (1961) found that patients relied on general hospital characteristics *unrelated* to their medical needs (such as building design) and the general evaluation of "validating groups" to decide whether or not to seek particular health services at the hospital in question.

Second, prestige increases an organization's visibility, thereby enhancing the likelihood that potential buyers will know about an organization's outputs (Lewin 1935, Granovetter 1985). Context influences what information people pay attention to, and the meanings they ascribe to information (Asch 1940). Thus, products from more prestigious organizations receive greater visibility than products from less prestigious organizations (Crane 1965, Merton 1968). For example, Merton (1968) found that a scientist's prestige influenced the amount of credit he or she received for a scientific paper because articles of equal academic importance written by less prestigious authors are less likely to be read than articles by more prestigious authors.

Third, prestige increases the credibility of an organization's claims about quality. People often consider information from prestigious sources to be more valuable than information from less prestigious sources (Hovland et al. 1953). For example, if researchers at Massachusetts Institute of Technology (MIT) and a small university in the Midwest both develop the same invention, past research suggests that MIT's claims about the commercialization potential of the technology would be viewed as more credible than similar claims by the small midwestern university.

Fourth, buyers prefer to transact with more prestigious organizations because interaction with higher status others increases their own prestige (Tallman and Shenkar 1996). This creates a dynamic in which "more customers simply flow to the producer without the producer actively seeking them out" (Podolny 1993, p. 838). In the context of our study, this means that buyers prefer to search for inventions at, and transact with, more prestigious universities.

In summary, sociologists argue that institutional prestige increases the likelihood of exchange transactions through four mechanisms that operate over and above the effect of past performance: (1) the halo effect, (2) increased visibility, (3) increased credibility, and (4) buyer preferences to transact with more prestigious others. These mechanisms lead us to the following hypothesis, which we test empirically.

Hypothesis 1. *A university's prestige will increase its rate of licensing over and above the rate expected from its past licensing performance.*

Methodology

Sample

We explore the licensing rate of university-assigned inventions from 102 U.S. universities from 1992–1998 as a function of university attributes measured from 1991–1997. Because we examine whether institutional prestige influences the rate of technology licensing from universities, we first identify the population of institutions that are at risk of licensing technology. To be at risk of licensing technology, a university must have faculty, staff, and/or students who invent licensable intellectual property. Because social science and humanities research does not result in licensable inventions, being at risk of licensing effectively requires departments in engineering or science. Thus, most liberal arts colleges are not at risk of licensing and lie outside the population we examine.

Moreover, universities can only be at risk of licensing technology if the institution asserts a property right over technology produced by its faculty, students, and staff. Some institutions do not assert these rights, leaving them to the inventors themselves. Although people at institutions who do not assert property rights can license technology, their institutions cannot. In these cases, examining the effect of the university on the licensing process is not meaningful, therefore, these institutions lie outside of the population we examine.

One good sampling frame for the population of institutions that assert property rights over technologies that their faculty, staff, and students invent is the population of universities with technology transfer offices. Technology transfer offices are units of university administration whose mission is to manage the university's intellectual property. Because these units track intellectual property that is created through the use of university resources and manage the licensing process, it is extremely rare for institutions whose faculty, staff, or students produce technological inventions and which assert property rights over them, not to have these offices.

The membership of the Association of University Technology Managers (AUTM) thus represents the population of institutions at risk of licensing their inventions. We believe that the AUTM sample accurately represents the population of university technology licensing offices because we were unable to identify any universities that have technology licensing offices but are not members of AUTM. Our initial sample includes all of the members of AUTM.

AUTM annually surveys universities to obtain information about their intellectual property activity. AUTM collects data on licensing, technology office staff, funding, and invention disclosures, among other variables. Because AUTM has only collected licensing activity data since 1991, we examine panel data on licensing activity for the 102 universities for which licensing data exists for at least 2 years during this period.

In our analysis, we define a university as a system that operates under a single set of intellectual property rules. When university systems have disparate campuses governed by the same policies or procedures, we aggregated data from the different campuses into a single annual observation for the university. While most state medical schools share a single technology licensing office with their state university, or at least share common policies, three state medical schools had independent policies and administration and had to be treated as separate institutions. Therefore, we also conducted separate analyses that omitted these three institutions. Our results did not change.

We confirmed the accuracy of the AUTM data in two ways. First, we conducted a search of the U.S. Patent and Trademark database to generate counts of university patents in each year from 1991–1998. We compared those counts to the counts reported by AUTM and found that they correlated at $r = 0.95$. Second, we spoke to technology licensing officers at MIT, Georgia Institute of Technology, and Stanford University who confirmed that they have an incentive to accurately report data to AUTM, and any discrepancies between AUTM data and actual numbers would be clerical errors.

Our sample captures almost all of the universities in our population. It incorporates more than 90% of the top 100 U.S. universities in terms of research and development expenditures and approximately 90% of the total number of university assigned patents. However, AUTM data is missing responses from some institutions from some years. Specifically, the AUTM data has complete records for 45 universities and is missing responses from all years for 6 universities. We drop the 6 universities for which no data are available. The remaining institutions in our sample contain an average of 5.5 years of data.

We examine whether the universities that provide more data are different from those that provide less data, and whether those that provide no data are different from those that provide 1some data. T-tests comparing important university attributes such as prestige scores, size of research program, number of invention disclosures, research revenue, and number of patents show no significant differences between universities missing panel observations and those not missing data. Similar tests between universities that did not send their data to AUTM and the general sample showed no significant differences on prestige and research funding. Moreover, we reran regression analyses with a dummy variable representing universities that were missing at least 1 year of data. This dummy variable was not significant. Thus, we believe that the reasons for missing data are idiosyncratic and unrelated to the factors that we measure in our study.

Dependent Variable

The dependent variable in our analysis was the annual count of new technology licensing and option agreements established by the university. These data are provided by AUTM through their surveys of university technology licensing offices.

Covariates

Prestige. Our predictor variable is university prestige. Prestige arguments suggest that the behavior of potential licensees will be influenced by external perceptions of universities that are not necessarily directly linked to university's past performance at licensing. Our primary measure of prestige is the overall *U.S. News & World Report* graduate school ranking (1991–1998), a measure of the relative status ordering of different institutions as perceived by university presidents, deans, and admissions directors.

U.S. News & World Report distributes questionnaires to college presidents, deans, and admissions directors throughout the U.S., and asks them to evaluate the prestige of other schools by placing them into four quartiles. Four points were given for each vote in the top quartile, three for the second, two for the third, and one for the last category (*U.S. News & World Report* September 30, 1991, p. 83). Universities were then placed in order of their scores and ranked against one another. Because some of the years were reported in ranks (1991–1997), while other years were reported using a scale (1997–1998), we converted the scores to ranks to make all years consistent.

To confirm the validity of the *U.S. News & World Report* ranking as a measure of university prestige, we also collected *Gourman Report* scores (Gourman 1991, 1994, 1997), a commonly utilized measure of the overall intellectual prestige of the university's graduate programs as compared to other universities. The *Gourman Report* measures the collective assessment, relative to peer institutions, of the university's graduate programs in all fields, including the arts, humanities, social sciences, physical sciences, natural sciences, medicine, law, business, and engineering. University faculty and administrators are asked to rate universities' overall graduate program quality on 10 dimensions on a 1 to 5 scale. The *Gourman Report* staff also assesses the universities' strengths and weaknesses and assigns them an overall score. Because these scores are produced every 3 years, we update the *Gourman Report* measure in 1991, 1994, and 1997.

One of the advantages of using the *Gourman Report* measure in addition to the *U.S. News & World Report* measure is that the *Gourman Report* provides a score, while the *U.S. News & World Report* provides a ranking. By showing that we obtain the same results with a score as we did with a ranking, we can demonstrate that our results do not depend on constraining our analysis to comparisons within the sample.

As a final check, we also gathered data from the 1992 National Research Council (NRC) graduate department rankings. The NRC collects its data through a survey of graduate faculty at 3,634 programs around the country, who are asked to rank programs in their field (NRC 1995).

Compared to the *Gourman Report* ratings and *U.S. News & World Report* rankings, the NRC rankings have the disadvantage of being gathered only once per decade. However, the NRC has the advantage of ranking specific departments on a 1 to 5 scale. This specificity allows us to create separate scores for departments that create patentable technologies (e.g., biology) and those that do not (e.g., history). For each university, we averaged the scores of the arts, humanities, social, and behavioral sciences to create the nontechnical measure, and averaged the engineering, physical science, mathematics, and biological science scores to create the technical measure.

All three measures capture university prestige because they are not tightly coupled with past licensing performance. It is unlikely that the respondents to the *U.S. News & World Report*, the *Gourman Report*, or NRC surveys were aware of the particulars of each university's past performance at licensing, and even less likely that they would use that criteria to rate the general prestige of the university.

The measures also demonstrate considerable convergent validity. The *U.S. News & World Report* ranking had a 0.90 correlation with *Gourman Report* scores and a 0.86 correlation with NRC scores. *Gourman Report* scores also were highly correlated with the NRC scores ($r = 0.85$). We observed little change in the *Gourman Report* scores and the *U.S. News & World Report* rankings during the duration of the study. Correlations between measures for the years 1991–1998 were at least at the 0.88 level, with most years correlated above the 0.92 level. Correlations between values for adjacent years were strongest and slightly deteriorated over time.

Past Performance. The behavior of potential licensees should be directly influenced by the historical performance of the universities at technology licensing. However, past performance at licensing might be manifested in different ways. Potential licensees might pay particular attention to different indicators, such as the average level of licensing income generated per invention; the probability that an institution's inventions are worthy of license; the frequency with which past licenses yielded income; or the magnitude of the university's past licensing revenue. Therefore, we control for past performance with four different measures. All four measures are derived from data AUTM collected from the universities.

Average Licensing Revenue. Potential licensees might view the average performance of licenses at a particular university as the appropriate measure of past licensing performance. If this were the case, then the average amount of licensing revenue per license would make a licensor more appealing to potential buyers. Therefore, we measure the average revenue per license in the past year. Licensing should be higher from universities that generate inventions of higher average value.

Past Licensing Yield. Potential licensees might recognize that only some university inventions are of interest to the private sector. If potential licensees expect that institutions will vary on the degree to which they produce technologies that appeal to the private sector, then the licensing yield may be an important signal to potential buyers. Therefore, we measure the proportion of invention disclosures in the past year that result in licenses. To create this variable, we divide the number of licenses issued in the past year by the number of inventions disclosed in that year.

Past Number of Licenses Yielding Income. Licensing should be higher from universities whose past licensing yield is higher. Potential licensees might recognize that not all licenses yield income. If potential licensees expect that institutions will vary in the degree to which they produce commercialized technologies, then the number of licenses yielding income will be an important indicator of past performance. Therefore, we measure the count of licenses yielding income in the past year.

Past Licensing Revenues. Potential licensees might recognize that licensing is an inherently uncertain process in which a few inventions account for most of the licensing revenue. If potential licensees expect licensing revenue to be generated from a small number of successful licenses, then the total royalties generated from licensing at an institution will capture past performance. Therefore, we measure the total revenue generated from royalties on licensed inventions in the previous year. We expect that this variable will positively influence the current rate of licensing.

Level of Technology Production. Because the volume of technology produced will influence a university's rate of licensing, we control for the volume of technology available for licensing. We capture this effect by measuring the number of invention disclosures that the university produces in the year under investigation. The universities provided these data to AUTM.

Technology Licensing Office Resources. Universities often hire personnel to market their inventions to private-sector firms. Because technology licensing officers have limited time, the effort that they can put into marketing a given invention is a function of the total number of inventions that they must handle. To capture this resource effect, we control for the number of invention disclosures per professional staff member in the university year. We expect an inverse relationship between the number of disclosures per professional staff member and the number of licenses created in a university year. The universities provided these data to AUTM.

As an alternative operationalization of licensing office resources, we also examined the absolute number of professional staff. However, we found it to be a proxy for the size of the university technical research program and, thus, highly correlated with the number of invention disclosures ($r = 0.85$). Moreover, we find that this measure has no effect in the regression analysis (most likely due to collinearity), but that the ratio of number of inventions to staff does. Because the former measure explains much of the same variance as the number of invention disclosures and does not have an effect, we report the regressions that show the ratio of inventions to staff.

Source of Funding. Inventions are an outgrowth of investment in research. Government agencies or the private sector can fund university research. Prior research suggests that universities that receive more of their funding from the private sector generate more commercially useful inventions than universities that receive more of their funding from the public sector, because private firms have commercial goals for funding university research (Henderson et al. 1998). To capture the commercial orientation of university research, we measure the proportion of university research funded by private-sector firms in the previous year. We expect that universities that receive a greater share of funding from the private sector will have a greater number of licenses. We obtained these data from AUTM.

Medical School. Researchers have observed that biomedical inventions are more likely to be patented and licensed by universities than are other inventions (Mowery et al. 2001). For this reason, we expect that universities with medical schools will have a higher rate of licensing than universities without medical schools. We control for this effect with a dummy variable of one if the university operates a medical school. We gathered these data from a search of university websites.

Geography. We control for two attributes of the university's location: The level of private-sector high-technology activity in the area and the density of universities that license technology. Universities are more likely to license technology to firms located geographically close to them because the transfer of university technology often requires face-to-face contact (Mansfield 1998). Because proximity to high-technology firms should make universities more likely to license their technology, we controlled for the amount of high-technology employment in the county in which the university was located. We use the county rather than the metropolitan statistical area because some of the universities we examine have rural locations and do not belong to a metropolitan statistical area.

Following Hecker (1999), we defined high-technology industries as those in which research and development employment is at least twice the average for all industries. Using the Bureau of Labor Statistics annual survey, we created an annual measure of the total number of employees in high-technology industries in each of the counties in which a university was located. As an alternative operationalization of local private-sector technology activity, we measured the number of high-technology organizations in the area, but it was not significant. Therefore, we report the regressions with the measure of high-technology employment.

A second effect of location could be that of competition between universities marketing technology to local firms. Because we would expect that institutions located in areas with a higher population of technology-producing universities would face a higher degree of competition for potential licensees, we also control for the number of universities that are members of AUTM and are located within the same county as the focal institution.

Year. Invention and licensing activity varies over time as a function of various perturbations in the external environment. Therefore, we include year dummy variables to control for the time period (1992 is the omitted year).

Model Specification

Our model estimates the variation in annual license counts per university across a 7-year panel. Our explanatory variables are a mixture of continuous and discrete variables. We used generalized estimating equations (GEE) with a negative binomial distribution and a log linear link function to estimate the regressions (Liang and Zeger 1986).

Pooling multiple observations over time for each organization increases the likelihood that cross-sectional autocorrelation (general factors that characterize a particular university influence the behavior of the university at all points in time) will bias parameter estimates. In GEE models, one can correct for this autocorrelation by specifying the association among observations from each subject over time (Diggle et al. 1994). We specified a first-order autoregressive pattern (AR1) because examination of the data revealed that observations closest in time had higher correlations than those more temporally distant.

To reduce problems associated with heteroskedasticity or misspecification of the error structure, we used robust variance estimators in our analyses (White 1981). We also included a number of university-level controls (technology licensing office staffing, research funding, number of invention disclosures, and existence of a medical school) to limit problems related to repeated observations.

We do not employ fixed effects models to analyze our data for methodological reasons. Typical fixed effects models for panel data cannot estimate effects for samples that include respondents for which there is no variation in the dependent variable over time. Approximately 10% of our sample falls into this category. Because universities that have no licensing activity over the observation period may be systematically different from those in which there was some licensing activity, dropping those observations (and thereby enabling the use of fixed effects models) would likely bias the estimates in the regression analysis. Estimating our regressions using a general estimating equation with an AR1 correlation structure enabled us to include universities that did not license technology during the observation period, without invoking the random effects assumption that errors are uncorrelated between years (Stata 1999).

Because we seek to separate the portion of our predictor variable that captures variation in technology production capability from that which relates to prestige alone, we conduct two residual analyses. The first residual analyss, shown in Tables 4 and 5, uses *U.S. News & World Report* rankings and *Gourman Report* scores residualized on measures of past licensing performance. We generated this measure by regressing *U.S. News & World Report* rankings and the *Gourman Report* scores on each of the four measures of past performance (in different analyses), and using the residuals from these analyses as measures of prestige in Tables 4 and 5. To the extent that our measures of prestige represent actual licensing capability, then past performance and *U.S. News & World Report* rankings and the *Gourman Report* scores should be closely correlated. Thus, separated from the performance component, the residualized measures of prestige capture that portion of prestige unrelated to past licensing performance.

Our second residual analysis incorporates information from *Gourman Report* engineering scores. The ranking of nontechnical areas cannot represent actual invention capability because these areas do not invent technology. Therefore, the overall ranking, stripped of the engineering program effect, more directly represents prestige effects unrelated to licensing performance, and provides a more precise test of our arguments. Because engineering is one of the major sources of inventions in a university, the ranking of engineering programs provides a good proxy for an institution's technology ranking. To test this effect, we regress the overall rating on the engineering school scores and then use the residual values in the regression models that include the engineering school scores. We recognize that a better proxy would also include other fields that produce licensable inventions in the technology ranking. However, *Gourman Report* data were available only for engineering departments. For this reason, we use the NRC data to parcel out technical and nontechnical prestige effects in other regressions.

Results

We provide the summary statistics for the variables in our regression analysis in Table 1. Table 2 presents estimates of the number of university licenses produced in a given year. Model 1 measures past performance as the university's average amount of licensing revenue per active license in the previous year. Model 2 measures past performance as the university's yield of licenses per invention disclosure in the previous year. Model 3 measures past performance as the magnitude of the university's licensing revenue in the previous year. Model 4 measures past performance as the number of university licenses yielding income in the previous year. Finally, Model 5 combines the four measures of past performance in a single model.

To increase the ease of interpretation, all results are reported as incidence rate ratios. Incident rate ratios can be interpreted as the percentage change in the dependent variable with a one-unit change in the independent variables. A ratio of 1 signifies no change, a ratio less than 1 indicates a negative relationship, and a ratio greater than 1 indicates a positive relationship.

Table 2 shows that the university's general prestige increases its rate of licensing, controlling for the volume of invention disclosures, the regional amount of high-technology activity, the number of universities within a county, the source of university funding, the presence or absence of a medical school, the year, and the university's past licensing performance. Depending on which measure of past performance we controlled for in the regression models, a one-unit increase in the *U.S. News & World Report* ranking increased the rate of licensing by approximately 1.5%.

Several of the control variables were also significant. Perhaps most importantly, all measures of past performance significantly increased licensing rates. Density of licensing universities in an area and the number of disclosures per professional staff decreased the rate of licensing, while the number of invention disclosures increased the rate of licensing. Consistent with our earlier arguments, the negative effect of density of licensing universities indicates competition for licensees between colocated universities. The negative effect of the number of disclosures per professional staff indicates the adverse effect of managing a high volume of technology on the ability of licensing officers to interest private-sector firms in university technology. The positive effect of the number of

Table 1 Correlations and Summary Statistics

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Mean	38.29	0.41	71.05	27.12	4.11	3.77	0.11	0.60	20.35	2.71	2.83	0.31	41.87	0.073	2.79	50.63	0.13	0.13	0.13	0.13	0.13	0.13
Standard deviation	70.93	0.84	82.10	24.91	0.51	0.78	0.09	0.49	26.92	0.72	0.76	0.34	70.67	0.162	7.36	31.13	0.33	0.33	0.33	0.33	0.33	0.33
Minimum	0.00	0.00	0.00	0.00	3.11	2.01	0.00	0.00	0.00	0.98	0.92	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	577.00	3.00	742.00	250.00	4.94	4.95	0.56	1.00	191.00	4.42	4.64	5.89	763.00	2.72	67.28	108.00	1.00	1.00	1.00	1.00	1.00	1.00
1. Density of high-technology employees*	1.00																					
2. Density of licensing universities	−0.16	1.00																				
3. Invention disclosures	0.72	−0.21	1.00																			
4. Disclosures per professional staff	0.16	−0.10	0.21	1.00																		
5. Gourman engineering scores	0.45	−0.22	0.56	0.23	1.00																	
6. *Gourman Report* scores	0.35	−0.06	0.46	0.12	0.75	1.00																
7. Industry funding ratio	−0.15	−0.02	−0.12	−0.01	−0.17	−0.27	1.00															
8. Medical school	0.11	0.22	0.13	−0.13	0.08	0.37	−0.18	1.00														
9. Number of licenses	0.53	−0.20	0.75	−0.09	0.52	0.45	−0.15	0.18	1.00													
10. NRC nontechnical scores	0.40	−0.13	0.49	0.06	0.66	0.83	−0.26	0.31	0.50	1.00												
11. NRC technical scores	0.44	−0.26	0.54	0.17	0.79	0.84	−0.24	0.16	0.53	0.88	1.00											
12. Past licenses/disclosures	0.00	−0.03	−0.07	−0.23	0.07	0.14	−0.06	0.08	0.31	0.17	0.16	1.00										
13. Past licenses yielding income	0.64	−0.17	0.78	−0.12	0.45	0.40	−0.11	0.13	0.79	0.46	0.47	0.14	1.00									
14. Past licensing revenue/year**	0.01	0.31	−0.03	0.02	−0.02	0.00	−0.02	0.04	−0.01	−0.09	−0.10	−0.03	0.00	1.00								
15. Past licensing revenue**	0.62	−0.03	0.65	−0.10	0.35	0.31	−0.10	0.17	0.69	0.35	0.34	0.09	0.78	0.29	1.00							
16. U.S. News & World Report ranking	0.32	−0.06	0.41	0.13	0.72	0.90	−0.22	0.31	0.43	0.88	0.86	−0.18	−0.36	0.03	−0.27	1.00						
17. 1993	0.02	0.03	−0.01	−0.04	0.05	0.05	0.08	0.03	−0.04	0.06	0.06	0.10	−0.03	0.03	−0.04	−0.06	1.00					
18. 1994	0.00	0.00	−0.05	0.00	−0.02	−0.01	−0.02	0.01	−0.03	0.01	0.00	0.03	−0.06	−0.04	−0.04	0.01	−0.16	1.00				
19. 1995	−0.01	−0.02	−0.03	0.00	−0.03	−0.03	0.02	−0.02	−0.03	−0.04	−0.04	−0.02	−0.04	0.01	−0.02	0.05	−0.17	−0.19	1.00			
20. 1996	0.00	−0.01	0.00	0.04	−0.04	−0.03	0.00	−0.02	−0.01	−0.04	−0.03	−0.04	0.01	−0.05	−0.01	0.03	−0.16	−0.18	−0.19	1.00		
21. 1997	−0.01	0.01	0.06	0.04	0.00	0.00	−0.01	0.02	0.06	−0.01	−0.01	−0.02	0.06	0.01	0.05	0.00	−0.15	−0.17	−0.18	−0.17	1.00	
22. 1998	−0.02	−0.02	0.06	−0.02	0.01	−0.01	−0.02	−0.04	0.11	−0.03	−0.02	0.01	0.13	0.04	0.12	0.02	−0.16	−0.17	−0.19	−0.18	−0.17	1.00

*Thousands of employees.
**Millions of dollars.

Table 2 Negative Binomial Estimation of the Annual Count of University Technology Licenses Using the *U.S. News & World Report Rankings* as a Measure of Prestige

	Model				
Variable	1[a,b]	2[a,b]	3[a,b]	4[a,b]	5[a,b]
Density of high-technology employees	0.998	0.998	0.998	0.998	0.998
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Density of licensing universities	0.879*	0.885+	0.878+	0.895+	0.881*
	[0.057]	[0.056]	[0.059]	[0.058]	[0.051]
Invention disclosures	1.006**	1.006**	1.006**	1.005**	1.005**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Disclosures per professional staff	0.996*	0.995*	0.996*	0.997	0.996+
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Industry funding ratio	0.716	0.795	0.739	0.771	0.722
	[0.338]	[0.349]	[0.356]	[0.371]	[0.319]
Medical school	1.174	1.182	1.236	1.254	1.174
	[0.179]	[0.176]	[0.197]	[0.192]	[0.152]
Licensing revenue/year[c]	1.080+				1.107*
	[0.043]				[0.049]
Past licenses/disclosures[c]		1.058**			1.069**
		[0.010]			[0.017]
Past licensing revenue (in millions of dollars)			1.015*		0.995
			[0.007]		[0.008]
Past licenses yielding income				1.003+	1.003*
				[0.001]	[0.002]
U.S. News & World Report ranking	1.015**	1.014**	1.015**	1.015**	1.012**
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
1993	1.254*	1.230*	1.247*	1.230*	1.221*
	[0.117]	[0.125]	[0.123]	[0.125]	[0.120]
1994	1.422**	1.339**	1.395**	1.366**	1.316**
	[0.124]	[0.112]	[0.124]	[0.125]	[0.117]
1995	1.343**	1.293**	1.337**	1.335**	1.239**
	[0.094]	[0.094]	[0.098]	[0.106]	[0.095]
1996	1.299**	1.251**	1.287**	1.242*	1.189+
	[0.110]	[0.107]	[0.113]	[0.116]	[0.116]
1997	1.481**	1.462**	1.476**	1.411**	1.340**
	[0.142]	[0.136]	[0.145]	[0.156]	[0.149]
1998	1.539**	1.566**	1.529**	1.460**	1.366*
	[0.161]	[0.152]	[0.176]	[0.188]	[0.184]
Observations	521	534	537	535	516
Number of schools	95	97	97	97	95
Chi-squared statistic	362.55	507.59	386.65	405.54	572.21

[a]The results are reported as incidence rate ratios.
[b]AR1 correlation structure.
[c]Log transformation.
Standard errors in brackets.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, $^{+}p < 0.10$

Table 3 Negative Binomial Estimation of the Annual Count of University Technology Licenses Using the *Gourman Report* Scores as a Measure of Prestige

	Model				
Variable	1[a,b]	2[a,b]	3[a,b]	4[a,b]	5[a,b]
Density of high-technology employees	0.998	0.998	0.998	0.998	0.997
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Density of licensing universities	0.876*	0.887+	0.877+	0.895+	0.883*
	[0.059]	[0.058]	[0.060]	[0.060]	[.053]
Invention disclosures	1.006**	1.007**	1.006**	1.006**	1.01***
	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]
Disclosures per professional staff	0.996*	0.995*	0.996*	0.997+	0.996*
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Industry funding ratio	0.777	0.726	0.749	0.788	0.778
	[0.412]	[0.413]	[0.414]	[0.438]	[0.375]
Medical school	1.142	1.151	1.200	1.219	1.150
	[0.169]	[0.170]	[0.185]	[0.181]	[0.144]
Licensing revenue/year[c]	1.095*				1.12*
	[0.044]				[0.05]
Past licenses/disclosures[c]		1.038**			1.28*
		[0.012]			[0.06]
Past licensing revenue			1.018*		1.040
(in millions of dollars)			[0.008]		[0.036]
Past licenses yielding income				1.003+	1.21*
				[0.002]	[0.109]
Gourman Report scores	1.723**	1.730**	1.752**	1.726**	1.66**
	[0.161]	[0.155]	[0.151]	[0.147]	[0.117]
1993	1.275**	1.270*	1.282**	1.262*	1.23*
	[0.112]	[0.123]	[0.121]	[0.124]	[0.115]
1994	1.432**	1.375**	1.414**	1.382**	1.32*
	[0.122]	[0.112]	[0.119]	[0.121]	[0.115]
1995	1.308**	1.256**	1.298**	1.299**	1.21*
	[0.092]	[0.093]	[0.097]	[0.106]	[0.094]
1996	1.270**	1.225*	1.261**	1.217*	1.160
	[0.108]	[0.104]	[0.113]	[0.117]	[0.116]
1997	1.416**	1.400**	1.412**	1.353**	1.29*
	[0.135]	[0.124]	[0.138]	[0.147]	[0.144]
1998	1.508**	1.537**	1.503**	1.437**	1.33*
	[0.162]	[0.154]	[0.185]	[0.194]	[0.186]
Observations	549	567	570	568	544
Number of schools	100	103	103	103	100
Chi-squared statistic	383.69	463.15	417.09	431.92	630.35

[a]The results are reported as incidence rate ratios.
[b]AR1 correlation structure.
[c]Log transformation.
Standard errors in brackets.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, $^{+}p < 0.10$.

disclosures indicates the positive effect of the quantity of technology available on licensing rates.

Table 3 provides a robustness check of the results presented in Table 2 by substituting the *Gourman Report* scores for the *U.S. News & World Report* rankings. The results shown in Table 3 confirm the prior results. Depending on which measure of past performance was controlled; a one-unit increase in the *Gourman Report* scores increased the rate of licensing around 75%. (The coefficients for the *Gourman Report* scores and the *U.S. News & World Report* rankings differ in magnitude because they are measured in very different ways. An increase of one unit has a different meaning in the two measures.)

Tables 4 and 5 provide a second robustness check by substituting *U.S. News & World Report* rankings and *Gourman Report* scores residualized on past performance for the nonresidualized scores. The results in Tables 4 and 5 corroborate those in Table 2. The residualized prestige scores have a positive and significant effect on the rate of licensing in all models.

We provide a third robustness check by adding the *Gourman Report* scores for engineering programs to the models shown in Table 2.[1] The residualized *Gourman Report* score has a positive effect, indicating that the prestige of the university influences a university's ability to license, even after past performance and engineering department rankings are controlled. A one-unit increase in the general *Gourman Report* score increases licensing activity by between 38% and 39% and one-unit increase in the *Gourman Report* engineering score increases licensing activity by between 118% to 128%, depending on the independent variables included in the model.

In our fourth and final robustness check, we use NRC's ratings of university programs to measure prestige. The NRC data allow us to measure both technical and nontechnical fields. Because nontechnical areas of the university have no direct effect on the university's inventive capability, any positive effect of the nontechnical areas on licensing rates, controlling for the technical area score, have to be attributed to prestige.

The measures of technical and nontechnical departments were highly correlated, so we orthogonalized them on one another and on the measure of quality corresponding to each model (Saville and Wood 1991). Because we are orthogonalizing several variables, we used a modified Gram-Schmidt procedure (Golub and Van Loan 1989, Parlett and Scott 1979). This technique can be viewed as a process of subtracting the vector from its projection, resulting in orthogonal variables. The interpretation of the orthogonalized variable is the independent variable in question minus the linear influences of the variables upon which it is orthogonalized. In our case, one can interpret the nontechnical score as that part of prestige that is not explained by the technical score or past performance.

The results indicate that the NRC scores for nontechnical departments are significant predictors of licensing rates after controlling for past performance at licensing, the scores for technical departments, and the other controls are included in the regression equations, supporting our hypothesis: university prestige increases the rate of licensing over that expected from past performance at licensing. Specifically, a one-unit increase in the NRC technical rankings increases licensing activity by between 95% to 100%, while a one-unit increase in the nontechnical rankings increases licensing activity by between 40% to 42%, depending on the measure of past licensing performance included in the regressions.

Discussion

This paper examined why some universities license more of their inventions than other universities during the 1991–1998 period. We showed how general university prestige increases the licensing rate over that predicted by past performance. We also showed that this prestige effect occurs after controlling for the amount of technology produced by the university, the source of research funding, the presence or absence of a medical school, the geographic location of the university, and the resources of the technology licensing office. Moreover, this remained true across several measures of prestige, and after controlling for the rankings of engineering and other technical programs.

[1] Because of space limitations, the tables showing these results, and the results using NRC's rating of prestige, are not included, but are available directly from the authors.

Table 4 Negative Binomial Estimation of the Annual Count of University Technology Licenses Using the Residualized Measure of the *U.S. News & World Report* Rankings

	Model				
Variable	1[a,b]	2[a,b]	3[a,b]	4[a,b]	5[a,b]
Density of high-technology employees	0.998	0.998	0.998	0.998	0.998
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]
Density of licensing universities	0.879*	0.885+	0.878+	0.895+	0.881**
	[0.057]	[0.056]	[0.059]	[0.058]	[0.051]
Invention disclosures	1.006**	1.006**	1.006**	1.005**	1.010***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
Disclosures per professional staff	0.996*	0.995*	0.996*	0.997	0.996*
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Industry funding ratio	0.716	0.795	0.739	0.771	0.722
	[0.338]	[0.349]	[0.356]	[0.371]	[0.32]
Medical school	1.174	1.182	1.236	1.254	1.170*
	[0.179]	[0.176]	[0.197]	[0.192]	[0.152]
Licensing revenue/year[c]	1.175**				1.190*
	[0.049]				[0.05]
Past licenses/disclosures[c]		1.090**			1.390*
		[0.011]			[0.075]
Past licensing revenue			1.033**		1.013*
(in millions of dollars)			[0.008]		[0.034]
Past licenses yielding income				1.006**	1.450***
				[0.001]	[0.134]
Residualized measure of the *U.S. News*	1.015**	1.014**	1.015**	1.015**	1.400***
& World Report ranking	[0.002]	[0.002]	[0.002]	[0.002]	[0.0775]
1993	1.254*	1.230*	1.247*	1.230*	1.220*
	[0.117]	[0.125]	[0.123]	[0.125]	[0.12]
1994	1.422**	1.339**	1.395**	1.366**	1.320*
	[0.124]	[0.112]	[0.124]	[0.125]	[0.117]
1995	1.343**	1.293**	1.337**	1.335**	1.241*
	[0.094]	[0.094]	[0.098]	[0.106]	[0.095]
1996	1.299**	1.251**	1.287**	1.242*	1.191+
	[0.110]	[0.107]	[0.113]	[0.116]	[0.116]
1997	1.481**	1.462**	1.476**	1.411**	1.340*
	[0.142]	[0.136]	[0.145]	[0.156]	[0.149]
1998	1.539**	1.566**	1.529**	1.460**	1.366
	[0.161]	[0.152]	[0.176]	[0.188]	[0.184]
Observations	521	534	537	535	516
Number of schools	95	97	97	97	95
Chi-squared statistic	362.55	507.59	386.65	405.54	572.21

[a]The results are reported as incidence rate ratios.
[b]AR1 correlation structure.
[c]Log transformation.
Standard errors in brackets.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, $^{+}p < 0.10$.

Table 5 Negative Binomial Estimation of the Annual Count of University Technology Licenses Using the Residualized Measure of the *Gourman Report* Scores

	Model				
Variable	1[a,b]	2[a,b]	3[a,b]	4[a,b]	5[a,b]
Density of high-technology employees	0.998	0.998	0.998	0.998	0.998*
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Density of licensing universities	0.876*	0.887+	0.877+	0.895+	0.881
	[0.059]	[0.058]	[0.060]	[0.060]	[0.051]
Invention disclosures	1.006**	1.007**	1.006**	1.006**	1.010*
	[0.002]	[0.002]	[0.001]	[0.001]	[0.001]
Disclosures per professional staff	0.996*	0.995*	0.996*	0.997+	0.996*
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]
Industry funding ratio	0.777	0.726	0.749	0.788	0.722
	[0.412]	[0.413]	[0.414]	[0.438]	[0.32]
Medical school	1.142	1.151	1.200	1.219	1.170*
	[0.169]	[0.170]	[0.185]	[0.181]	[0.152]
Licensing revenue/year[c]	1.204**				1.110*
	[0.047]				[0.05]
Past licenses/disclosures[c]		1.064**			1.230*
		[0.013]			[0.068]
Past licensing revenue			1.037**		1.030
(in millions of dollars)			[0.008]		[0.035]
Past licenses yielding income				1.006**	1.20*
				[0.002]	[0.104]
Residualized measure of the	1.723**	1.730**	1.752**	1.726**	1.710**
Gourman Report scores	[0.161]	[0.155]	[0.151]	[0.147]	[0.113]
1993	1.275**	1.270*	1.282**	1.262*	1.220*
	[0.112]	[0.123]	[0.121]	[0.124]	[0.12]
1994	1.432**	1.375**	1.414**	1.382**	1.320*
	[0.122]	[0.112]	[0.119]	[0.121]	[0.117]
1995	1.308**	1.256**	1.298**	1.299**	1.240*
	[0.092]	[0.093]	[0.097]	[0.106]	[0.095]
1996	1.270**	1.225*	1.261**	1.217*	1.190*
	[0.108]	[0.104]	[0.113]	[0.117]	[0.116]
1997	1.416**	1.400**	1.412**	1.353**	1.340*
	[0.135]	[0.124]	[0.138]	[0.147]	[0.149]
1998	1.508**	1.537**	1.503**	1.437**	1.370*
	[0.162]	[0.154]	[0.185]	[0.194]	[0.184]
Observations	549	567	570	568	516
Number of schools	100	103	103	103	95
Chi-squared statistic	383.69	463.15	417.09	431.92	572.21

[a]The results are reported as incidence rate ratios.
[b]AR1 correlation structure.
[c]Log transformation.
Standard errors in brackets.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, $^{+}p < 0.10$.

While our results provide support for economic arguments that past performance at licensing affects licensing activity, they also provide support for sociological explanations about how external perceptions influence interorganizational transactions. Specifically, by demonstrating that prestige has an effect on market transactions over and above the effects of past performance, this study provides evidence of the incomplete relationship between past performance and demand suggested by sociologists and organizational theorists (Podolny 1993).

Demonstrating support for the effect of prestige is important because if external perceptions of organizations are narrow in scope and solely dependent on organizational past performance, then actors can use external perceptions to influence market transactions only in similar settings. However, theories of prestige argue that actors can transfer external perceptions across domain barriers. For example, a university can use the overall external perceptions that accrue from a variety of highly ranked nontechnical departments (such as English, history, etc.) to license more of its inventions.

A second major implication of our results is that prestige helps to overcome problems of market failure, extending research on the social embeddedness of market transactions in a new direction. Prior research (Granovetter 1985, Bradach and Eccles 1989, Powell 1990) has argued that social ties between actors help to overcome the problems inherent in market transactions. Because social ties enhance trust and facilitate information transfer, they overcome information problems that undermine market-based transactions. Unlike past research on social ties, this paper supports a different stream of research on the social embeddedness of markets. Similar to Podolny (1994), our results demonstrate that, under conditions of uncertainty, people often use prestige to make decisions. Because the mechanism through which prestige influences market transactions is different from that of social ties, this study suggests the importance of examining prestige (as well as social ties) to correct undersocialized views of market transactions.

The third major implication of our results is to extend prestige effects to markets for knowledge. Arrow (1962) explained that markets for knowledge-based assets are plagued by problems of uncertainty, indivisibility, and inappropriability. Yet, markets for knowledge are facilitated by prestige. Although organizational theorists have often viewed economic arguments for market failure as undersocialized, they have undertaken little investigation of social mechanisms, like prestige, that overcome failure in markets for knowledge. Because these assets are increasingly important, the absence of research concerning how prestige facilitates knowledge transfer in markets is an important void in organizational conceptions of market behavior.

The fourth major implication of our study has been to provide an organizational explanation for university technology transfer. Although economists have been quick to develop theories to explain technology transfer in the post-Bayh-Dole era, few organizational theorists have sought to explain this phenomenon (an important exception is Etzkowitz 1998). This study provides support for an organizational perspective on university technology transfer. Although economic studies of technology transfer assume that inventions with the best technical specifications are the ones that will be licensed from universities, this study is more in line with the logic of the sociology of technology (e.g., Podolny and Stuart 1995), suggesting that technical attributes alone may be insufficient to explain the likelihood of transfer.

The evidence that prestigious universities are more successful at licensing technology is also consistent with several themes in the sociology of technology. It supports the thesis that technical outcomes are not only a function of objective attributes, but are also a function of the social context in which those activities are embedded (Granovetter 1985, Podolny 1994). In addition, it suggests the idea that technological evolution is socially constructed. As a result, a Matthew effect (Merton 1968) might explain the higher performance of prestigious universities at technology licensing better than the argument that more prestigious universities produce better technology (Henderson et al. 1998). Prestigious universities may be better able to license their inventions than less prestigious universities not because the technologies that they produce are better ex ante, but because the universities that produce them are perceived as more prestigious. Because increased revenues derived from licensing lead to greater likelihood of licensing and greater prestige in following years, over time, an initial prestige effect becomes embedded and strengthens status differentials in a circular flow of advantage to prestigious actors.

An important extension of this idea concerns the contribution of different universities to technical advance in industry. Because firms are more likely to invest in the development of licensed inventions than unlicensed ones, the exploitation of university technology by the private sector is enhanced by the prestige of the school transferring the technology. This pattern suggests that prestigious universities will have a disproportionate influence on the evolution of technology and industry, not because they are necessarily superior creators of technology, but because their prestige facilitates technology transfer. If more prestigious institutions are better able to diffuse knowledge than less prestigious institutions, then inventors from high-prestige institutions and their research will have a disproportionate effect on technological change in society.

Conclusion

This paper demonstrates that, during the period 1991–1998, university prestige increased the rate at which U.S. universities licensed their inventions above the rate predicted by the universities' past licensing performance. By demonstrating empirical support for the effect of prestige over and above the university's past licensing performance, the source of research funding, their rate of invention production, and the resources of the technology licensing offices, these findings provide evidence of prestige effects in market transactions.

We hope that these results encourage future researchers to consider the importance of prestige as a mechanism for overcoming market failure, particularly in the context of markets for knowledge.

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