Benchmarking U.S. University Patent Value and Commercialization Efforts: A New Approach[*]

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Abstract: Despite the significance of patented university research, it is difficult to measure the economic value of their patented inventions and observe the extent to which universities are able to capture such value through patent licensing. Moving beyond assessing commercialization performance by simple statistics, we propose a new approach to benchmarking university patents and commercialization performance based on comparative corporate patent value. Our procedure involves matching university patents to patents granted to public corporations with similar patent characteristics to estimate the "potential value" of these university patents by stock market reactions to matched corporate patent grants. These estimated values of university patents can significantly explain the technology-level licensing data from a leading US research university and the annual licensing income of the Association of University Technology Managers' (AUTM). We also investigate the correlates of university-level potential patent value and suggest avenues for future research.

Keywords: university patents; patent value; patent licensing

JEL classification: G12; L30; O30

1. INTRODUCTION

According to the Association of University Technology Managers' (AUTM) 2018 survey of U.S. university technology transfer operations, its 198 respondents filed over 17,000 patent applications and received about 7,600 patent grants that year.[1] These patents based on university scientific research have generated significant income. For example, approximately $9.56 billion in licensing revenues accrued to participants of the AUTM survey over the 1991-2010 time period (our calculations based on AUTM data). In addition, in 2018 over 1,000 new ventures were formed, and 828 new products based on university research were reported to have been introduced.

Recent examples of influential products based on scientific discoveries from university research include Emory University's HIV drug Emtricitabine, New York University's anti-inflammatory agent, Remicade (to treat rheumatoid arthritis), and the University of Pennsylvania's recent pioneering work in CAR-T immunotherapy. These advances have occurred not just in the life sciences; university-based breakthrough products have been achieved in cryptography (such as the RSA encryption algorithm), computing (autonomous vehicle technologies), and other fields.

Numerous assessments of economic activity based on university research have been generated based on the AUTM survey data (e.g., Huggett, 2017). These assessments and rankings are often based on simple statistics such as the number of patents granted, counts of startups formed or licensing revenues received. While informative, such approaches typically lack a comparative benchmark, making it difficult to gauge whether realized license revenues are "large" or "small".

Compounding the challenge of constructing a comparative benchmark is the issue of valuing intellectual property (IP). Even in the private sector context, estimating the economic value of patents or patent portfolios is notoriously difficult, as observable market transactions of patent sales or licenses are rare (the transfers do not occur regularly, and even when they do, transfers are privately negotiated and may be unrepresentative of the full distribution of patent values). Efforts to estimate the private value of corporate patents have been based on forward citations, corporate

[1] While patenting by U.S. universities occurred as early as the 1920s, the 1980 Bayh–Dole Act (granting universities ownership of discoveries resulting from federally-funded research) is associated with a rise in university patenting, licensing, and commercialization efforts (Henderson et al., 1998; Mowery et al., 2004).

acquisition events, observed patent renewal fees at various stages of the patent lifecycle, or through patent disputes such as litigation.[2] All of these prior efforts at valuation are not contemporaneous to the patent grant event, and are only realized *ex post*. A further complication arises in valuing university patents, as there is a debate about the extent to which academic institutions should be involved in technology commercialization and economic development in addition to its traditional mission of teaching and research (e.g., Bok 2003; Sanberg et al. 2004).

To address the challenge of contemporaneous and broader patent valuation, we base our patent value estimates using stock market reactions to patent grants (following Kogan et al., 2017). We estimate the notional "potential" economic value of university patents as benchmarked to a similar portfolio of patents granted to private firms, after controlling for the effect of private firms' complementary assets (such as marketing, production, and logistics). Interpreting such comparisons requires care, as they traverse social value creation and private value capture. We discuss this issue at length in our concluding section.

To fulfill their misson of public benefit, universities rely on a number of revenue sources including tuition income, endowment returns, philanthropy, and increasingly, commercialization revenues. These sources help further the traditional activities of the modern research university in the domains of teaching and research. Benchmarking IP asset valuation therefore directly impacts financial resources for the mainstream university mission in addition to the increasing call for university involvement in commercialization and economic development more generally (Sanberg et al., 2004).

2. DATA, METHOD & RESULTS

Our method follows a five-step process: construct university patent portfolios (step 1); relate patent characteristics to estimated value in corporate patents (step 2); relate patents of a major U.S. research university to estimated value (step 3); relate AUTM licensing income and start-up to the

[2] For example, Trajtenberg (1990), Harhoff et al. (1999), and Hall et al. (2005) have documented a positive relation between forward citations and market value. Lanjouw (1998) and Schankerman (1998) examine the relation between patent value and patent renewal. Others such as Bhagat et al. (1994) and Lerner (1995), and have examined market reactions to firms' involvement in patent litigation.

estimated value (step 4), and explore the correlates of estimated university patent value (step 5). Our discussion of data, variables, and method below mirrors these steps.

2.1. Construct university patent portfolios (step 1).

We first collect data on patents granted to U.S. universities from 1976 to 2010. Specifically, we manually construct a list of assignees and corresponding identifiers that are U.S. universities, institutes, and foundations. The National Bureau of Economic Research (NBER) patent assignee file (1976-2006) allows us to identify all assignees in the category of "U.S. University."[3] We use other sources to identify research institutes and other entities affiliated with these universities.[4] We also manually search possible names (universities, research institutes, and foundations) in other non-university categories in the NBER patent assignee file and extract related unique identifiers (known as "PDPASS" in the dataset). This process results in a list of 362 U.S. universities which received at least one patent in the sample period. University-PDPASS pairs are listed in Online Table 1.

Based on the university-PDPASS pairs, we construct a dataset of U.S. university patents. We combine the patent and citation data from NBER (Hall et al., 2001), Patent Network Dataverse of Harvard University (Li et al., 2014), and USPTO PatentsView to construct a dataset that includes detailed information on each patent granted to U.S. universities from 1976 to 2010.[5] The resulting sample consists of 77,880 university-linked patents.

These data allow us to construct variables for the following patent characteristics commonly used in the prior literature on (university) patenting: (i) *Quality* is defined as the number of forward citations received by a patent within five years after its grant year (Trajtenberg, 1990;

[3] For example, Harvard University has several different names in this category, including "Harvard College," "Harvard President & Fellows of Harvard College," "Harvard Univ. Office of Tech Transfer".
[4] Some university patents are assigned to categories other than universities, such as institutes (e.g., university hospitals) or research corporations affiliated to universities. We use the *U.S. News National University Rankings* and *Top 100 Worldwide Universities Granted U.S. Utility Patents* published by the National Academy of Inventors to help identify universities and their affiliates in our sample.
[5] The NBER database is available for download at http://www.nber.org/patents/; Patent Network Dataverse of Harvard University: https://dataverse.harvard.edu/dataverse/patent; and the USPTO PatentsView database: http://www.patentsview.org/web/.

Sampat and Ziedonis, 2004; Hall et al., 2005);[6] (ii) *Generality* is defined as one minus the Herfindahl-Hirschman Index (HHI) of patent subcategory citations received from forward citing patents (Trajtenberg et al., 1997; Hall et al., 2001); (iii) *Originality* is defined as one minus the HHI of patent subcategory citations of the focal patent (Trajtenberg et al., 1997; Hall et al., 2001); (iv) *Basicness* is defined as the ratio of the number of references to prior non-patent documents divided by the total references in the focal patent, which reflects patent dependence on scientific and academic knowledge (Fleming and Sorenson, 2004);[7] (v) *Claims* denotes the number of claims of each granted patent, which defines the coverage and scope of a patent (Lerner, 1994); and (vi) *IntlFamily* is defined as an indicator if the patent belongs to an international patent family.[8]

We report the descriptive statistics of these measures in Table 1, comparing university patents in our sample with patents assigned to U.S. public firms.[9] University patents receive more forward patent citations (5.55 vs. 4.97) on average, are more general (0.44 vs. 0.38), are more original (0.42 vs. 0.36), are more "basic" (0.47 vs. 0.11), contain more claims (20.39 vs. 16.31), and less likely to be affiliated with international families (0.49 vs. 0.57), compared to corporate patents.[10] These differences are all statistically significant, largely consistent with the literature (e.g., Trajtenberg et al., 1997; Henderson et al., 1998), and suggest high university patent commercial potential.

2.2. Relate patent characteristics to financial valuation in corporate patents (step 2).

We collect the patent value of corporate patents (i.e., patents assigned to public firms) from Kogan et al. (2017).[11] They calculate the value of a patent granted to a U.S. public firm using stock market reaction to the announcement of the patent grant. We proxy a public firm's patent value with the 3-

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[6] Lanjouw and Schankerman (2004) find that forward citations explain 48% of the variation of their patent quality index. Harhoff et al. (1999) and Hall et al. (2005) show that forward citations are associated with higher patent valuation from survey and stock price data, respectively.

[7] This variable is similar to the "Science" measure of Trajtenberg et al. (1997).

[8] We thank an anonymous reviewer for the suggestion of incorporating the effects of international patent family. We collect the data from the PATSTAT database.

[9] Our corporate patents include 1,361,771 patents granted to assignees in U.S. public firms (i.e., assignees with GVKEY identifiers) in the NBER assignee file from 1976-2010.

[10] Consistent patterns are observed in different sample periods (Panel A in Online Table 2), in distribution (Panel B in Online Table 2), and in different technology subcategories (Panel D to Panel I in Online Table 2). We also observe that university patents are concentrated in certain technology fields such as Drugs, Chemicals, and Surgery and Medical Instruments, as shown in Panel C of Online Table 2.

[11] The patent value data is downloadable via: https://iu.app.box.com/v/patents.

day appreciation of market capitalization of this firm around the grant date of a patent, adjusted for measurement noise and various fixed effects. The details of the estimation are provided in the Online Appendix (section 1). The estimated patent value is also inflation-adjusted based on the consumer price index, CPI (the index is normalized as 1 for years 1982-1984).[12]

The estimated value of corporate patents results from both technological merit as well as corporate complementary assets such as marketing and production. We seek to disaggregate these two effects since universities do not possess the latter asset category. We regress the natural logarithm of one plus each corporate patent value (in millions) on its patent characteristics (*Quality*, *Generality*, *Originality*, *Basicness*, *Claims*, and *IntlFamily*) as well as the following firm characteristics of its assignee:[13] *R&D intensity*, *Investment intensity*, *SG&A intensity*, *Ads intensity*, and *M/B*. We also include the subcategory-year joint fixed effects to control for time-varying specific trends of different technology subcategories. Table 2 shows that patent quality, generality, basicness, and international patent family affiliation are positively associated with estimated patent value based on 450,329 patents granted to U.S.-listed firms.

2.3. Relate patents of a major U.S. research university to financial value (step 3).

In this step, we use the coefficients on patent characteristics estimated from step 2 to "fit/extrapolate" the value for university patents.[14] To assess this estimated value for university patent, we first make use of the complete patent licensing records of a major U.S. research university (step 3a) and then examine the extent to which the estimated university patent value explains licensing income (step 3b).

2.3.1. Licensing records from a major U.S. research university (step 3a).

[12] Under the efficient market hypothesis, the stock market should reflect the value change due to patent grants in real time. Kogan et al.'s (2017) market reaction-based valuation approach follows Austin (1993) and is consistent with the valuation of patent litigation of Bhagat et al. (1994), Lerner (1995), and Bessen and Meurer (2012) and the valuation of new products of Chen et al. (2005). An alternative way of evaluating the value of corporate patents is to collect the disclosed licensing contracts by public firms (see Kankanhalli et al., 2019); however, even those disclosed contracts are subject to selection issues and redactions.

[13] *R&D intensity* is the ratio of R&D expenditure over total assets to account for innovation input, *Investment intensity* is the ratio of capital expenditure over total assets to account for physical investment input, *SG&A intensity* is the ratio of selling, general & administrative expense over total assets to account for general human capital input, *Ads intensity* is the ratio of advertisement expenses over total assets to account for marketing input, and *M/B* is the ratio of market equity over book equity to account for the growth opportunities perceived by the stock market.

[14] For each university patent, we estimate its patent value by multiplying its patent characteristics by coeffcients from Table 2, model (2).

The dataset includes 7,797 unique technologies and 779 licensing contracts from 1974 to 2018. Among unique technologies, 2,246 are licensed and 5,551 remain unlicensed. Not all technologies in the sample are patented. A licensing contract (i.e., agreement) includes one or more technologies with related patent numbers (if associated patent applications were filed and granted), licensing status, execution date, license fee, maximum royalty rate, exclusivity in licensing or not, lifetime revenue, technology fields, etc. There are on average 2.88 technologies included in a licensing contract. Among the 779 licensing contracts, 227 are exclusive, 12 are co-exclusive, and 540 are non-exclusive. The licensing revenue reflects the total amount of cash received based on licensing, royalties, or equity.[15] According to our interview with the university technology transfer director, the majority of licenses with startups do *not* include an equity component at this university; thus, lifetime revenue accrues primarily from license fees and royalties.

We focus on 765 licensed patents and 821 unlicensed patents from 1976 to 2010 and calculate a patent's licensing revenue as the lifetime revenue of the contract divided by the number of patents involved.[16] Because patents in our data have different "lifetimes" to be licensed, truncation bias is a potential concern and may thus underestimate the lifetime revenue.[17] Our dataset also includes unlicensed patents; their licensing revenue is assumed to be zero if the patent is never observed to generate positive revenue.[18] We discuss the summary statistics of the licensed and unlicensed patents in the Online Table 3.

2.3.2. Relate university patents to financial value through patent characteristics (step 3b).

We now cross-check our valuation method by comparing the estimated patent values to patent licensing revenue in the 1,586 patents (765 licensed patents and 821 unlicensed patents) of a major U.S. research university. In particular, we regress the natural logarithm of one plus the

[15] Note that all revenue income recorded at this level is inclusive of the amount which will be shared with the inventor and the inventor's department (which together represent an average of about 30% of the gross licensing revenues at this institution).
[16] Note that one patent may belong to two or more different licensing contracts. We treat these cases as different patents due to different contract condtions.
[17] For example, the lifetime revenue from a patent that was recently granted could be zero if it has not been licensed or may be underestimated as we can only observe its income until 2017. We take a conservative approach and do not extrapolate or estimate the future income from those patents that are subject to such truncation bias.
[18] This assumption may unavoidably underestimate the value of university patents for several reasons: (1) some unlicensed patents may have industrial value but remain unlicensed; and (2) patents may have been exploited by firms without the university receiving royalties if the university was not agressive in enforcing its IP rights.

patent lifetime revenue on the natural logarithm of one plus the estimated patent value (*PatVal*), controlling for other patent and contract characteristics, the joint fixed effects for technology field (by subcategory defined in Hall et al. (2001)) and year. As shown in Table 3, our estimated patent value is significantly and positively associated with the actual realized licensing revenue in all specifications. The fact that our estimated patent value explains realized licensing revenue suggests that our method indeed captures variation in university patent values. Taking Column (3) as an example, the coefficient on *PatVal* is 0.288 when we do not include the intercept term, which implies that a patent worth $1 million is associated with $0.288 million of licensing income on average. As a result, Table 3 suggests that the focal university realizes approximately 21.5-28.8% of the total private value of corporate patents with similar patent characteristics.

2.4. Relate AUTM licensing income and start-up to financial value (step 4).

Similar to step 3, we use the coefficients on patent characteristics estimated from step 2 to "fit/extrapolate" the value for university patents for all universities in the AUTM record. We use a sample of 167 AUTM-member universities reporting the annual university-level license income and the number of startups formed from the AUTM annual reports from 1991 to 2010.[19] To understand to what extent a university's estimated patent value explains its total license income (and start-up) spanning multiple years, we estimate a cross-sectional regression that regresses universities' time-series average of annual license income on the time-series average of estimated patent value, *Average PatVal Capital*.[20] We report the regression estimations in both a linear form and a log form in Table 4 Panel A. We find that the coefficients on *Average PatVal Capital* are significant in all specifications, suggesting that the estimated patent value explains university-level license income. Taking Column (1) as an example, the coefficient on *Average PatVal Capital* is 0.156. This implies that an increase of $1 million worth in a university's new patents correlates

[19] We use the CPI to adjust all annual licensing incomes to the level of 1982-1984. In this sample, the average, median, and standard deviation of annual license income (in millions) are 4.50, 0.69, and 16.75, respectively. Moreover, the average, median, and standard deviation of the number of startups formed are 2.84, 1.00, and 4.51, respectively.

[20] First, we define a university's patent value in year t as the sum of estimated values of all patents granted to the university in year t. The average, median, and standard deviation of estimated university patent value (in millions) are 10.74, 4.89, and 19.34, respectively. We then calculate the time-series average of each university's patent value to be the main explanatory variable, *Average PatVal Capital*, in Table 4. Each university-year observation is included in our regression sample for Table 4 when the university appears in the AUTM report in that year. In the 2,109 observations of university-year observations, we impose the missing license income of 36 observations (or 1.71% of the sample) to be zero.

with an increase of \$0.16 million worth in a license income stream on average. This estimate suggests that AUTM universities realize 16% of the estimated value based on publicly-held corporate patents with similar patent characteristics as those from our sample of universities.

In Table 4 Panel B, we examine the relation between our estimated university patent value and the number of startups formed at the university level. Similar to the approach used in Panel A, we use the time-series average of the discounted number of startups created by the university as the dependent variable.[21] Results reported in Panel B are also based on cross-sectional regressions, in which we regress the time-series average number of startups created by a university on the university's *Average PatVal Capital*. Results suggest a positive and statistically significant relation and confirm the intuition that more technologically capable universities create more new businesses. In terms of economic magnitude, Column (1) suggests that 3 (=0.1496*19.34) more startups will be formed in a year if the value of a university's patent portfolio increases by one standard deviation. Such an estimate is substantial given that sample average and median are 2.84 and 1.00, respectively, per year.

2.5 Explore the correlates of university patent value (step 5).

Finally, we discuss the university characteristics and inputs that correlate with patent value creation. After demonstrating that university patent value is correlated with both patent licensing and startup formation, we estimate a production function of university patent value to understand what inputs are crucial to valuable university patents. We collect several university variables as "inputs".[22] The first set includes five basic university characteristic variables including the five-year cumulative inflation-adjusted R&D expenditure (*R&D*, with a 20% obsolescence rate per year), the number of full-time faculty members (*Faculty*), a dummy variable indicating whether the sample university is a Carnegie-ranked research university or not (*Carnegie*), the full-time equivalents (*FTE*) in technology transfer office in that year, and a dummy variable indicating whether the sample

[21] Each university-year observation is included in our regression sample for Table 4 when the university appears in the AUTM report in that year. We assume that a missing value for startups in the report corresponds to a zero value (this occurs in 709 of the 2,109 total university-year observations).

[22] These input variables are considered because they are publicly available and have been discussed in Siegel and Wright (2015).

university has a technology transfer office in that year (*TTO*). We also consider six additional university characteristics, including five-year cumulative NSF grants (*NSF*, with a 20% obsolescence rate per year), five-year cumulative NIH grants (*NIH*, with a 20% obsolescence rate per year), age of a sample university (*Age*), a dummy variable indicating whether the sample university has a medical school or not (*MedicalSchool*), a dummy variable indicating whether the sample university has a business school or not (*BusinessSchool*), and a dummy variable indicating whether the sample university is a member of the Ivy League or not (*IvyLeague*).[23]

Table 5, Panel A reports the cross-sectional correlation matrix of these university characteristics. Not surprisingly, some variables are highly correlated. For example, the correlation coefficient between R&D expenditure and the number of full-time faculty (number of full-time equivalents) is 0.89 (0.92).

We then regress the estimated potential value of all patents applied by (and later granted to) a university in a year on several university characteristics in a log-log form assuming a Cobb-Douglas production function of patent value.[24] Similar to Table 4, we implement cross-sectional estimation by OLS regressions of the time-series average of university patent value on the time-series averages of all input variables. To avoid multi-collinearity, we first include these characteristics in regressions one-by-one in Columns (1) to (11) in Panel B. We find that almost all (except the business school dummy) are positively and significantly correlated with the output of patent value. When we include the five basic university characteristic variables together in one regression, we find that only R&D expenditure, the number of full-time faculty members, and the number of full-time equivalents in the TTO are statistically significant in Column (12). In terms of economic magnitude, a doubling of R&D expenditure, the number of full-time faculty, and TTO employees, is associated with patent value increases of 50%, 24%, and 37%,

[23] *PatentVal*, *R&D*, *NSF*, and *NIH* are in $ millions and adjusted for inflation. *R&D* and *FTE* come from the annual reports of the Association of University Technology Managers (AUTM) 1991-2010. *Faculty*, *NSF*, and *NIH* are collected from the Carnegie reports (1994, 2000, 2005, and 2010). We assign the number of faculty members in 1994 to all years before 1994, and apply this rule to estimate the number of faculty for each university in all other years. All other variables are collected from online searches.

[24] We also consider a non-parametric Data Envelpement Analyses (DEA) estimation in the Online Table 4, following Thursby and Kemp (2002), Thursby and Thursby (2002), and Siegel, Waldman, and Link (2003).

respectively, holding other variables fixed. The coefficients on *Carnegie, TTO,* and *Medical School* become insignificantly negative in Column (12), likely due to multi-collinearity. When we include all variables together in Column (19), we find that Ivy League affiliation also positively explains patent value output.

3. DISCUSSION AND CONCLUSION

The degree to which universities should be in the business of commercially translating their scientific discoveries through patenting, licensing and startup efforts has long been, and continues to be, debated (e.g., Etzkowitz, 1994; Bok, 2003; Mowery et. al., 2004; Siegel and Wright, 2015). For example, some U.S. public universities have been under budget pressure and may have to justify their contribution to local communities and economies. Within such debates, our methodology sets a benchmark to estimate economic values associated with university patenting, thus offering a tool to administrators of universities a way to benchmark their commercialization efforts. In this section we interpret our results, discuss implications and limitations, and offer directions for future research.

The seminal "profiting from innovation" framework by Teece (1986) investigates conditions associated with imperfect organizational value capture, and provides insights that can put our results in perspective. Figure 1 depicts the relationship between economic value generation and its "capture." Panel A in this figure plots private value creation (x-axis) versus private value capture (y-axis). A 45-degree line from the origin represents complete capture of the value generated by the innovator (under perfect appropriability and control of organizational complementary assets). Departures from this condition (according to Teece, 1986) result in imperfect value capture by the innovator (as depicted by the dotted line below the 45-degree line).

Panel A of Figure 1 represents the estimation we undertake: private economic value capture on the horizontal axis and private economic value creation on the vertical axis. We accomplish this by asking the counterfactual question: what would be the degree of value capture if private organizations held a similar patent portfolio as U.S. research universities? However, universities do not possess the downstream organizational complementary assets Teece identifies, such as sales, marketing and distribution capabilities necessary for commercialization. This difference between corporate organizations and universities is one important reason for diminished value capture by universities (our analysis in Table 2 aims to adjust for these differences). A second reason for a shallower value capture slope in Panel A is due to potential frictions in the market for technology transfer (again, stemming from the fact that universities are typically not self-commercializers, with the exception of startup venture creation for some universities). Such frictions stem from: (1) asymmetric information (sellers of technology, universities, may possess more information than the buyers (potential licensees) about the technology and the circumstances under which it works well, for example; and (2) the "embryonic" nature of many university discoveries, which requires further elaboration and proof of commercial development. As a result, the fraction of estimated economic value captured by university licensing revenues represents the proportion of the total value that is generated from "upstream" research by the university which may be dampened both by universities' lack of complementary assets for commercialization as well as the need to transfer the IP to commercializers.

This narrow interpretation of private economic value generation and capture neglects an important caveat. The missions of research universities within the U.S. have traditionally included numerous social goals including teaching, the wide dissemination of research results, and local economic development for the public good (Rosenberg and Nelson, 1994). As a result, our analysis underestimates value creation from commercializing university discoveries by an unknown extent. Panel B represents a more accurate picture of value capture in our university setting - *social* economic value capture versus *social* economic value creation.

Estimating social value creation and capture would require us to include economic spillovers created from academic research activities in enhancing the human and knowledge capital of faculty members, lab researchers, and students, all of which are positively associated with future economic payoffs. Measuring the value of such spillovers would be challenging, however, even if they were more narrowly construed, such as those associated solely with the commercialization process. These analyses would require judgments regarding time horizon and would have to value difficult-to-measure constructs such as experience as applied to a range of human capital development (Åstebro et al., 2012), as well as adjustments (and values) associated with academic trajectories.[25] The challenges raised by such an undertaking suggest an analysis in the style of Trajtenberg's (1990) estimation of the social economic value of computed tomography (CT) scanner patents. One possibility in our setting which mirrors's the spirit of the Trajtenberg (1990) approach is to use the estimated values of all patents that cite one prior patent to reflect the social value of that prior patent. We conduct such an analysis in the Online Appendix, Table 5.

Future work would also benefit from calibrating a patent-level empirical model of valuation based on a broader spectrum of data, including differences in university technology transfer policies outside of the U.S. context. Our effort is based on commercialization outcomes at a single U.S. research university. While this university is a leading research institution and prolific patenter and licensor, its practices and outcomes may not be be fully representative of all academic institutions (especially those outside the U.S.), though we are unaware of any specific policies which materially differ in its university's technology transfer policy as compared to its U.S. peers. Nevertheless, the ideal empirical model would be calibrated against a nationally and internationally representative dataset of all licensing outcomes (both licensed and unlicensed).

The economic incentives shaped by university patent valuation has a number of university and public policy implications. Recent research has examined whether academic founders might alter their commercialization behavior in response to the financial incentive environment on IP ownership (Lach and Schankerman, 2008; Hvide and Jones, 2018; Oullette and Tutt, 2020). While IP ownership and financial incentive sharing policies are not the main subject of our analysis, financial incentives to academic inventors or universities weakened by less economic value capture may shape behavior and subsequently affect the net social benefit from commercializing or spilling over university technology. As we acknowledge above, we are unable to analyze the overall social welfare effects since it requires valuing academic research effort across commercial and research domains. We hope that our preliminary analysis of university-level patent value correlates helps

[25] Counterfactuals (e.g., foregone or added social value from potentially altering the trajectory of academic careers) would also need to be considered.

guide future policy-relevant research.

The goal of our benchmarking approach is to provoke a conversation among university administrators, technology transfer officers, and policy makers regarding commercializing university IP assets. Such a conversation would benefit from a benchmarking exercise beyond the summary (yet simplistic) metrics by which university commercialization performance is often judged. Clearly a complete understanding and a fair assessment of the economic value generated and captured by universities of their scientific discoveries through patents requires further research and data beyond this initial foray. Nevertheless, as the commercialization of university research increases in significance, the tools and methodologies by which we assess such efforts must keep pace.

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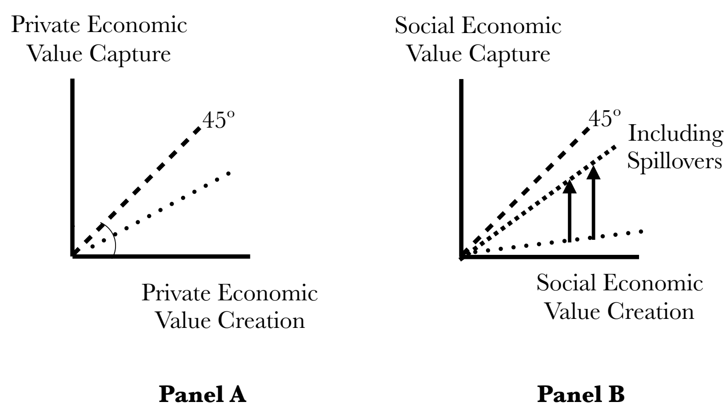
Figure 1: Conceptual Framework of Our Analysis



Tables

Table 1: Summary Statistics of Characteristics of Patents Granted to Public Firms and Universities in the U.S.

We compare the distribution of patent quality (the citations received five years after the patent is granted), patent generality (one minus the HHI of citations received from other patents over patent subcategories), patent originality (one minus the Herfindahl-Hirschman Index (HHI) of citations given to other patents over patent subcategories), patent basicness (the ratio of the number of references to prior "non-patent documents" divided by the total references), and number of claims of patents granted to public firms and universities. The definitions of generality, originality, and basicness follow Trajtenberg et al. (1997). ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively, when comparing the mean characteristics of universities' patents with those of public firms' patents. Sample period: 1976-2010.

	Universities						Public Firms					
	Quality	Generaility	Originality	Basicness	Claims	Intl Family	Quality	Generaility	Originality	Basicness	Claims	Intl Family
Mean	5.55***	0.44***	0.42***	0.47***	20.39***	0.49***	4.97	0.38	0.36	0.11	16.31	0.57
Median	2.00	0.50	0.49	0.50	17.00	0.00	2.00	0.40	0.36	0.00	14.00	1.00
Standard Deviation	10.31	0.32	0.34	0.35	17.34	0.50	9.06	0.32	0.33	0.20	13.03	0.49
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
1st Percentile	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00
5th Percentile	0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	3.00	0.00
25th Percentile	0.00	0.00	0.00	0.12	9.00	0.00	1.00	0.00	0.00	0.00	8.00	0.00
75th Percentile	6.00	0.69	0.69	0.79	26.00	1.00	6.00	0.66	0.66	0.14	21.00	1.00
95th Percentile	22.00	1.00	1.00	1.00	51.00	1.00	19.00	0.92	0.91	0.56	39.00	1.00
99th Percentile	50.00	1.00	1.00	1.00	84.00	1.00	43.00	1.00	1.00	0.89	63.00	1.00
Maximum	213.00	1.00	1.00	1.00	642.00	1.00	539.00	1.00	1.00	1.00	868.00	1.00
#Obs	77,880	77,880	77,880	77,880	77,880	77,880	1,361,771	1,361,771	1,361,771	1,361,771	1,361,771	1,361,771

Table 2: Patent Characteristics and Corporate Patent Value.

OLS regressions estimating the relation between patent and firm characteristics and patent value are reported. Excluding observations of missing corporate characteristics, our sample contains 450,329 patents of U.S.-listed firms. The dependent variable is the natural logarithm of one plus the patent value estimated by Kogan et al. (2017). The independent variables include six patent characteristics in natural logarithm (quality, generality, originality, basicness, number of claims, and international family dummy), and five firm characteristics related to complementary assets in natural logarithm (R&D intensity, investment intensity, SG&A intensity, Ads intensity, and M/B). R&D intensity is the ratio of R&D expenditure over total assets. Investment intensity is the ratio of capital expenditure over total assets. SG&A intensity is the ratio of SG&A expenses over total assets. Ads intensity is the ratio of advertisement expenses over total assets. M/B is the ratio of market equity over book equity. We also include the subcategory-year joint fixed effects to control for time-varying specific trends of different technology subcategories. Patent value is in $ millions and adjusted for inflation. All variables are winsorized at their 1% and 99% percentiles. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively.

	(1) Not control for complementary assets	(2) Control for complementary assets
Quality	0.0477***	0.0423***
	(0.0016)	(0.0015)
Generality	0.0374***	0.0416***
	(0.0063)	(0.0058)
Originality	-0.0216***	-0.0210***
	(0.0060)	(0.0055)
Basicness	0.3232***	0.3110***
	(0.0092)	(0.0084)
Claims	0.0120***	0.0399***
	(0.0020)	(0.0019)
IntlFamily	-0.0005	0.0232***
	(0.0039)	(0.0036)
R&D Intensity	----	2.8461***
	----	(0.0427)
Investment Intensity	----	-1.4698***
	----	(0.0405)
SG&A Intensity	----	-3.9931***
	----	(0.0207)
Ads Intensity	----	8.4344***
	----	(0.0593)
M/B	----	0.7628***
	----	(0.0031)
Observations	450,329	450,329
R-squared	0.2740	0.3968
SubCat-Year FE	YES	YES

Table 3: Patent Innovation Value and Actual University Patent Revenue.

OLS regressions examining the explanatory power of estimated patent innovation value for realized patent revenue are reported. Our sample of patent revenue, including 765 licensed and 821 unlicensed patents, is obtained from a large patent office in a prominent U.S. university. The dependent variable is the natural logarithm of one plus the patent lifetime revenue. Lifetime revenue is split evenly to each intellectual property item in the same licensed agreement. If a patent is not licensed, we set its lifetime revenue as zero. Lifetime revenue and estimated patent value are in $ millions and adjusted for inflation. The independent variable of interest is the natural logarithm of one plus the estimated patent value (PatVal). To calculate PatVal, we first adopt regression model (2) in Table 2 and estimate the coefficients on patent characteristics. We then input the coefficient estimates and patent characterstics of each university patent and compute its PatVal. PatVal is set to be zero if it is estimated as negative. We also control for patent characteristics, such as patent generality, originality, basicness, number of claims, international familty, and patent sub-category by grant year fixed effects, and license agreement characteristics, such as a dummy indicating whether the patent is licensed or not and a dummy indicating whether the agreement is exclusive or not. All variables are winsorized at their 1% and 99% percentiles. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)
PatVal	0.2147***	0.4648***	0.2883**
	(0.0453)	(0.1564)	(0.1466)
Cite5yr	----	-0.0007	-0.0008
	----	(0.0010)	(0.0009)
Generality	----	-0.0035	-0.0120
	----	(0.0155)	(0.0144)
Originality	----	-0.0283**	-0.0286**
	----	(0.0129)	(0.0120)
Basicness	----	-0.0823**	-0.0569*
	----	(0.0353)	(0.0331)
#Claims	----	-0.0009*	-0.0007
	----	(0.0005)	(0.0005)
IntlFamily	----	0.0341***	0.0226***
	----	(0.0085)	(0.0080)
Licensed Dummy	----	----	0.0360***
	----	----	(0.0093)
Exclusivity	----	----	0.0911***
	----	----	(0.0094)
Constant	-0.0140	----	----
	(0.0104)	----	----
Observations	1,586	1,586	1,586
R-squared	0.2479	0.2729	0.3740
F statistics	22.43***	9.10***	29.35***
SubCat-Year FE	YES	YES	YES

Table 4: Association between Estimated Patent Value and License Income & Startups Formed across U.S. Universities.

In this table, we examine the explanatory power of our estimated university patent value (Average PatVal Capital) for license income and number of startups formed at the university level. To do so, we run cross-sectional regressions of future license income (in Panel A) and future number of startups formed (in Panel B) on the capital of patent value. We define a university's capital patent value in year *t* as the sum of estimated values of all patents granted to the university in year *t*. We calculate the time-series average of each university's patent value to be the main explanatory variable, Average PatVal Capital. We then calculate the time-series average of each university's annual license income to be the dependent variable. Last, we regress universities' average total license income on Average PatVal Capital in Panel A. In Panel B, we use a similar approach to calculate the total number of startups per year. License income and patent value are in $ millions and adjusted for inflation. The data of license income and number of startups formed are from the annual reports of the Association of University Technology Managers (AUTM) 1991-2010. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively.

Panel A: Total License Income		
	(1)	(2)
Average PatVal Capital	0.1563***	0.5349***
	(0.0159)	(0.0391)
Constant	0.3359	-0.3189***
	(0.2746)	(0.0740)
Obs	167	167
R2	0.3694	0.6508
Specification	Linear-Linear	Log-Log
Panel B: Startups Formation		
	(1)	(2)
Average PatVal Capital	0.1496***	0.5059***
	(0.0074)	(0.0273)
Constant	0.9672***	0.1291**
	(0.1275)	(0.0518)
Obs	167	167
R2	0.7136	0.6750
Specification	Linear-Linear	Log-Log

Table 5: Production Function of Patent Value in U.S. Universities

After finding that university patent value is economically relevant to both patent licensing and startup formation, we analyze the production function of patent value to analyze what inputs are important correlates of valuable patents. The dependent variable *PatVal* is the total value of patents applied for (and later granted to) a university. We consider five basic university characteristic variables, including five-year cumulative R&D expenditures (*R&D*, with a 20% obsolescence rate per year, following Chan et al. (2001)), the number of full-time faculties (*Faculty*), a dummy variable indicating whether the sample university is a Carnegie-ranked research university or not (*Carnegie*), and the full-time equivalents (*FTE*) in a technology transfer office (*TTO*). We also consider six additional university characteristics variables, including five-year cumulative NSF grants (*NSF*, with a 20% obsolescence rate per year), five-year cumulative NIH grants (*NIH*, with a 20% obsolescence rate per year), age of a sample university (*Age*), a dummy variable indicating whether the sample university has a medical school or not (*MedicalSchool*), a dummy variable indicating whether the sample university has a business school or not (*BusinessSchool*), and a dummy variable indicating whether the sample university is a member of the Ivy League or not (*IvyLeague*). Panel A reports the correlation among all variables. In Panel B, we report cross-sectional OLS regressions in a log-log form to estimate the Cobb-Douglas production function of patent value in universities:

$$ln(PatVal_i) = Constant + \beta_1 \cdot ln(R\&D_i) + \beta_1 \cdot ln(Faculty_i) + \beta_3 \cdot Carnegie_i + \beta_4 \cdot TTO_i + \beta_5 \cdot FTE_i + \beta_6 \cdot ln(NSF_i) + \beta_7 \cdot ln(NIH_i)$$
$$+\beta_8 \cdot ln(Age_i) + \beta_9 \cdot MedicalSchool_i + \beta_{10} \cdot BusinessSchool_i + \beta_{11} \cdot IvyLeague_i + ln(\varepsilon_i).$$

All variables are averaged across sample years for each university. *PatVal*, *R&D*, *NSF*, and *NIH* are in $ millions and adjusted for inflation. *R&D* and *FTE* come from the annual reports of the Association of University Technology Managers (AUTM) 1991-2010. *Faculty*, *NSF*, and *NIH* are collected from the Carnegie reports (1994, 2000, 2005, and 2010). All other variables are collected from online searches. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively.

(Table 5 continued)

Panel A: Correlation Matrix											
	R&D	Faculty	Carnegie	FTE	TTO	NSF	NIH	Age	Medical	Business	Ivy
R&D	1	----	----	----	----	----	----	----	----	----	----
Faculty	0.89***	1	----	----	----	----	----	----	----	----	----
Carnegie Research	0.30***	0.31***	1	----	----	----	----	----	----	----	----
FTE	0.92***	0.90***	0.24***	1	----	----	----	----	----	----	----
TTO	0.08	0.10	0.05	0.06	1	----	----	----	----	----	----
NSF	0.83***	0.89***	0.20**	0.92***	0.07	1	----	----	----	----	----
NIH	0.90***	0.81***	0.23***	0.89***	0.07	0.81***	1	----	----	----	----
Age	0.14*	0.17**	0.22***	0.11	0.11	0.07	0.23***	1	----	----	----
Medical School	0.24***	0.22***	0.24***	0.21***	-0.05	0.15*	0.32***	0.19**	1	----	----
Business School	0.06	0.11	0.26***	0.07	0.10	0.07	0.01	-0.04	-0.07	1	----
Ivy League	0.09	0.09	0.07	0.07	0.04	-0.01	0.14*	0.52***	0.10	-0.18**	1

(Table 5 continued)

Panel B: Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
R&D	0.8655***	----	----	----	----	----	----	----	----	----	----	0.4975***	0.4985***	0.4695***	0.4845***	0.5139***	0.4699***	0.4753***	0.4321***
	(0.0494)	----	----	----	----	----	----	----	----	----	----	(0.1013)	(0.1019)	(0.1120)	(0.1066)	(0.1035)	(0.1020)	(0.1019)	(0.1154)
Faculty	----	0.9245***	----	----	----	----	----	----	----	----	----	0.2358*	0.2398*	0.2360*	0.2472**	0.2409**	0.2686**	0.2160*	0.2339*
	----	(0.0808)	----	----	----	----	----	----	----	----	----	(0.1205)	(0.1238)	(0.1202)	(0.1209)	(0.1206)	(0.1181)	(0.1202)	(0.1197)
Carnegie Research	----	----	1.2947***	----	----	----	----	----	----	----	----	-0.2031	-0.2044	-0.2031	-0.2419	-0.2042	-0.1499	-0.1802	-0.1416
	----	----	(0.1985)	----	----	----	----	----	----	----	----	(0.1718)	(0.1727)	(0.1723)	(0.1801)	(0.1722)	(0.1811)	(0.1754)	(0.1957)
FTE	----	----	----	1.0411***	----	----	----	----	----	----	----	0.3656**	0.3693**	0.3540**	0.3574**	0.3793***	0.3645**	0.3808**	0.3706**
	----	----	----	(0.0796)	----	----	----	----	----	----	----	(0.1479)	(0.1540)	(0.1489)	(0.1498)	(0.1430)	(0.1488)	(0.1476)	(0.1509)
TTO	----	----	----	----	0.7860**	----	----	----	----	----	----	0.1523	0.1567	0.1253	0.1152	0.1090	0.1854	0.1314	0.0406
	----	----	----	----	(0.3170)	----	----	----	----	----	----	(0.1341)	(0.1362)	(0.1464)	(0.1243)	(0.1329)	(0.1808)	(0.1377)	(0.1864)
NSF	----	----	----	----	----	0.8629***	----	----	----	----	----	----	-0.0108	----	----	----	----	----	0.0264
	----	----	----	----	----	(0.0734)	----	----	----	----	----	----	(0.0836)	----	----	----	----	----	(0.0810)
NIH	----	----	----	----	----	----	0.4959***	----	----	----	----	----	----	0.0342	----	----	----	----	0.0577
	----	----	----	----	----	----	(0.0476)	----	----	----	----	----	----	(0.0375)	----	----	----	----	(0.0403)
Age	----	----	----	----	----	----	----	1.0836***	----	----	----	----	----	----	0.1555	----	----	----	-0.0141
	----	----	----	----	----	----	----	(0.2523)	----	----	----	----	----	----	(0.1609)	----	----	----	(0.1664)
Medical School	----	----	----	----	----	----	----	----	0.9683***	----	----	----	----	----	----	-0.2000	----	----	-0.2746**
	----	----	----	----	----	----	----	----	(0.2185)	----	----	----	----	----	----	(0.1228)	----	----	(0.1201)
Business School	----	----	----	----	----	----	----	----	----	-0.1138	----	----	----	----	----	----	-0.3921	----	-0.2504
	----	----	----	----	----	----	----	----	----	(0.4141)	----	----	----	----	----	----	(0.2801)	----	(0.2672)
Ivy League	----	----	----	----	----	----	----	----	----	----	1.5102***	----	----	----	----	----	----	0.6482***	0.6341***
	----	----	----	----	----	----	----	----	----	----	(0.3231)	----	----	----	----	----	----	(0.1850)	(0.2076)
Constant	-2.9508***	-3.4141***	0.3590**	-0.1248	0.5485*	0.3467***	-0.3223	-3.9401***	0.6477***	1.4162***	1.2331***	-2.8502***	-2.8712***	-2.7851***	-3.5207***	-2.7953***	-2.5863***	-2.6928***	-2.2300**
	(0.2622)	(0.4377)	(0.1615)	(0.1429)	(0.2981)	(0.1301)	(0.1962)	(1.2287)	(0.1844)	(0.3994)	(0.1063)	(0.4935)	(0.5219)	(0.5131)	(0.8232)	(0.4829)	(0.5625)	(0.4914)	(0.9367)
#Obs	158	147	158	158	158	158	158	158	158	158	158	147	147	147	147	147	147	147	147
R2	0.7508	0.5626	0.1885	0.7170	0.0109	0.4371	0.4827	0.1110	0.1169	0.0004	0.0632	0.7992	0.7992	0.8001	0.8011	0.8034	0.8041	0.8115	0.8214

Online Appendix

Benchmarking U.S. University Patent Value and Commercialization Efforts: A New Approach

1. Patent Value Estimation Technique of Kogan et al. (2017)

We use estimates of the value of patents granted to U.S. public firms to proxy for the value of patents granted to U.S. universities. First, we use the economic value of each patent (*PatVal*) assigned to a public firm estimated by Kogan et al. (2017), which is the 3-day change in market capitalization of this firm around the announcement of the patent, adjusted for measurement noise and various fixed effects. The technical details of the estimation technique from Kogan et al. (2017) are provided below:

A firm's three-day announcement return for patent *j* (denoted as r_j) is the sum of two underlying distributions: (i) the value of newly granted patent *j* as a fraction of the firm's market capitalization (denoted as p_j), which is assumed to follow a truncated normal distribution with a mean equal to zero and a variance equal to σ_p^2; and (ii) the noise component in the three-day stock return unrelated to the newly granted patent (denoted as ε_j), which follows a normal distribution with a mean zero and a variance σ_ε^2. With both $\sigma_p^2$and σ_ε^2known, Kogan et al. compute the expected patent value following Bayes' rule:

$$E\left[p_j|r_j\right] = \delta r_j + \sqrt{\delta}\frac{\phi\left(-\sqrt{\delta}\frac{r_j}{\sigma_\varepsilon}\right)}{1-\Phi\left(-\sqrt{\delta}\frac{r_j}{\sigma_\varepsilon}\right)}\sigma_\varepsilon, \qquad \text{(OA.1)}$$

where $\emptyset$ and Φ denote the probability density function and cumulative distribution function of a standard normal distribution, respectively, and δ is the ratio of signal to noise as defined below:

$$\delta = \frac{\sigma_p^2}{\sigma_p^2 + \sigma_\varepsilon^2}.$$

In calculating $E\left[p_j|r_j\right]$ in Equation (OA.1), the values of two variables are vital: δ and σ_ε^2. Kogan et al. assume δ to be constant across firms and time but allow σ_ε^2 to vary across firms and time. To estimate δ, they execute the following panel regression to compute the increase in volatility of firm returns around announcement days of newly granted patents:

$$\ln\left(r_{fd}\right)^2 = \gamma I_{fd} + cZ_{fd} + u_{fd},$$

where $r_{fd}$is the three-day market-adjusted return of firm *f*, starting from day *d*. I_{fd} is a dummy for the day when there is any newly granted patent(s). *Z* is a vector of controls including the day-of-week fixed effects and the firm-year joint fixed effects. The calculation based on the above equation produces the estimate $\hat{\gamma} = 0.0146$. Using the value of $\hat{\gamma}$, $\hat{\delta}$ is estimated by the following equation:

$$\hat{\delta} = \left(e^{\hat{\gamma}} - 1\right)\left(1 - 2{C_0}^2 + e^{\hat{\gamma}}{C_0}^2\right)^{-1},$$

where $C_0 = \phi(0)/(1-\Phi(0))$. The resulting estimate of $\hat{\delta} = 0.0145$.

To estimate the firm- and year-specific σ_ε^2 (we use the notation $\sigma_{\varepsilon,ft}^2$ instead), Kogan et al. first follow Anderson and Terasvirta (2009) to non-parametrically estimate the market-adjusted daily return variance, $\widehat{\sigma_{ft}^2}$, for each firm and each year. With the estimate of $\widehat{\sigma_{ft}^2}$, the fraction of trading days that are announcement days for a firm in a year, d_{ft},and the estimate of $\hat{\gamma}$, they compute the variance of the measurement error in the following equation:

$$\hat{\sigma}_{\varepsilon,ft}^2 = 3\hat{\sigma}_{ft}^2 \left(1 + 3d_{ft}\hat{\gamma}/(1-\hat{\gamma})\right)^{-1}.$$

Inserting the previously estimated $\hat{\delta}$ and $\hat{\sigma}_{\varepsilon,ft}^2$, they calculate the value of $E\widehat{[p_j|r_j]}$.[1] Finally, they employ the following equation to compute the market value of patent j, θ_j, as the product of the estimated stock return associated with the patent, $E\widehat{[p_j|r_j]}$, multiplied by the market capitalization, M_j, of the firm granted with patent j on the day prior to the patent issuance announcement:

$$\theta_j = (1-\pi)^{-1}\frac{1}{N_j}E\widehat{[p_j|r_j]}M_j,$$

Where π is the unconditional probability of a successful patent application (estimated to be 0.56 in Carley et al. (2015)), and N_j is the number of patents granted to the same firm on the same day.

[1] $E\widehat{[p_j|r_j]}$ is not always positive in Kogan et al. (2017). Negative estimates are excluded.

Online Table 1: U.S. Universities and Their PDPASSs.

We manually match the university names with their PDPASSs using the assignee file (1976-2006) of the NBER patent data. We first examine the NBER patent assignee name file, focus on the assignees in the category of "U.S. University," and manually harmonize the PDPASSs for each university. To ensure full coverage, we search the university names in other categories and extract their PDPASSs. For example, Purdue Research Foundation of the Purdue University is in the category of "U.S. Institute." Our resulting sample is 362 universities.

uni_code	Name	PDPASS
U1	ACAD OF APPLIED SCI	10205990
U1	ACAD OF APPLIED SCI	12177703
U2	ALABAMA A&M UNIV	13099221
U3	ALCORN STATE UNIV	13218771
U4	ALFRED UNIV	10262334
U4	ALFRED UNIV	11071946
U5	ALKANSAS STATE UNIV	12905751
U6	ALVERNO COLLEGE	12751071
U7	AMBASSADOR COLLEGE	11367305
U9	AMERICAN LANGUAGE ACAD	11110495
U10	AMERICAN UNIV	10562759
U11	AMERICAN UNIV OF TECHNOLOGY	10287189
U12	AMHERST COLLEGE	12598036
U13	APPALACHAIN STATE UNIV	11883123
U14	ARIZONA STATE UNIV	10586414
U14	ARIZONA STATE UNIV	10916444
U14	ARIZONA STATE UNIV	11750489
U14	ARIZONA STATE UNIV	13118987
U15	ART CENT COLLEGE OF DESIGN	12846166
U16	ASSOCIATION OF AMERICAN UNIVERSITIES	11678831
U17	AT STILL UNIV OF HEALTH SCI	12672896
U18	AUBURN UNIV	10206900
U18	AUBURN UNIV	10996882
U18	AUBURN UNIV	11012600
U19	AVIATION SUPPLIES & ACADEMICS	10931538
U20	BALL STATE UNIV	12544684
U21	BAYLOR COLLEGE OF MEDICINE	11671697
U22	BAYLOR UNIV	11130200
U22	BAYLOR UNIV	11141078
U223	SPELMAN COLLEGE	12847735
U224	SPRINGFIELD COLLEGE	11833736
U225	ST JOHNS UNIV	10597806
U226	ST LOUIS UNIV	10383391
U226	ST LOUIS UNIV	12224461
U226	ST LOUIS UNIV	12307452
U227	STANFORD UNIV	10052880
U227	STANFORD UNIV	10085770
U227	STANFORD UNIV	12589299
U227	STANFORD UNIV	12959736
U227	STANFORD UNIV	13083418
U227	STANFORD UNIV	13141479
U227	STANFORD UNIV	21027770
U227	STANFORD UNIV	21478343
U227	STANFORD UNIV	22274727
U228	STARMARK ANIMAL BEHAVIOR CENTER	12706967
U229	STATE UNIV OF NEW YORK	10457174
U229	STATE UNIV OF NEW YORK	10506876
U229	STATE UNIV OF NEW YORK	12494736
U229	STATE UNIV OF NEW YORK	13107693
U229	STATE UNIV OF NEW YORK	13117389
U229	STATE UNIV OF NEW YORK	21917944
U230	STEPHEN F AUSTIN STATE UNIV	-16787
U231	STEVENS INST OF TECH	11021612
U231	STEVENS INST OF TECH	22918193
U232	SYRACUSE UNIV	10230164
U232	SYRACUSE UNIV	10625734
U233	TEMPLE UNIV	10843583
U233	TEMPLE UNIV	22503640

U22	BAYLOR UNIV	12374742	U233	TEMPLE UNIV	22912002
U22	BAYLOR UNIV	12840679	U234	TENNESSEE TECHNOLOGICAL UNIV	12667795
U23	BEMIDJI STATE UNIV	11414638	U235	TEXAS A&M UNIV	10834168
U24	BLIND FAITH SCHOOL OF MUSIC & ART	13121340	U235	TEXAS A&M UNIV	11616790
U25	BOISE STATE UNIV	12792627	U235	TEXAS A&M UNIV	21698632
U26	BOSTON COLLEGE	11266208	U235	TEXAS A&M UNIV	21991443
U27	BOSTON UNIV	10676948	U235	TEXAS A&M UNIV	22579636
U27	BOSTON UNIV	11282111	U236	TEXAS CHRISTIAN UNIV	12881011
U27	BOSTON UNIV	12923205	U237	TEXAS LUTHERAN UNIV	13060087
U28	BOWIE STATE UNIV	23055717	U238	TEXAS STATE UNIV	23152176
U29	BOWLING GREEN STATE UNIV	10931188	U239	TEXAS TECH UNIV	10666462
U30	BRADLEY UNIV	11765786	U239	TEXAS TECH UNIV	12864691
U31	BRANDEIS UNIV	11614407	U239	TEXAS TECH UNIV	12970897
U32	BRIGHAM YOUNG UNIV	11208780	U239	TEXAS TECH UNIV	13003183
U33	BROWN UNIV	10659299	U239	TEXAS TECH UNIV	22359003
U33	BROWN UNIV	10810030	U239	TEXAS TECH UNIV	22400311
U33	BROWN UNIV	12039323	U239	TEXAS TECH UNIV	22464759
U34	BRYN MAWR COLLEGE	12172060	U240	TEXAS WESLEYAN UNIV	11255546
U35	CALIFORNIA INST OF TECH	10212849	U241	THOMAS JEFFERSON UNIV	12233242
U35	CALIFORNIA INST OF TECH	10968828	U242	TOURO COLLEGE	11068476
U35	CALIFORNIA INST OF TECH	11532066	U243	TOWSON UNIV	21216599
U35	CALIFORNIA INST OF TECH	12756450	U244	TRINITY UNIV	11402737
U35	CALIFORNIA INST OF TECH	12962121	U245	TROY UNIV	12127624
U35	CALIFORNIA INST OF TECH	13108675	U246	TRUMAN STATE UNIV	12676105
U35	CALIFORNIA INST OF TECH	13208934	U247	TUFTS UNIV	10178972
U35	CALIFORNIA INST OF TECH	20961588	U247	TUFTS UNIV	11184034
U36	CALIFORNIA POLYTECHNIC STATE UNIV	10266866	U247	TUFTS UNIV	11598631
U37	CALIFORNIA STATE UNIV	10932917	U247	TUFTS UNIV	11880040
U37	CALIFORNIA STATE UNIV	11328517	U247	TUFTS UNIV	21959307
U37	CALIFORNIA STATE UNIV	11635555	U248	TULANE UNIV	10893927
U37	CALIFORNIA STATE UNIV	21564750	U248	TULANE UNIV	11014189
U38	CALVIN COLLEGE	12084416	U248	TULANE UNIV	11487378
U39	CARGENIE MELLON UNIV	10545965	U248	TULANE UNIV	22101801
U40	CARROLL COLLEGE	22293949	U248	TULANE UNIV	22495964
U41	CASE WESTERN RESERVE UNIV	11702110	U249	TUSKEGEE UNIV	10960490
U41	CASE WESTERN RESERVE UNIV	11991624	U250	UNIFORMED SERVICES UNIV OF HEALTH SCI	12454297
U41	CASE WESTERN RESERVE UNIV	21727241	U250	UNIFORMED SERVICES UNIV OF HEALTH SCI	22680937
U41	CASE WESTERN RESERVE UNIV	22823322	U250	UNIFORMED SERVICES UNIV OF HEALTH SCI	22743534

U41	CASE WESTERN RESERVE UNIV	23106232
U42	CATHOLIC UNIV OF AMERICA	11381523
U43	CENT MICHIGAN UNIV	12906223
U44	CENTENARY COLLEGE OF LOUISIANA	22391824
U45	CHAPMAN COLLEGE	10829901
U46	CITY UNIV OF NEW YORK	10878585
U46	CITY UNIV OF NEW YORK	11242285
U46	CITY UNIV OF NEW YORK	11370797
U46	CITY UNIV OF NEW YORK	11736050
U46	CITY UNIV OF NEW YORK	13138208
U47	CLARK UNIV	11748183
U48	CLARKSON UNIV	11418797
U49	CLEMSON UNIV	12487493
U49	CLEMSON UNIV	12648438
U50	CLEVELAND STATE UNIV	12475096
U51	COCKERILL SAMBRE CAMPUS UNIV DU SART TILMAN	22132506
U52	COLLEGE OF AMERICAN PATHOLOGISTS	12538533
U53	COLLEGE OF HOLY CROSS	12462375
U54	COLLEGE OF MEDICINE & DENTISTRY OF NEW JERSEY	10429743
U55	COLLEGE OF NEW JERSEY	11597056
U56	COLLEGE OF WILLIAM & MARY	12230512
U57	COLLEGE PARK IND INC	11258570
U58	COLLEGE SAVINGS BANK	10822055
U59	COLORADO SCHOOL OF MINES	11039458
U60	COLORADO STATE UNIV	10703054
U60	COLORADO STATE UNIV	22142825
U60	COLORADO STATE UNIV	23194527
U61	COLUMBIA UNIV	-3449
U61	COLUMBIA UNIV	10561876
U61	COLUMBIA UNIV	12510710
U61	COLUMBIA UNIV	13060440
U61	COLUMBIA UNIV	21275191
U61	COLUMBIA UNIV	21708108
U61	COLUMBIA UNIV	21841668
U61	COLUMBIA UNIV	22032616
U61	COLUMBIA UNIV	22745935
U62	CORNELL UNIV	10061102
U62	CORNELL UNIV	10075544
U251	UNION UNIV	10971488
U252	UNITY SCHOOL OF CHRISTIANITY	11313193
U253	UNIV ADVANCED BIO IMAGING ASSOCIATES	11979661
U254	UNIV CENT DEL CARIBE	22589357
U255	UNIV CORP FOR ATMOSPHERE RES	11451045
U256	UNIV HEALTHSYSTEM CONSORTIUM	13103470
U257	UNIV OF AKRON	11037269
U258	UNIV OF ALABAMA	10049068
U258	UNIV OF ALABAMA	10685560
U258	UNIV OF ALABAMA	11185055
U258	UNIV OF ALABAMA	13060486
U258	UNIV OF ALABAMA	20728027
U258	UNIV OF ALABAMA	21259067
U258	UNIV OF ALABAMA	22090093
U259	UNIV OF ALASKA	11456796
U260	UNIV OF ARIZONA	10298599
U260	UNIV OF ARIZONA	10586414
U260	UNIV OF ARIZONA	11043586
U260	UNIV OF ARIZONA	11750489
U260	UNIV OF ARIZONA	11821347
U260	UNIV OF ARIZONA	12975849
U260	UNIV OF ARIZONA	13092071
U260	UNIV OF ARIZONA	22358845
U261	UNIV OF ARKANSAS	-19842
U261	UNIV OF ARKANSAS	-18135
U261	UNIV OF ARKANSAS	10320721
U261	UNIV OF ARKANSAS	11210319
U261	UNIV OF ARKANSAS	11979879
U261	UNIV OF ARKANSAS	13183790
U262	UNIV OF BALTIMORE	13030169
U263	UNIV OF CALIFORNIA	10207181
U263	UNIV OF CALIFORNIA	10574877
U263	UNIV OF CALIFORNIA	11275757
U263	UNIV OF CALIFORNIA	11403026
U263	UNIV OF CALIFORNIA	11491547
U263	UNIV OF CALIFORNIA	11835845
U263	UNIV OF CALIFORNIA	12965526
U263	UNIV OF CALIFORNIA	13011309

U62	CORNELL UNIV	13114994	U263	UNIV OF CALIFORNIA	13031273
U62	CORNELL UNIV	22439140	U263	UNIV OF CALIFORNIA	13096429
U63	CREIGHTON UNIV	11404632	U263	UNIV OF CALIFORNIA	13130981
U63	CREIGHTON UNIV	11483474	U263	UNIV OF CALIFORNIA	13153610
U63	CREIGHTON UNIV	22870461	U263	UNIV OF CALIFORNIA	21880971
U64	DARTMOUTH COLLEGE	10398824	U263	UNIV OF CALIFORNIA	22128483
U64	DARTMOUTH COLLEGE	13074801	U263	UNIV OF CALIFORNIA	23213594
U64	DARTMOUTH COLLEGE	23184628	U263	UNIV OF CALIFORNIA	23253509
U65	DAVIDSON COLLEGE	10510509	U264	UNIV OF CENT FLORIDA	11719517
U66	DENVER PUBLIC SCHOOLS	11622732	U264	UNIV OF CENT FLORIDA	13073164
U67	DOWLING COLLEGE	11963203	U264	UNIV OF CENT FLORIDA	13099239
U68	DREXEL UNIV	10954865	U265	UNIV OF CHICAGO	10154594
U68	DREXEL UNIV	11315969	U265	UNIV OF CHICAGO	11423007
U68	DREXEL UNIV	11765555	U265	UNIV OF CHICAGO	12796484
U68	DREXEL UNIV	11940708	U265	UNIV OF CHICAGO	13062601
U68	DREXEL UNIV	13118803	U265	UNIV OF CHICAGO	21343459
U68	DREXEL UNIV	21467059	U266	UNIV OF CINCINNATI	10041121
U69	DUGUESNE UNIV	11269645	U266	UNIV OF CINCINNATI	10622190
U70	DUKE UNIV	10381645	U266	UNIV OF CINCINNATI	21616788
U70	DUKE UNIV	10811240	U267	UNIV OF COLORADO	11023299
U70	DUKE UNIV	11118479	U267	UNIV OF COLORADO	11481253
U70	DUKE UNIV	11914519	U267	UNIV OF COLORADO	12265471
U70	DUKE UNIV	22672650	U267	UNIV OF COLORADO	13125454
U70	DUKE UNIV	31462732	U267	UNIV OF COLORADO	13131054
U71	EAST CAROLINA UNIV	12187351	U268	UNIV OF CONNECTICUT	10685585
U71	EAST CAROLINA UNIV	22093804	U268	UNIV OF CONNECTICUT	11231993
U72	EAST TENNESSEE STATE UNIV	10799878	U268	UNIV OF CONNECTICUT	12551316
U73	EASTERN MICHIGAN UNIV	11659189	U269	UNIV OF DAYTON	11580808
U74	EASTERN VIRGINIA MED SCHOOL	10776979	U270	UNIV OF DELAWARE	10967975
U74	EASTERN VIRGINIA MED SCHOOL	11290554	U271	UNIV OF DENVER	10531434
U74	EASTERN VIRGINIA MED SCHOOL	11568736	U272	UNIV OF DETROIT MERCY	22210580
U74	EASTERN VIRGINIA MED SCHOOL	13248021	U273	UNIV OF FLORIDA	10062206
U74	EASTERN VIRGINIA MED SCHOOL	21158600	U273	UNIV OF FLORIDA	11645650
U74	EASTERN VIRGINIA MED SCHOOL	21940531	U273	UNIV OF FLORIDA	11914084
U74	EASTERN VIRGINIA MED SCHOOL	22381251	U273	UNIV OF FLORIDA	12304022
U75	EASTERN WASHINGTON UNIV	12794799	U273	UNIV OF FLORIDA	12940121
U76	EMORY UNIV	11907114	U273	UNIV OF FLORIDA	13067084
U76	EMORY UNIV	12952537	U273	UNIV OF FLORIDA	21531655

U76	EMORY UNIV	13153100
U76	EMORY UNIV	21940314
U77	ERSKINE COLLEGE	12208271
U78	FAIRFIELD UNIV	10326534
U79	FERRIS STATE UNIV	12744811
U80	FLORIDA A&M UNIV	10688530
U81	FLORIDA ATLANTIC UNIV	11374602
U81	FLORIDA ATLANTIC UNIV	11397556
U82	FLORIDA INST OF TECH	11653616
U82	FLORIDA INST OF TECH	21264587
U83	FLORIDA INT UNIV	11351849
U84	FLORIDA STATE UNIV	10572253
U85	FORDHAM UNIV	12483494
U86	FORMAN SCHOOL	12512261
U87	FORT VALLEY STATE COLLEGE	10945959
U88	FRANCISCAN UNIV OF STEUBENVILLE	12857699
U89	GEORGE MASON UNIV	12053388
U89	GEORGE MASON UNIV	13160830
U90	GEORGE WASHINGTON UNIV	10643340
U90	GEORGE WASHINGTON UNIV	11232401
U91	GEORGETOWN UNIV	10420768
U91	GEORGETOWN UNIV	23160283
U92	GEORGIA INST OF TECH	10245256
U92	GEORGIA INST OF TECH	11201574
U92	GEORGIA INST OF TECH	11907114
U92	GEORGIA INST OF TECH	12242425
U92	GEORGIA INST OF TECH	13168377
U92	GEORGIA INST OF TECH	13189746
U92	GEORGIA INST OF TECH	21544042
U93	GEORGIA REGENTS UNIV	10495486
U94	GEORGIA STATE UNIV	11063676
U94	GEORGIA STATE UNIV	13058237
U94	GEORGIA STATE UNIV	31917686
U94	GEORGIA STATE UNIV	32072969
U95	GLOBAL PETROLEUM RESOUCES INST	10834168
U96	GONZAGA UNIV	10148287
U97	GOSHEN COLLEGE	10490341
U98	GRAND VALLEY STATE UNIV	11530764
U273	UNIV OF FLORIDA	22795882
U274	UNIV OF GEORGIA	10709716
U274	UNIV OF GEORGIA	10743899
U274	UNIV OF GEORGIA	20980632
U274	UNIV OF GEORGIA	21024097
U274	UNIV OF GEORGIA	31292804
U275	UNIV OF HARTFORD	11289490
U276	UNIV OF HAWAII	10643212
U276	UNIV OF HAWAII	11798517
U277	UNIV OF HEALTH SCI	10832755
U278	UNIV OF HOUSTON	10359318
U278	UNIV OF HOUSTON	11083253
U278	UNIV OF HOUSTON	11826512
U278	UNIV OF HOUSTON	11973901
U278	UNIV OF HOUSTON	12008832
U278	UNIV OF HOUSTON	12950314
U278	UNIV OF HOUSTON	21504424
U279	UNIV OF IDAHO	10495969
U280	UNIV OF ILLINOIS	10041842
U280	UNIV OF ILLINOIS	10568328
U280	UNIV OF ILLINOIS	13082277
U280	UNIV OF ILLINOIS	13176072
U280	UNIV OF ILLINOIS	13209235
U280	UNIV OF ILLINOIS	21997696
U280	UNIV OF ILLINOIS	23017867
U281	UNIV OF IOWA	10062450
U281	UNIV OF IOWA	10430486
U281	UNIV OF IOWA	13108782
U281	UNIV OF IOWA	13212573
U281	UNIV OF IOWA	21559317
U281	UNIV OF IOWA	21619052
U281	UNIV OF IOWA	22019136
U281	UNIV OF IOWA	22148979
U282	UNIV OF KANSAS	10077203
U282	UNIV OF KANSAS	10144154
U282	UNIV OF KANSAS	10764366
U282	UNIV OF KANSAS	11157105
U282	UNIV OF KANSAS	11652313

U99	HAMPSHIRE COLLEGE	12134308	U282	UNIV OF KANSAS	12422786
U100	HAMPTON UNIV	12750799	U283	UNIV OF KENTUCKY	10367449
U101	HARVARD UNIV	10441766	U283	UNIV OF KENTUCKY	11623208
U101	HARVARD UNIV	10669916	U283	UNIV OF KENTUCKY	13166469
U101	HARVARD UNIV	11644197	U283	UNIV OF KENTUCKY	21124944
U101	HARVARD UNIV	13092079	U283	UNIV OF KENTUCKY	22503627
U101	HARVARD UNIV	21754150	U283	UNIV OF KENTUCKY	22630049
U101	HARVARD UNIV	21836318	U283	UNIV OF KENTUCKY	22731487
U101	HARVARD UNIV	22120144	U284	UNIV OF LOUISIANA	10906343
U101	HARVARD UNIV	23194752	U284	UNIV OF LOUISIANA	12681831
U101	HARVARD UNIV	31904374	U285	UNIV OF LOUISVILLE	10317341
U102	HATHAWAY BROWN SCHOOL	12723620	U285	UNIV OF LOUISVILLE	11059353
U103	HOFSTRA UNIV	21517215	U285	UNIV OF LOUISVILLE	11298212
U104	HONOLULU UNIV	12479573	U285	UNIV OF LOUISVILLE	13062808
U105	HOWARD UNIV	11630148	U286	UNIV OF MAINE	10640468
U106	HUMBOLDT STATE UNIV	12503249	U287	UNIV OF MARYLAND	11191953
U107	IDAHO STATE UNIV	12717588	U287	UNIV OF MARYLAND	11358284
U108	ILLINOIS INST OF TECH	11788448	U287	UNIV OF MARYLAND	11632204
U109	ILLINOIS STATE UNIV	10949075	U287	UNIV OF MARYLAND	11714398
U110	INDIANA UNIV	10592322	U287	UNIV OF MARYLAND	12256952
U110	INDIANA UNIV	11793501	U287	UNIV OF MARYLAND	13133766
U110	INDIANA UNIV	12961647	U287	UNIV OF MARYLAND	13138078
U110	INDIANA UNIV	21779511	U287	UNIV OF MARYLAND	23091698
U111	IOWA STATE UNIV	-19842	U288	UNIV OF MASSACHUSETTS	10644545
U111	IOWA STATE UNIV	10241419	U288	UNIV OF MASSACHUSETTS	11043142
U111	IOWA STATE UNIV	12637792	U288	UNIV OF MASSACHUSETTS	11078564
U111	IOWA STATE UNIV	13166241	U288	UNIV OF MASSACHUSETTS	11159519
U111	IOWA STATE UNIV	21589443	U288	UNIV OF MASSACHUSETTS	11249757
U111	IOWA STATE UNIV	22014247	U288	UNIV OF MASSACHUSETTS	11533895
U112	ITHACA COLLEGE	32157288	U288	UNIV OF MASSACHUSETTS	11947081
U113	JACKSON STATE UNIV	12641196	U288	UNIV OF MASSACHUSETTS	11979607
U114	JACKSONVILLE STATE UNIV	12606791	U288	UNIV OF MASSACHUSETTS	12673072
U115	JAMES MADISON UNIV	12217658	U288	UNIV OF MASSACHUSETTS	22669651
U116	JIT INST OF TECH INC	11540480	U288	UNIV OF MASSACHUSETTS	32465352
U117	JOHN COSTANZA INST OF TECH	-19842	U289	UNIV OF MEDICINE & DENISTRY OF NEW JERSEY	10805756
U117	JOHN COSTANZA INST OF TECH	12298980	U289	UNIV OF MEDICINE & DENISTRY OF NEW JERSEY	13081942
U118	JOHNS HOPKINS UNIV	10272382	U289	UNIV OF MEDICINE & DENISTRY OF NEW JERSEY	13179673
U118	JOHNS HOPKINS UNIV	11701894	U289	UNIV OF MEDICINE & DENISTRY OF NEW JERSEY	22823702

U118	JOHNS HOPKINS UNIV	21796135
U119	JOHNSON & WALES UNIV	11079610
U120	JORDAN COLLEGE	10335223
U121	KANSAS STATE UNIV	10144154
U121	KANSAS STATE UNIV	11312062
U121	KANSAS STATE UNIV	22576010
U122	KENT STATE UNIV	11421533
U123	KIRKWOOD COMMUNITY COLLEGE	11093484
U124	LAWRENCE TECHNOLOGICAL UNIV	11231979
U124	LAWRENCE TECHNOLOGICAL UNIV	12267391
U124	LAWRENCE TECHNOLOGICAL UNIV	12890518
U125	LE TOURNEAU UNIV	10926566
U126	LEHIGH UNIV	11235848
U126	LEHIGH UNIV	12652233
U127	LIFE CHIROPRACTIC COLLEGE WEST	10343025
U128	LOMA LINDA UNIV	11515547
U128	LOMA LINDA UNIV	11564411
U128	LOMA LINDA UNIV	12803206
U129	LOUISANA STATE UNIV	10140805
U129	LOUISANA STATE UNIV	11062023
U129	LOUISANA STATE UNIV	11627788
U129	LOUISANA STATE UNIV	11947081
U129	LOUISANA STATE UNIV	12966870
U129	LOUISANA STATE UNIV	13009436
U129	LOUISANA STATE UNIV	13166469
U129	LOUISANA STATE UNIV	13209300
U129	LOUISANA STATE UNIV	21195745
U129	LOUISANA STATE UNIV	21685347
U129	LOUISANA STATE UNIV	21735512
U129	LOUISANA STATE UNIV	21952168
U129	LOUISANA STATE UNIV	22154284
U129	LOUISANA STATE UNIV	22637947
U129	LOUISANA STATE UNIV	43036639
U130	LOUISIANA TECH UNIV	10126534
U130	LOUISIANA TECH UNIV	12813408
U130	LOUISIANA TECH UNIV	13190783
U130	LOUISIANA TECH UNIV	23072046
U131	LOYOLA UNIV CHICAGO	11947185
U290	UNIV OF MEMPHIS	11618897
U290	UNIV OF MEMPHIS	11701534
U291	UNIV OF MIAMI	10488380
U291	UNIV OF MIAMI	10759815
U291	UNIV OF MIAMI	12362255
U291	UNIV OF MIAMI	22730154
U292	UNIV OF MICHIGAN	10633647
U292	UNIV OF MICHIGAN	10986768
U293	UNIV OF MINNESOTA	10088481
U293	UNIV OF MINNESOTA	11296379
U293	UNIV OF MINNESOTA	12952537
U293	UNIV OF MINNESOTA	13174559
U293	UNIV OF MINNESOTA	13243336
U293	UNIV OF MINNESOTA	21341069
U293	UNIV OF MINNESOTA	22906363
U294	UNIV OF MISSISSIPPI	10973250
U294	UNIV OF MISSISSIPPI	12115690
U295	UNIV OF MISSOURI	11007415
U295	UNIV OF MISSOURI	21097646
U296	UNIV OF MONTANA	10691564
U297	UNIV OF NEBRASKA	10109390
U297	UNIV OF NEBRASKA	12997875
U297	UNIV OF NEBRASKA	13156532
U297	UNIV OF NEBRASKA	33202059
U298	UNIV OF NEVADA	10237009
U298	UNIV OF NEVADA	11703838
U298	UNIV OF NEVADA	13071491
U298	UNIV OF NEVADA	13109172
U298	UNIV OF NEVADA	21844711
U298	UNIV OF NEVADA	21958662
U298	UNIV OF NEVADA	22186847
U298	UNIV OF NEVADA	22808133
U298	UNIV OF NEVADA	22814869
U298	UNIV OF NEVADA	22887683
U298	UNIV OF NEVADA	23202059
U299	UNIV OF NEW HAMPSHIRE	11724210
U299	UNIV OF NEW HAMPSHIRE	22689966
U300	UNIV OF NEW MEXICO	10913424

U132	LOYOLA UNIV MARYLAND	11561939	U300	UNIV OF NEW MEXICO	12773626
U133	MACOMB INTERMEDIATE SCHOOL DISTRICT	12317057	U300	UNIV OF NEW MEXICO	22240157
U134	MARION COUNTY SCHOOL BOARD	11775373	U301	UNIV OF NEW ORLEANS	11437146
U135	MARQUETTE UNIV	10660599	U301	UNIV OF NEW ORLEANS	12416380
U136	MARSHALL UNIV	11841525	U301	UNIV OF NEW ORLEANS	12452671
U137	MASSACHUSETTS INST OF TECH	10669916	U302	UNIV OF NORTH CARLOINA	10478431
U137	MASSACHUSETTS INST OF TECH	11527095	U302	UNIV OF NORTH CARLOINA	11068582
U137	MASSACHUSETTS INST OF TECH	11947081	U302	UNIV OF NORTH CARLOINA	21292761
U137	MASSACHUSETTS INST OF TECH	12641479	U302	UNIV OF NORTH CARLOINA	21616739
U137	MASSACHUSETTS INST OF TECH	12991382	U302	UNIV OF NORTH CARLOINA	21946714
U137	MASSACHUSETTS INST OF TECH	13006194	U302	UNIV OF NORTH CARLOINA	22104572
U137	MASSACHUSETTS INST OF TECH	13106289	U302	UNIV OF NORTH CARLOINA	22160569
U137	MASSACHUSETTS INST OF TECH	22536443	U302	UNIV OF NORTH CARLOINA	23027322
U137	MASSACHUSETTS INST OF TECH	22576921	U302	UNIV OF NORTH CARLOINA	23126469
U137	MASSACHUSETTS INST OF TECH	22955839	U303	UNIV OF NORTH DAKOTA	11031073
U138	MCNEESE STATE UNIV	12702967	U303	UNIV OF NORTH DAKOTA	11354521
U139	MED COLLEGE OF WISCONSIN	10580239	U303	UNIV OF NORTH DAKOTA	11877098
U139	MED COLLEGE OF WISCONSIN	10820459	U303	UNIV OF NORTH DAKOTA	12520107
U140	MED UNIV OF SOUTH CAROLINA	10995833	U304	UNIV OF NORTH FLORIDA	12458745
U141	MEHARRY MED COLLEGE	13126305	U305	UNIV OF NORTH TEXAS	10740277
U142	MERCER UNIV	12595514	U305	UNIV OF NORTH TEXAS	11784144
U142	MERCER UNIV	12655110	U305	UNIV OF NORTH TEXAS	12290304
U143	MIAMI UNIV	10834376	U306	UNIV OF NORTHERN IOWA	10669932
U143	MIAMI UNIV	12555248	U307	UNIV OF NOTRE DAME	10098786
U144	MICHIGAN STATE UNIV	10194972	U307	UNIV OF NOTRE DAME	11206968
U144	MICHIGAN STATE UNIV	13020373	U308	UNIV OF OKLAHOMA	10699216
U144	MICHIGAN STATE UNIV	13205811	U309	UNIV OF OREGON	10199918
U145	MICHIGAN TECH UNIV	10077900	U309	UNIV OF OREGON	10461110
U146	MILWAUKEE SCHOOL OF ENG	12409581	U309	UNIV OF OREGON	21141378
U147	MINNESOTA STATE UNIV	11729349	U309	UNIV OF OREGON	22250176
U148	MISSISSIPPI STATE UNIV	11300457	U310	UNIV OF PACIFIC	10069498
U148	MISSISSIPPI STATE UNIV	11640190	U311	UNIV OF PENNSYLVANIA	10553405
U148	MISSISSIPPI STATE UNIV	12603782	U311	UNIV OF PENNSYLVANIA	21448010
U148	MISSISSIPPI STATE UNIV	22458885	U311	UNIV OF PENNSYLVANIA	22163973
U149	MISSOURI STATE UNIV	12562207	U311	UNIV OF PENNSYLVANIA	22529353
U150	MONTANA STATE UNIV	10309530	U311	UNIV OF PENNSYLVANIA	41937492
U150	MONTANA STATE UNIV	10442746	U312	UNIV OF PITTSBURGH	10816904
U150	MONTANA STATE UNIV	10507582	U312	UNIV OF PITTSBURGH	11580909

U150	MONTANA STATE UNIV	12730146	U312	UNIV OF PITTSBURGH	13038211
U151	MONTCLAIR STATE COLLEGE	10998921	U312	UNIV OF PITTSBURGH	13098395
U152	MOREHOUSE SCHOOL OF MEDICINE	22229917	U312	UNIV OF PITTSBURGH	13157514
U153	NEW JERSEY INST OF TECH	10367156	U312	UNIV OF PITTSBURGH	13159719
U153	NEW JERSEY INST OF TECH	10630367	U312	UNIV OF PITTSBURGH	22651595
U154	NEW MEXICO HIGHLANDS UNIV	13174959	U312	UNIV OF PITTSBURGH	22834880
U156	NEW MEXICO STATE UNIV	10477157	U313	UNIV OF PORTLAND	12519096
U156	NEW MEXICO STATE UNIV	11784545	U314	UNIV OF PUERTO RICO	11159294
U155	NEW MEXICO TECH	10707696	U315	UNIV OF RHODE ISLAND	10211036
U155	NEW MEXICO TECH	10710305	U315	UNIV OF RHODE ISLAND	10332373
U157	NEW YORK CHIROPRACTIC COLLEGE	11001730	U315	UNIV OF RHODE ISLAND	11401123
U158	NEW YORK INST OF TECH	10323560	U316	UNIV OF ROCHESTER	10813351
U159	NEW YORK MED COLLEGE	11880029	U316	UNIV OF ROCHESTER	21383171
U160	NEW YORK UNIV	10225626	U316	UNIV OF ROCHESTER	23216874
U160	NEW YORK UNIV	10935256	U316	UNIV OF ROCHESTER	32265471
U160	NEW YORK UNIV	11038949	U317	UNIV OF SCI IN PHILADELPHIA	12403630
U160	NEW YORK UNIV	11853445	U318	UNIV OF SCRANTON	11695871
U160	NEW YORK UNIV	12839335	U319	UNIV OF SOUTH ALABAMA	10685560
U160	NEW YORK UNIV	13241582	U320	UNIV OF SOUTH CAROLINA	10464990
U161	NICHOLLS STATE UNIV	12274275	U320	UNIV OF SOUTH CAROLINA	11249621
U162	NORTH CAROLINA A&T STATE UNIV	12268714	U320	UNIV OF SOUTH CAROLINA	12753388
U163	NORTH CAROLINA CENT UNIV	11099366	U320	UNIV OF SOUTH CAROLINA	23046248
U164	NORTH CAROLINA STATE UNIV	10559924	U321	UNIV OF SOUTH FLORDIA	11233875
U164	NORTH CAROLINA STATE UNIV	11506123	U321	UNIV OF SOUTH FLORDIA	22073133
U164	NORTH CAROLINA STATE UNIV	13226041	U321	UNIV OF SOUTH FLORDIA	22669149
U164	NORTH CAROLINA STATE UNIV	23129971	U322	UNIV OF SOUTHERN CALIFORNIA	10578763
U165	NORTH DAKOTA STATE UNIV	10566870	U322	UNIV OF SOUTHERN CALIFORNIA	12328900
U165	NORTH DAKOTA STATE UNIV	10923756	U322	UNIV OF SOUTHERN CALIFORNIA	12758297
U165	NORTH DAKOTA STATE UNIV	11143192	U322	UNIV OF SOUTHERN CALIFORNIA	21438481
U165	NORTH DAKOTA STATE UNIV	12042637	U323	UNIV OF SOUTHERN MISSISSIPPI	11695908
U165	NORTH DAKOTA STATE UNIV	22032783	U323	UNIV OF SOUTHERN MISSISSIPPI	13039998
U166	NORTHEASTERN OHIO MED UNIV	11520028	U324	UNIV OF TENNESSEE	10395128
U167	NORTHEASTERN UNIV	11750270	U324	UNIV OF TENNESSEE	11073675
U168	NORTHERN ARIZONA UNIV	10586414	U324	UNIV OF TENNESSEE	11302430
U168	NORTHERN ARIZONA UNIV	11750489	U324	UNIV OF TENNESSEE	12727218
U168	NORTHERN ARIZONA UNIV	13126467	U324	UNIV OF TENNESSEE	12955536
U169	NORTHERN ILLINOIS UNIV	11371840	U324	UNIV OF TENNESSEE	21028705
U169	NORTHERN ILLINOIS UNIV	22044652	U324	UNIV OF TENNESSEE	21683109

U170	NORTHWEST MISSOURI STATE UNIV	12249694	U325	UNIV OF TEXAS	10179127
U171	NORTHWESTERN POLYTECHNIC UNIV	10901441	U325	UNIV OF TEXAS	11586204
U172	NORTHWESTERN UNIV	10265747	U325	UNIV OF TEXAS	12098212
U172	NORTHWESTERN UNIV	10935258	U325	UNIV OF TEXAS	13056214
U172	NORTHWESTERN UNIV	11495704	U325	UNIV OF TEXAS	13094961
U172	NORTHWESTERN UNIV	12057950	U325	UNIV OF TEXAS	13143500
U172	NORTHWESTERN UNIV	21478822	U325	UNIV OF TEXAS	20941968
U172	NORTHWESTERN UNIV	21802904	U325	UNIV OF TEXAS	21683220
U173	NOVA SOUTHEASTERN UNIV	10706233	U325	UNIV OF TEXAS	21722946
U173	NOVA SOUTHEASTERN UNIV	12380965	U325	UNIV OF TEXAS	22038636
U174	OAK RIDGE ASSOC UNIVERSITIES	10926602	U325	UNIV OF TEXAS	22101963
U174	OAK RIDGE ASSOC UNIVERSITIES	10933394	U325	UNIV OF TEXAS	22232724
U175	OAKLAND UNIV	12935463	U325	UNIV OF TEXAS	22265484
U176	OHIO NORTHERN UNIV	11589089	U325	UNIV OF TEXAS	22656893
U177	OHIO STATE UNIV	10875627	U325	UNIV OF TEXAS	22727731
U177	OHIO STATE UNIV	11671339	U325	UNIV OF TEXAS	31946946
U177	OHIO STATE UNIV	13062757	U326	UNIV OF TOLEDO	10651445
U177	OHIO STATE UNIV	13085082	U326	UNIV OF TOLEDO	11209129
U177	OHIO STATE UNIV	22412940	U327	UNIV OF TULSA	11783568
U177	OHIO STATE UNIV	22662337	U328	UNIV OF UTAH	10266457
U178	OHIO UNIV	11132407	U328	UNIV OF UTAH	10424292
U178	OHIO UNIV	23101755	U328	UNIV OF UTAH	11973831
U179	OKLAHOMA STATE UNIV	10042480	U328	UNIV OF UTAH	12979735
U179	OKLAHOMA STATE UNIV	10708257	U328	UNIV OF UTAH	13058323
U179	OKLAHOMA STATE UNIV	21419483	U329	UNIV OF VERMONT	10941045
U180	OLD DOMINION UNIV	10367573	U329	UNIV OF VERMONT	11313813
U180	OLD DOMINION UNIV	12618692	U329	UNIV OF VERMONT	21128253
U181	OREGON HEALTH SCI UNIV	11075430	U329	UNIV OF VERMONT	22014112
U181	OREGON HEALTH SCI UNIV	11223730	U330	UNIV OF VIRGINIA	-19842
U181	OREGON HEALTH SCI UNIV	11602038	U330	UNIV OF VIRGINIA	10170460
U181	OREGON HEALTH SCI UNIV	21729163	U330	UNIV OF VIRGINIA	10261198
U181	OREGON HEALTH SCI UNIV	21752368	U330	UNIV OF VIRGINIA	11045478
U182	OREGON STATE UNIV	-19842	U331	UNIV OF WASHINGTON	10239303
U182	OREGON STATE UNIV	10242939	U331	UNIV OF WASHINGTON	10886396
U182	OREGON STATE UNIV	10382255	U331	UNIV OF WASHINGTON	11277015
U182	OREGON STATE UNIV	10461110	U331	UNIV OF WASHINGTON	11534084
U182	OREGON STATE UNIV	13150579	U331	UNIV OF WASHINGTON	13062709
U182	OREGON STATE UNIV	21632142	U331	UNIV OF WASHINGTON	21940712

U182	OREGON STATE UNIV	21710031	U332	UNIV OF WEST FLORIDA	11606937
U182	OREGON STATE UNIV	22595588	U333	UNIV OF WISCONSIN	-18138
U183	PACE UNIV	12564893	U333	UNIV OF WISCONSIN	10758279
U184	PENN STATE UNIV	10126251	U333	UNIV OF WISCONSIN	11011139
U184	PENN STATE UNIV	10880590	U333	UNIV OF WISCONSIN	11091862
U184	PENN STATE UNIV	11381814	U333	UNIV OF WISCONSIN	11186941
U184	PENN STATE UNIV	12069216	U333	UNIV OF WISCONSIN	13174902
U184	PENN STATE UNIV	12242850	U333	UNIV OF WISCONSIN	13205491
U184	PENN STATE UNIV	12547753	U333	UNIV OF WISCONSIN	13241558
U184	PENN STATE UNIV	13142419	U333	UNIV OF WISCONSIN	22391743
U184	PENN STATE UNIV	21368573	U333	UNIV OF WISCONSIN	52256503
U185	PEPPERDINE UNIV	11608189	U334	UNIV OF WYOMING	11661065
U186	PHILADELPHIA COLLEGE OF OSTEOPATHIC MEDICINE	10268206	U334	UNIV OF WYOMING	11835948
U186	PHILADELPHIA COLLEGE OF OSTEOPATHIC MEDICINE	11687112	U335	UNIVERSITIES SPACE RES ASSOC	12108009
U187	PITTSBURG STATE UNIV	12673354	U336	UTAH STATE UNIV	10102878
U188	POLYTEC PACKAGING	11348040	U336	UTAH STATE UNIV	11777166
U189	PORTLAND STATE UNIV	10547299	U337	VALDOSTA STATE UNIV	12122456
U189	PORTLAND STATE UNIV	12059871	U338	VANDERBILT UNIV	10427180
U189	PORTLAND STATE UNIV	13142317	U338	VANDERBILT UNIV	11800654
U190	PRINCETON UNIV	10982333	U338	VANDERBILT UNIV	12958157
U190	PRINCETON UNIV	12941661	U338	VANDERBILT UNIV	13241160
U190	PRINCETON UNIV	13051753	U338	VANDERBILT UNIV	22085597
U190	PRINCETON UNIV	13153412	U338	VANDERBILT UNIV	22540680
U190	PRINCETON UNIV	13202451	U339	VAUGHN COLLEGE OF AERONAUTICS AND TECHNOLOGY	10967685
U190	PRINCETON UNIV	21645396	U340	VILLANOVA UNIV	10113411
U191	PURDUE UNIV	10035219	U341	VIRGINIA COMMONWEALTH UNIV	11421012
U191	PURDUE UNIV	10366981	U341	VIRGINIA COMMONWEALTH UNIV	11710180
U191	PURDUE UNIV	10398726	U342	VIRGINIA STATE UNIV	11788508
U191	PURDUE UNIV	10537031	U343	VIRGINIA TECH	10039044
U191	PURDUE UNIV	11901537	U343	VIRGINIA TECH	11187277
U191	PURDUE UNIV	32065493	U343	VIRGINIA TECH	11198954
U192	REED COLLEGE	23011649	U343	VIRGINIA TECH	12551167
U193	REGIS COLLEGE	10943971	U343	VIRGINIA TECH	12790182
U194	RENSSELAER POLYTECHIN INST	10403068	U343	VIRGINIA TECH	12942141
U194	RENSSELAER POLYTECHIN INST	22673373	U343	VIRGINIA TECH	21187277
U195	RICE UNIV	12224373	U343	VIRGINIA TECH	21231411
U195	RICE UNIV	12969084	U343	VIRGINIA TECH	21542029
U195	RICE UNIV	13148999	U343	VIRGINIA TECH	21917775

U195	RICE UNIV	13238100	U343	VIRGINIA TECH	22113740
U195	RICE UNIV	22555676	U344	WABASH COLLEGE	10622914
U196	ROANOKE COLLEGE	10866925	U345	WAKE FOREST UNIV	10806683
U197	ROCHESTER INST OF TECH	12641750	U345	WAKE FOREST UNIV	11643499
U198	ROCKEFELLER UNIV	11196703	U345	WAKE FOREST UNIV	12301988
U199	ROCKHURST UNIV	12065608	U345	WAKE FOREST UNIV	12624616
U200	ROSALIND FRANKLIN UNIV	21741747	U345	WAKE FOREST UNIV	13108395
U201	ROSE HULMAN INST OF TECH	12759972	U346	WASHINGTON STATE UNIV	11522428
U202	RUSH UNIV	12713330	U347	WASHINGTON UNIV ST LOUIS	10035548
U202	RUSH UNIV	13101393	U347	WASHINGTON UNIV ST LOUIS	10775140
U203	RUTGERS UNIV	10045993	U347	WASHINGTON UNIV ST LOUIS	12448185
U203	RUTGERS UNIV	10088481	U347	WASHINGTON UNIV ST LOUIS	12941559
U203	RUTGERS UNIV	11102710	U347	WASHINGTON UNIV ST LOUIS	22526196
U203	RUTGERS UNIV	11231993	U348	WAYNE STATE UNIV	10427180
U203	RUTGERS UNIV	13133618	U348	WAYNE STATE UNIV	10847404
U203	RUTGERS UNIV	13156493	U348	WAYNE STATE UNIV	31739712
U203	RUTGERS UNIV	13178411	U349	WEBER STATE UNIV	11896922
U203	RUTGERS UNIV	22265502	U350	WELLESLEY COLLEGE	12407978
U204	SACRAMENTO CITY UNIFIED SCHOOL DISTRICT	13118155	U351	WEST VIRGINIA UNIV	11146459
U205	SAGINAW VALLEY STATE UNIV	10883133	U351	WEST VIRGINIA UNIV	12644624
U206	SALEM INT UNIV	12840486	U352	WESTERN ILLINOIS UNIV	13033405
U207	SALISBURY UNIV	11612069	U353	WESTERN KENTUCKY UNIV	12663898
U208	SAN DIEGO STATE UNIV	12407625	U354	WESTERN MICHIGAN UNIV	11903740
U209	SAN JOSE STATE UNIV	11643621	U355	WESTERN UNIV OF HEALTH SCI	12859058
U209	SAN JOSE STATE UNIV	22947749	U355	WESTERN UNIV OF HEALTH SCI	12949269
U210	SANTA CLARA UNIV	21273474	U356	WESTERN WASHINGTON UNIV	10149309
U211	SETON HALL UNIV	12105148	U356	WESTERN WASHINGTON UNIV	10487689
U212	SHAW UNIV	10183841	U356	WESTERN WASHINGTON UNIV	12740543
U213	SIENA COLLEGE	10577917	U357	WHEELING JESUIT UNIV	12481346
U214	SMITH COLLEGE	10817258	U358	WICHITA STATE UNIV	11029736
U215	SOUTH DAKOGA SCHOOL OF MINES & TECH	11214687	U359	WIDNER UNIV	10162939
U216	SOUTH DAKOTA STATE UNIV	11777429	U360	WRIGHT STATE UNIV	10182806
U217	SOUTHEASTERN ILLINOIS COLLEGE	10960577	U361	YALE UNIV	11892773
U218	SOUTHEASTERN UNIV	11118387	U361	YALE UNIV	22196517
U218	SOUTHEASTERN UNIV	13086585	U361	YALE UNIV	22362025
U219	SOUTHERN COLLEGE OF OPTOMETRY	12759985	U361	YALE UNIV	23141298
U220	SOUTHERN ILLINOIS UNIV	10988029	U362	YESHIVA UNIV	10062715
U220	SOUTHERN ILLINOIS UNIV	13254608	U362	YESHIVA UNIV	10302665

U221	SOUTHERN METHODIST UNIV	11672060	U362	YESHIVA UNIV	12941547
U221	SOUTHERN METHODIST UNIV	13225986	U362	YESHIVA UNIV	20518059
U222	SOUTHERN UNIV & A&M COLLEGE	10988029	U362	YESHIVA UNIV	22793193

Online Table 2: Distributions of Characteristics of Patents Granted to Listed Firms and Universities in the U.S.

We compare the distribution of patent quality/importance (the citations received in five years after the patent is granted), patent originality (one minus the Herfindahl-Hirschman Index (HHI) of citations given to other patents over patent subcategories), patent generality (one minus the HHI of citations received from other patents over patent subcategories), patent basicness (the ratio of the number of references to prior "non-patent documents" divided by the total references), and international patent family affiliation of patents granted to listed public firms and universities. The definitions of patent originality, generality, and basicness follow Trajtenberg, Henderson, and Jaffe (1997). We also compare their distributions in the following three periods: 1976-1985, 1986-1995, and 1996-2010. We split our whole sample period (1976-2010) into three almost equal sub-periods to examine the evolution of patent forward citation, patent originality, and patent generality over time. We split our sample at 1985-1986 due to the adoption of the Bayh–Dole Act at 1980 and the surge of personal computer industry at early 1980s. We also split our sample at 1995-1996 for the “.com bubble” started around 1996-1997. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively, when comparing the mean of universities’ patents with the mean of listed firms’ patents.

Panel A

Panel A reports summary statistics for patent quality/importance (number of forward citations within 5 years) (A1), patent generality (A2), patent originality (A3), patent basicness (A4), number of claims (A5), and the indicator variable for international patent family affiliation (A6) in the following three periods: 1976-1985, 1986-1995, and 1996-2010.

Panel A1: Summary Statistics of Forward 5yr Citations

	Universities			Public Firms		
	1976-1985	1986-1995	1996-2010	1976-1985	1986-1995	1996-2010
Mean	3.97***	6.76***	5.34	2.88	5.63	5.28
Median	2.00	4.00	2.00	2.00	3.00	2.00
Standard Deviation	6.45	9.96	10.63	4.09	8.29	10.03
Minimum	0.00	0.00	0.00	0.00	0.00	0.00
1st Percentile	0.00	0.00	0.00	0.00	0.00	0.00
5th Percentile	0.00	0.00	0.00	0.00	0.00	0.00
25th Percentile	1.00	1.00	0.00	0.00	1.00	0.00
75th Percentile	5.00	8.00	6.00	4.00	7.00	6.00
95th Percentile	14.00	24.00	23.00	10.00	19.00	21.00
99th Percentile	29.00	47.00	52.00	19.00	39.00	48.00
Maximum	109.00	173.00	213.00	152.00	286.00	539.00
#Obs	4,646	15,915	57,319	213,285	262,794	885,692

Panel A (continued)

Panel A2: Summary Statistics of Patent Generality						
	Universities			Public Firms		
	1976-1985	1986-1995	1996-2010	1976-1985	1986-1995	1996-2010
Mean	0.46***	0.48***	0.43***	0.42	0.43	0.35
Median	0.51	0.53	0.50	0.47	0.48	0.33
Standard Deviation	0.29	0.29	0.33	0.31	0.30	0.33
Minimum	0.00	0.00	0.00	0.00	0.00	0.00
1st Percentile	0.00	0.00	0.00	0.00	0.00	0.00
5th Percentile	0.00	0.00	0.00	0.00	0.00	0.00
25th Percentile	0.22	0.26	0.00	0.07	0.16	0.00
75th Percentile	0.68	0.70	0.69	0.67	0.67	0.63
95th Percentile	0.87	0.86	1.00	0.90	0.87	1.00
99th Percentile	1.00	1.00	1.00	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00
#Obs	4,646	15,915	57,319	213,285	262,794	885,692

Panel A (continued)

Panel A3: Summary Statistics of Patent Originality						
	Universities			Public Firms		
	1976-1985	1986-1995	1996-2010	1976-1985	1986-1995	1996-2010
Mean	0.27***	0.37***	0.44***	0.25	0.35	0.38
Median	0.00	0.40	0.50	0.00	0.33	0.40
Standard Deviation	0.37	0.35	0.33	0.36	0.34	0.32
Minimum	0.00	0.00	0.00	0.00	0.00	0.00
1st Percentile	0.00	0.00	0.00	0.00	0.00	0.00
5th Percentile	0.00	0.00	0.00	0.00	0.00	0.00
25th Percentile	0.00	0.00	0.00	0.00	0.00	0.00
75th Percentile	0.62	0.67	0.70	0.56	0.67	0.66
95th Percentile	1.00	1.00	1.00	1.00	1.00	0.87
99th Percentile	1.00	1.00	1.00	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00
#Obs	4,646	15,915	57,319	213,285	262,794	885,692

Panel A (continued)

Panel A4: Summary Statistics of Patent Basicness						
	Universities			Public Firms		
	1976-1985	**1986-1995**	**1996-2010**	**1976-1985**	**1986-1995**	**1996-2010**
Mean	0.25***	0.411***	0.50***	0.07	0.10	0.12
Median	0.05	0.38	0.54	0.00	0.00	0.00
Standard Deviation	0.33	0.35	0.34	0.17	0.19	0.20
Minimum	0.00	0.00	0.00	0.00	0.00	0.00
1st Percentile	0.00	0.00	0.00	0.00	0.00	0.00
5th Percentile	0.00	0.00	0.00	0.00	0.00	0.00
25th Percentile	0.00	0.00	0.18	0.00	0.00	0.00
75th Percentile	0.50	0.73	0.81	0.00	0.13	0.17
95th Percentile	1.00	1.00	1.00	0.44	0.50	0.59
99th Percentile	1.00	1.00	1.00	1.00	0.88	0.89
Maximum	1.00	1.00	1.00	1.00	1.00	1.00
#Obs	4,646	15,915	57,319	213,285	262,794	885,692

Panel A (continued)

Panel A5: Summary Statistics of Number of Claims						
	Universities			Public Firms		
	1976-1985	1986-1995	1996-2010	1976-1985	1986-1995	1996-2010
Mean	14.65***	16.71***	22.22***	10.96	13.77	18.35
Median	11.00	14.00	18.00	9.00	11.00	16.00
Standard Deviation	15.83	13.28	18.39	9.41	11.31	13.74
Minimum	0.00	0.00	0.00	1.00	1.00	1.00
1st Percentile	1.00	1.00	1.00	1.00	1.00	1.00
5th Percentile	2.00	3.00	4.00	2.00	2.00	4.00
25th Percentile	7.00	8.00	10.00	5.00	6.00	9.00
75th Percentile	19.00	21.00	28.00	14.00	18.00	23.00
95th Percentile	36.00	40.00	55.00	27.00	33.00	42.00
99th Percentile	62.00	63.00	90.00	46.00	54.00	68.00
Maximum	642.00	219.00	309.00	298.00	868.00	683.00
#Obs	4,646	15,915	57,319	213,285	262,794	885,692

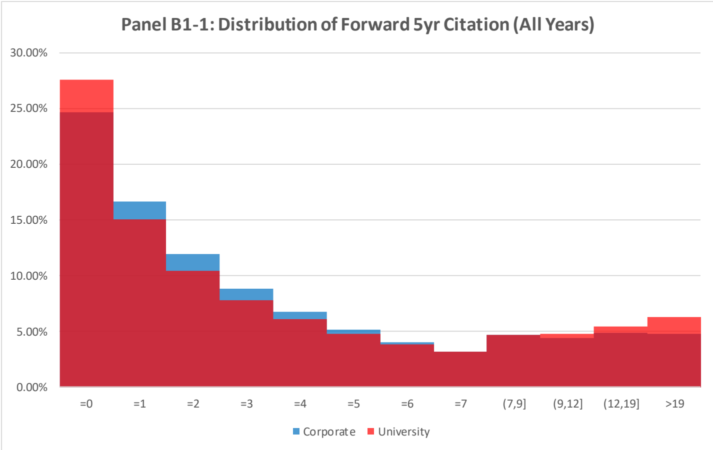
Panel A (continued)

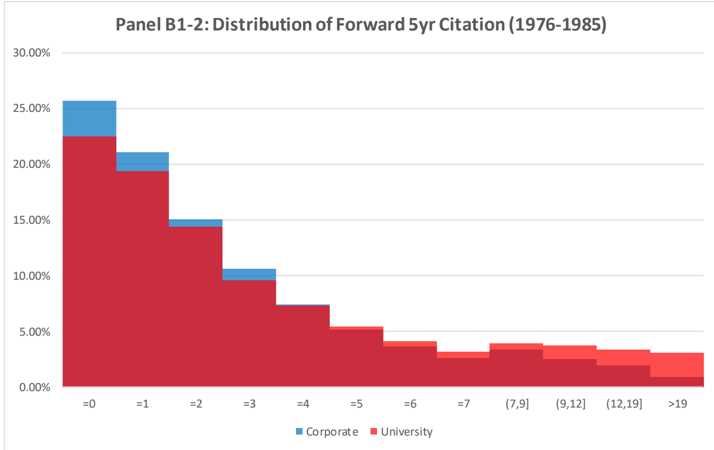
Panel A6: Summary Statistics of International Family						
	Universities			**Public Firms**		
	1976-1985	**1986-1995**	**1996-2010**	**1976-1985**	**1986-1995**	**1996-2010**
Mean	0.21***	0.32***	0.56***	0.48	0.57	0.60
Median	0.00	0.00	1.00	0.00	1.00	1.00
Standard Deviation	0.41	0.47	0.50	0.50	0.50	0.49
Minimum	0.00	0.00	0.00	0.00	0.00	0.00
1st Percentile	0.00	0.00	0.00	0.00	0.00	0.00
5th Percentile	0.00	0.00	0.00	0.00	0.00	0.00
25th Percentile	0.00	0.00	0.00	0.00	0.00	0.00
75th Percentile	0.00	1.00	1.00	1.00	1.00	1.00
95th Percentile	1.00	1.00	1.00	1.00	1.00	1.00
99th Percentile	1.00	1.00	1.00	1.00	1.00	1.00
Maximum	1.00	1.00	1.00	1.00	1.00	1.00
#Obs	4,646	15,915	57,319	213,285	262,794	885,692

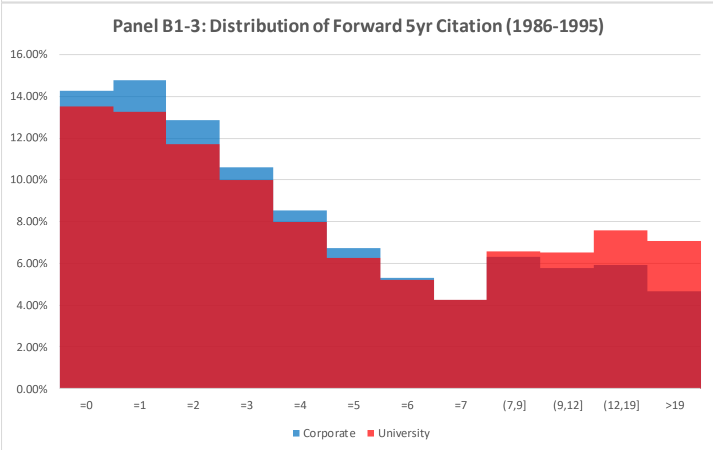
Panel B

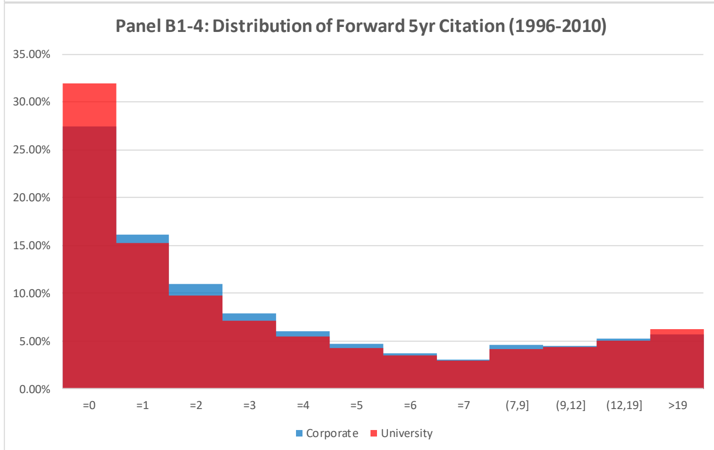
Panel B shows the distributions of patent quality/importance (number of forward citations within 5 years), patent originality, patent generality, and patent basicness of listed public firms and universities. For quality/importance, we compute the frequency of observations within each category of entities for twelve intervals (citation equal to 0 (5th-20th percentile), citation equal to 1 (25th-40th percentile), citation equal to 2 (45th-50th percentile), citation equal to 3 (55th-60th percentile), citation equal to 4 (65th percentile), citation equal to 5 (70th percentile), citation equal to 6 (75th percentile), citation equal to 7 (80th percentile), citation larger than 7 and smaller than or equal to 9 (85th percentile), citation larger than 9 and smaller than or equal to 12 (90th percentile), citation larger than 12 and smaller than or equal to 19 (95th percentile), and citation larger than 19). For the distributions of patent originality, generality, and basicness (all bounded from 0 to 1), we report their frequencies in each equal bin between 0 to 1. For number of claims, we compute the frequency of observations within each category of entities for ten intervals (smaller than 4 (10th percentile), larger than 4 and smaller than 7 (20th percentile), larger than 7 and smaller than 9 (30th percentile), larger than 9 and smaller than 11 (40th percentile), larger than 11 and smaller than 14 (50th percentile), larger than 14 and smaller than 17 (60th percentile), larger than 17 and smaller than 20 (70th percentile), larger than 20 and smaller than 23 (80th percentile), larger than 23 and smaller than 31 (90th percentile), and larger than 31). We also compare their distributions in the following four periods: 1976-1985, 1986-1995, 1996-2010, and 1976-2010 (all years).

Panel B (continued)









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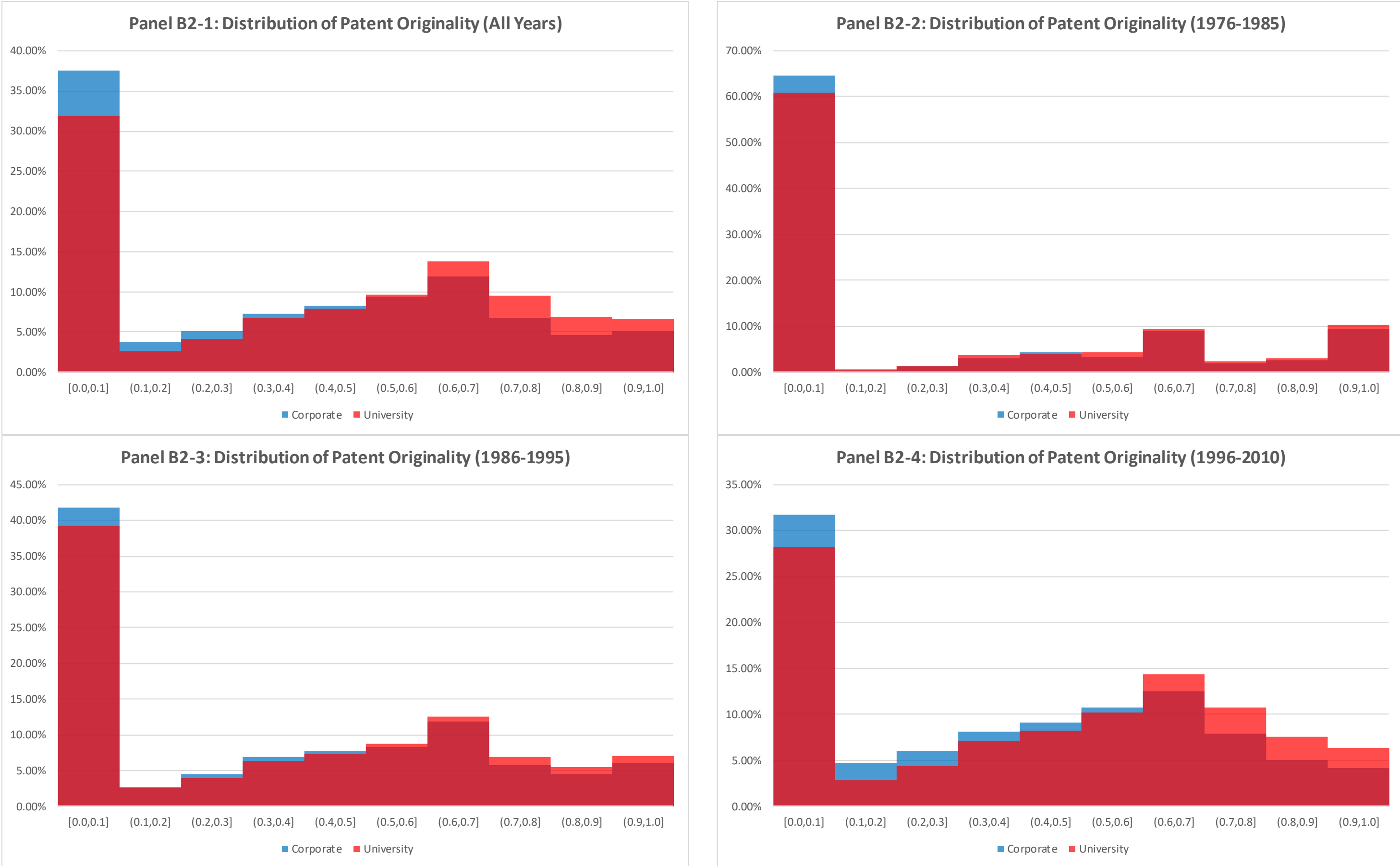

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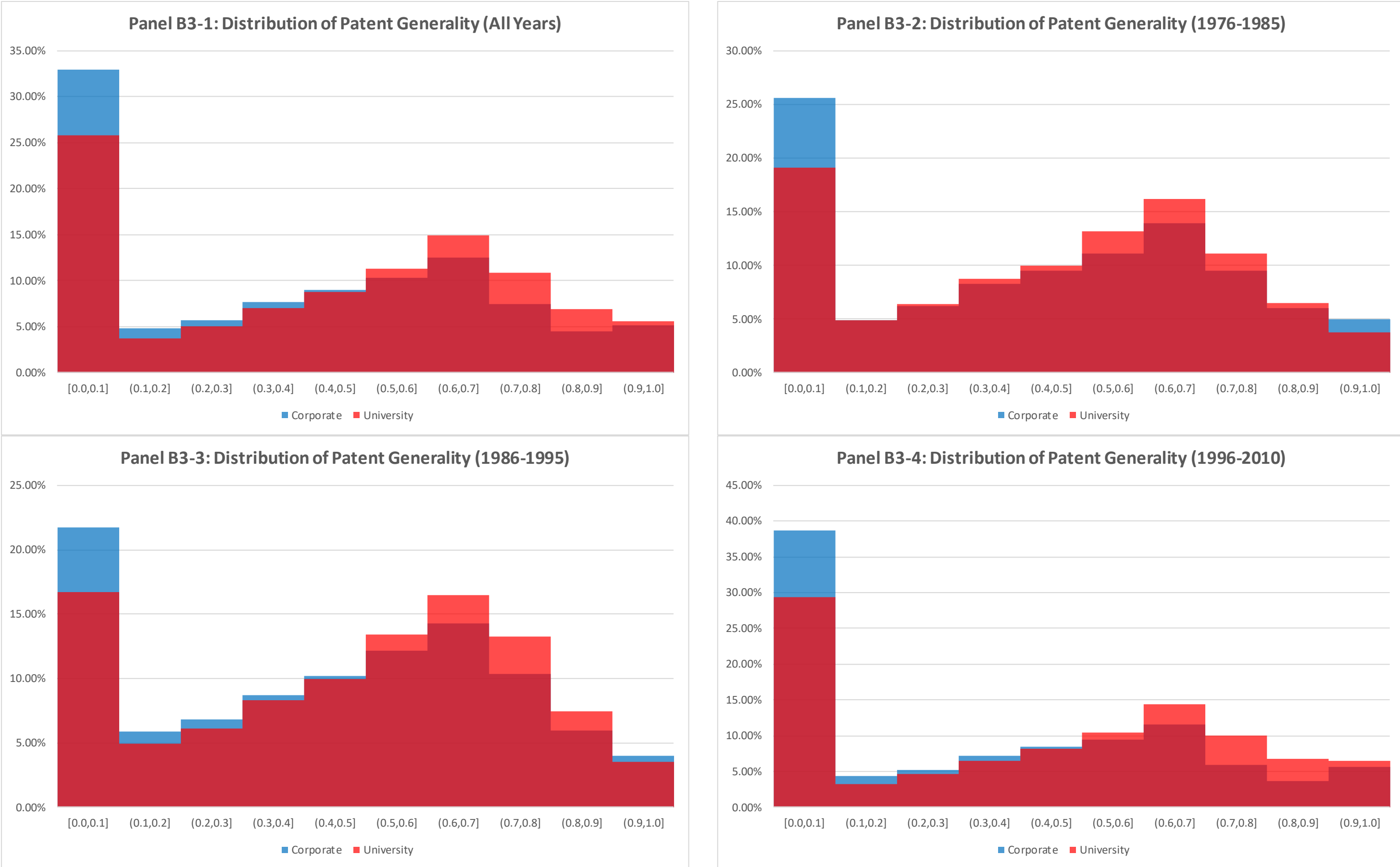

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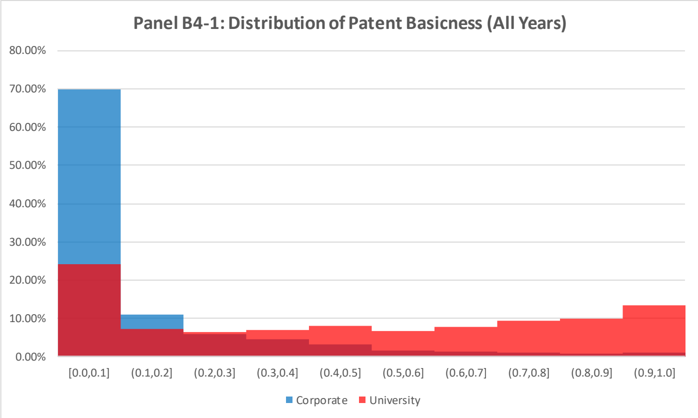

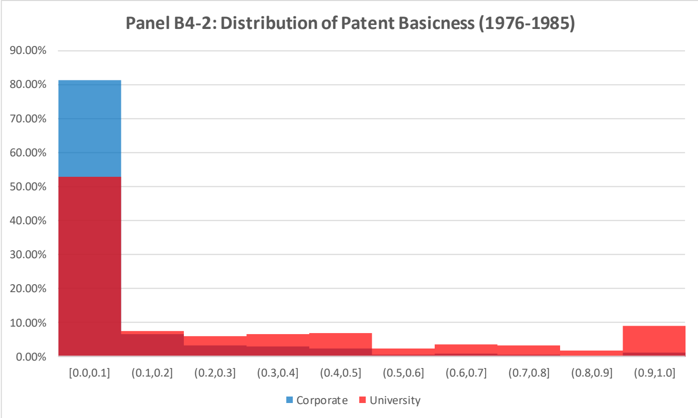

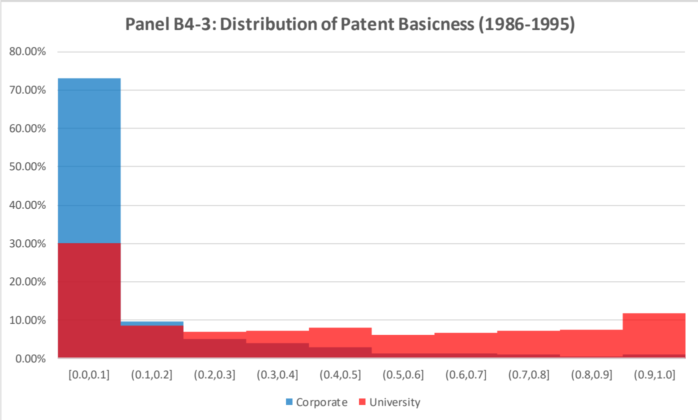

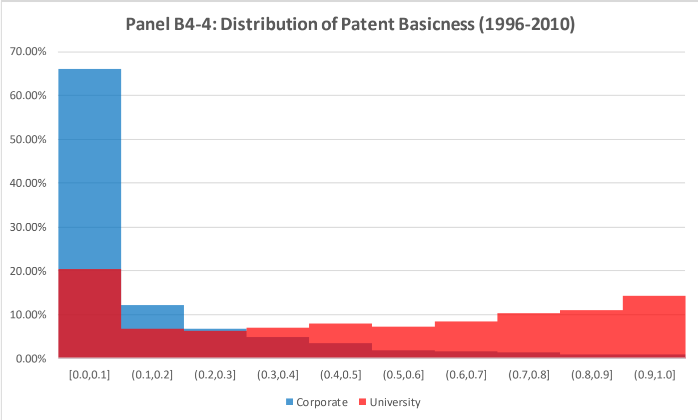

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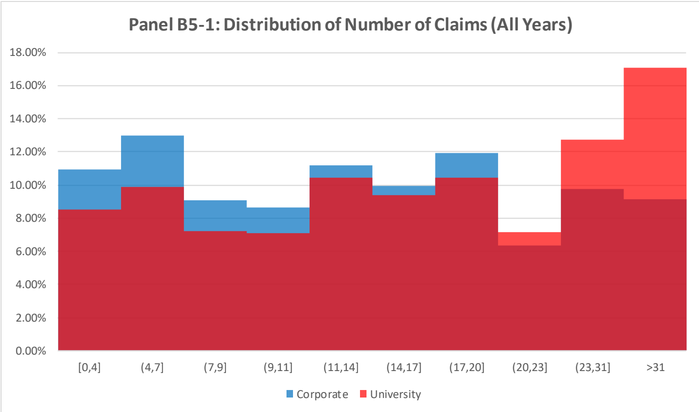
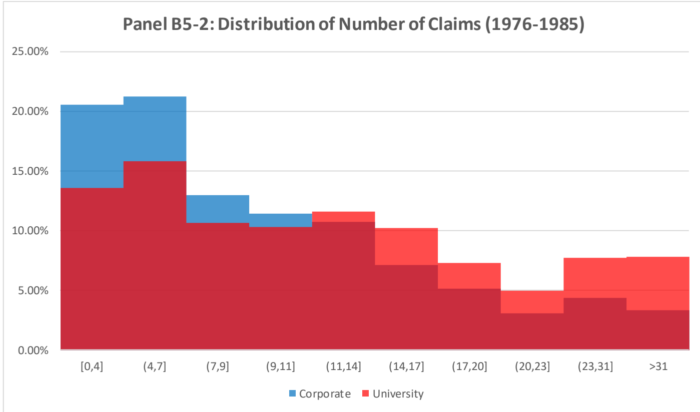
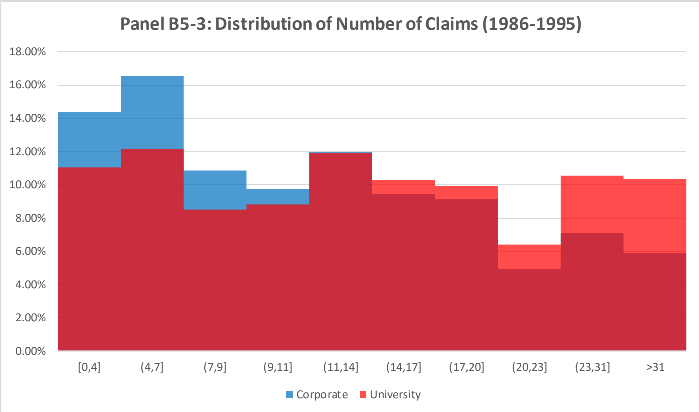
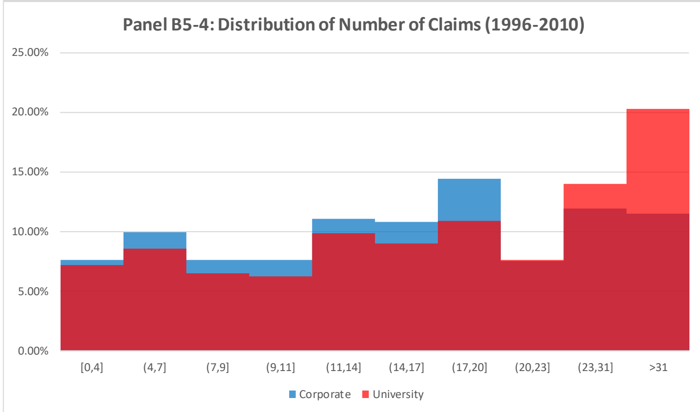


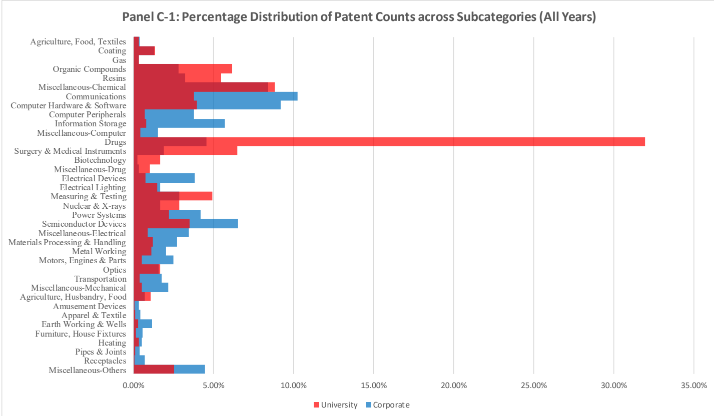


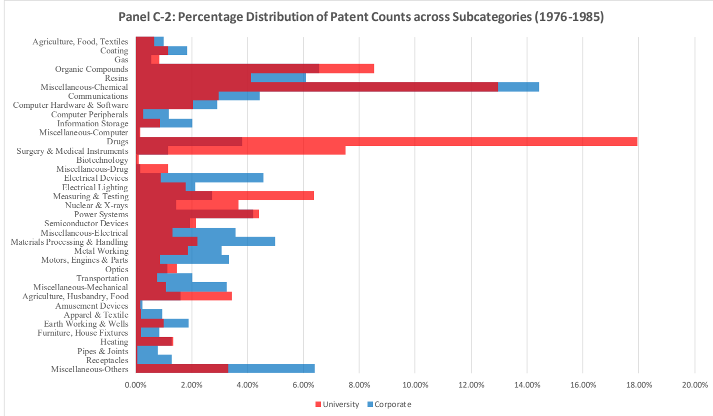


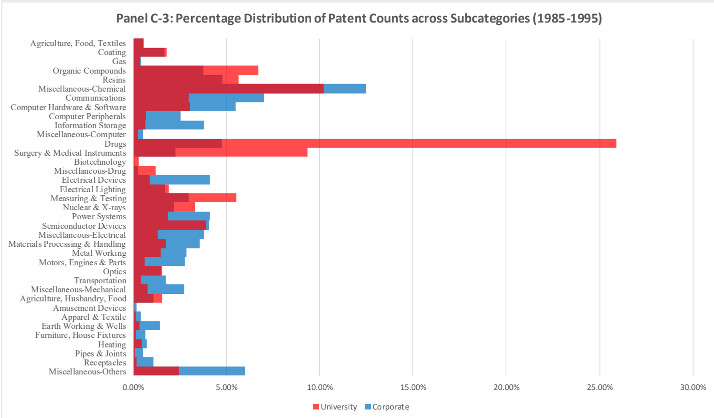


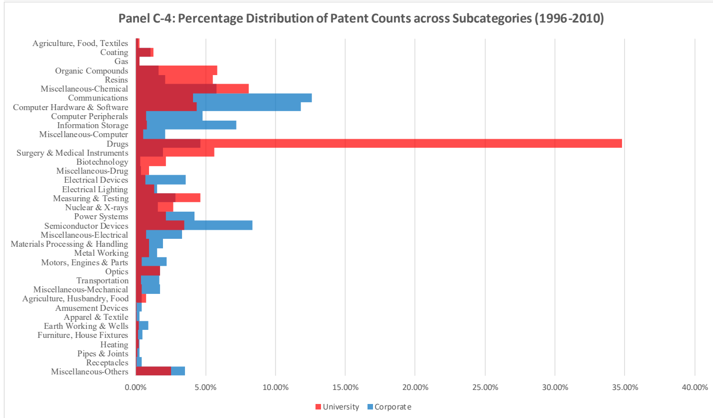
Panel C

Panel C compares the number of patents granted in each subcategory of listed public firms and universities. Percentages are reported within each category of entities. We also compare their distributions in the following four periods: 1976-1985, 1986-1995, 1996-2010, and 1976-2010 (all years). A Kolmogorov-Smirnov test confirms that distributions of patent counts across subcategories are statistically different (p-value<0.01) between universities and public firms.



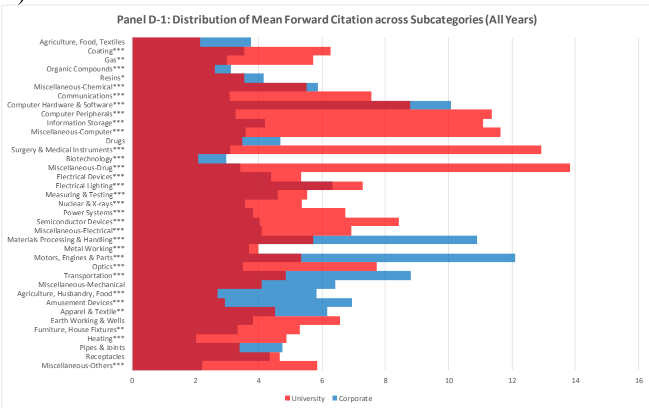


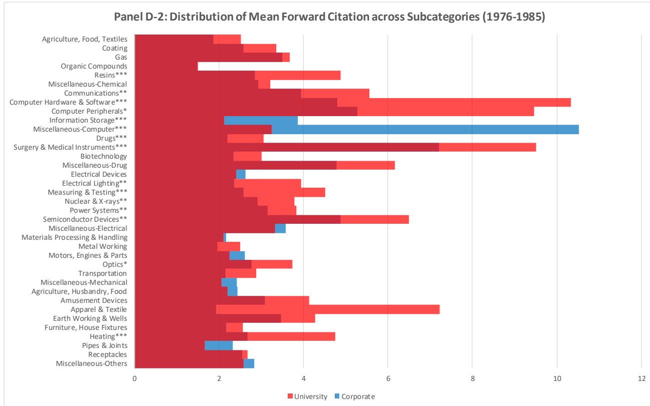


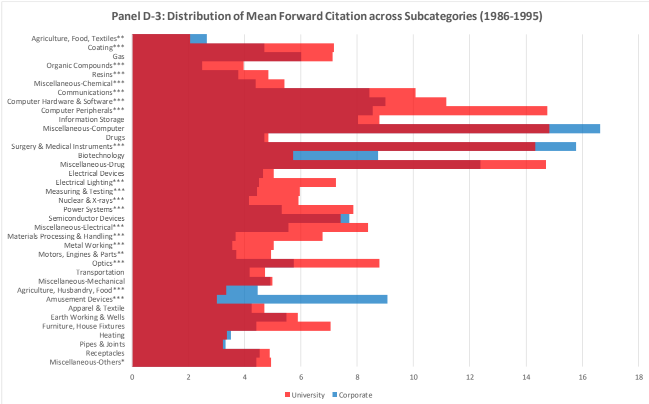


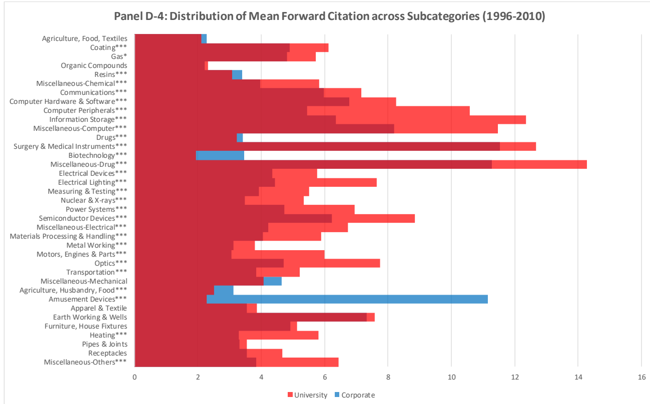
Panel D

Panel D reports the mean patent quality/importance (number of forward citations within 5 years) in each subcategory within each category of entities (i.e., public firm and university). We report the statistical significance of the difference between corporates and universities in each subcategory with two-sample t-test. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. We also compare their distributions in the following four periods: 1976-1985, 1986-1995, 1996-2010, and 1976-2010 (all years).







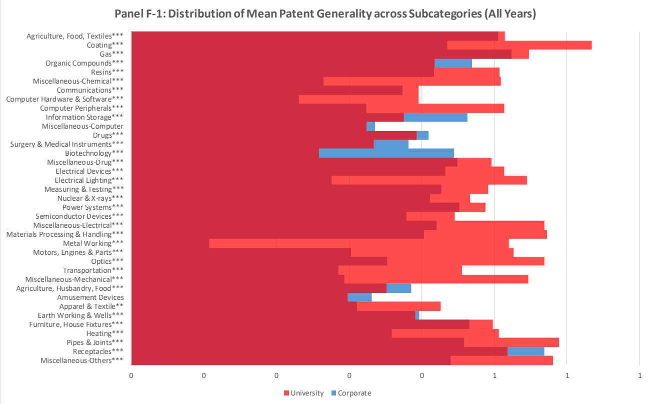


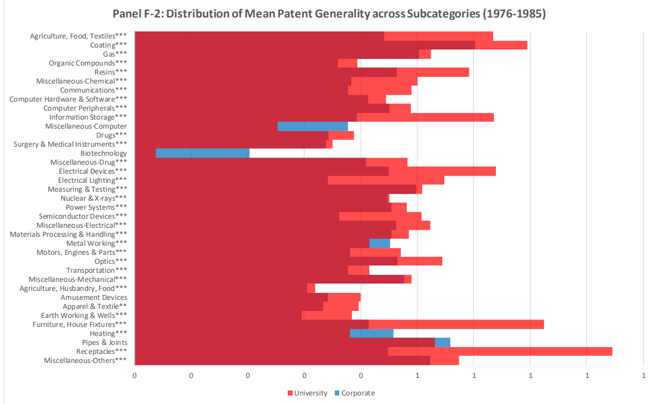
Panel E

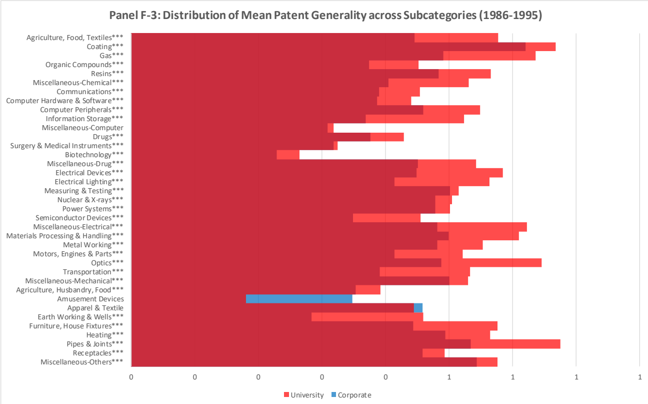
Panel E reports the mean patent originality (one minus the HHI of citations given to other patents over patent subcategories) in each subcategory within each category of entities (i.e., corporate and university). We test the statistical significance of the difference between corporates and universities in each subcategory with two-sample t-test. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. We also compare their distributions in the following four periods: 1976-1985, 1986-1995, 1996-2010, and 1976-2010 (all years).

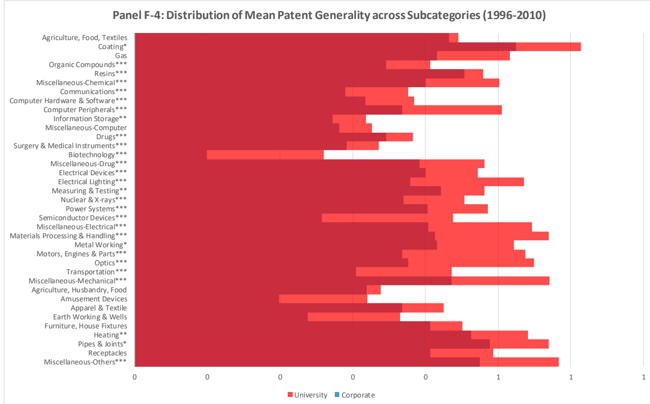
Panel F

Panel F reports the mean patent generality (one minus the HHI of citations received from other patents over patent subcategories) in each subcategory within each category of entities (public firm and university). We report the statistical significance of the difference between public firms and universities in each subcategory with two-sample t-test. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. We also report their distributions in the following four periods: 1976-1985, 1986-1995, 1996-2010, and 1976-2010 (all years).



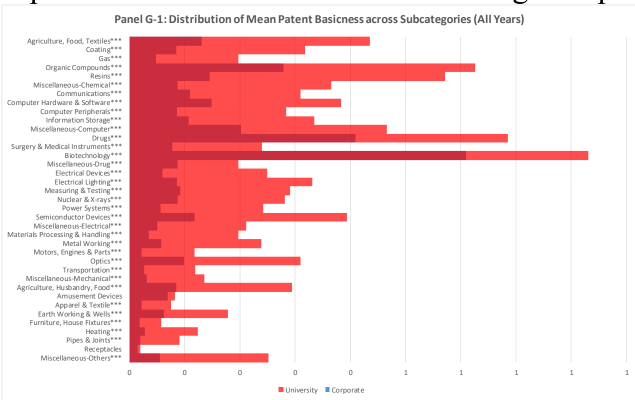


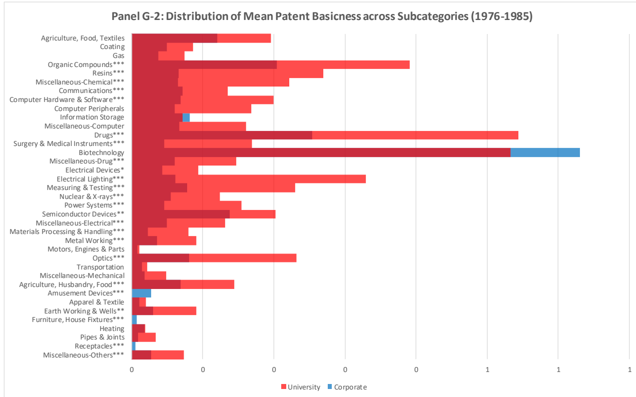


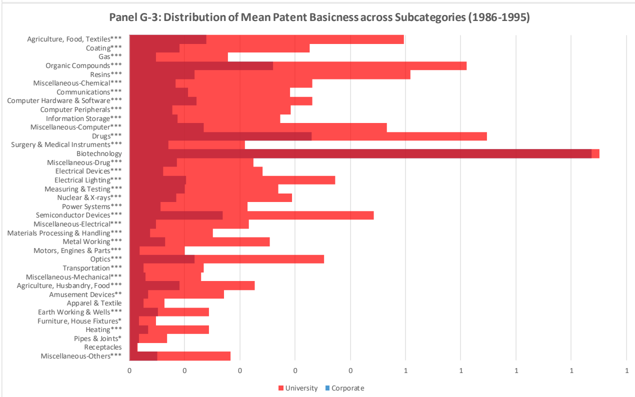


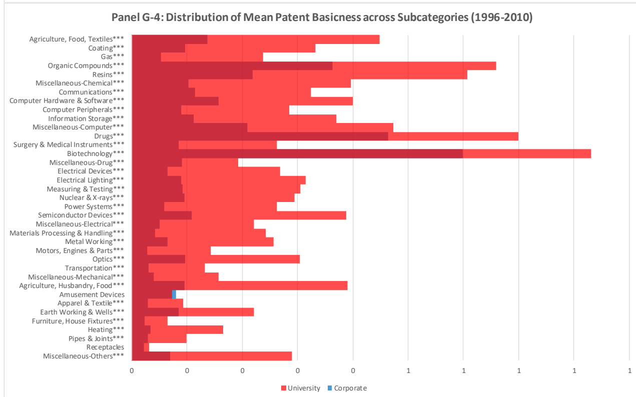
Panel G

Panel G reports the mean patent basicness (the ratio of the number of references to prior "non-patent documents" divided by the total references) in each subcategory within each category of entities (public firm and university). We report the statistical significance of the difference between public firms and universities in each subcategory with two-sample t-test. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. We also report their distributions in the following four periods: 1976-1985, 1986-1995, 1996-2010, and 1976-2010 (all years).



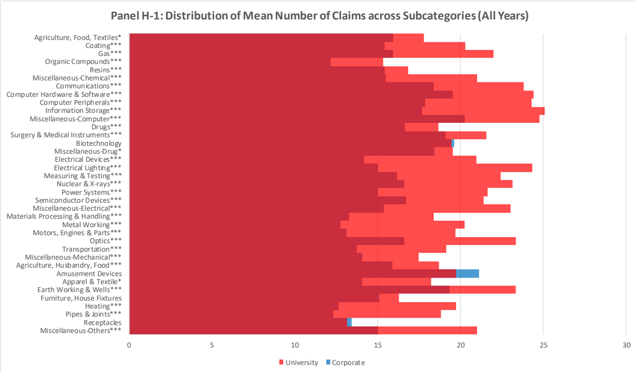


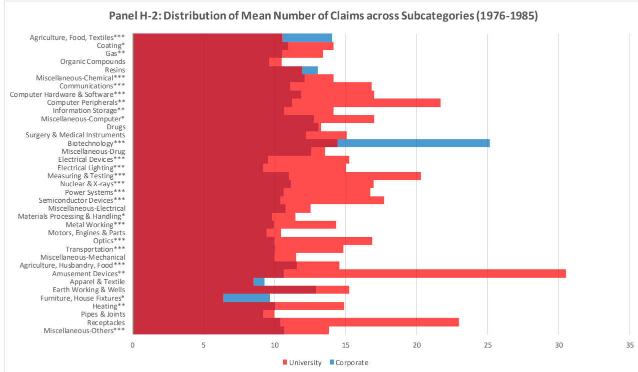


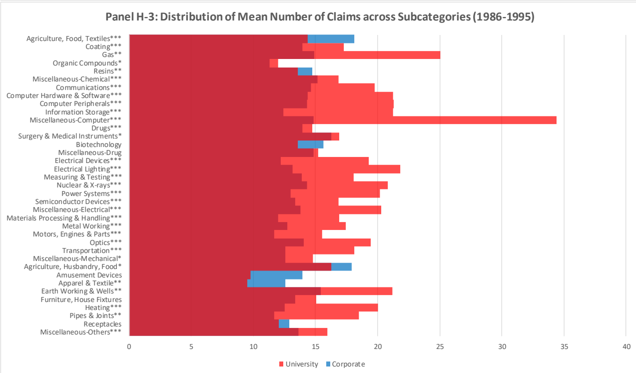


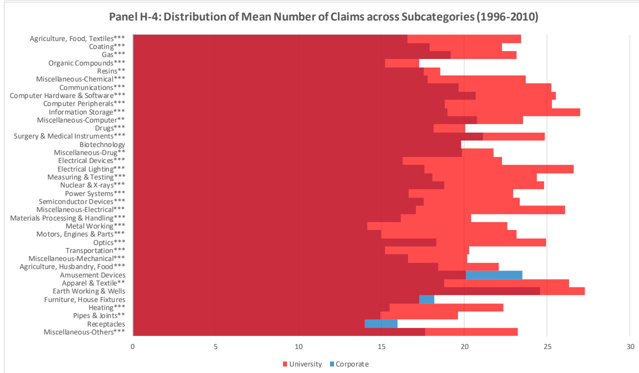
Panel H

Panel H reports the mean number of claims in each subcategory within each category of entities (public firm and university). We report the statistical significance of the difference between public firms and universities in each subcategory with two-sample t-test. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. We also report their distributions in the following four periods: 1976-1985, 1986-1995, 1996-2010, and 1976-2010 (all years).



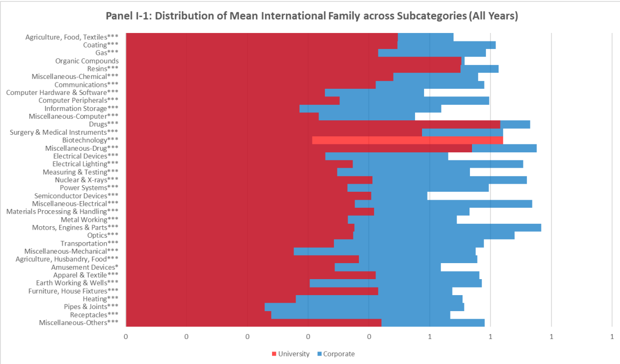


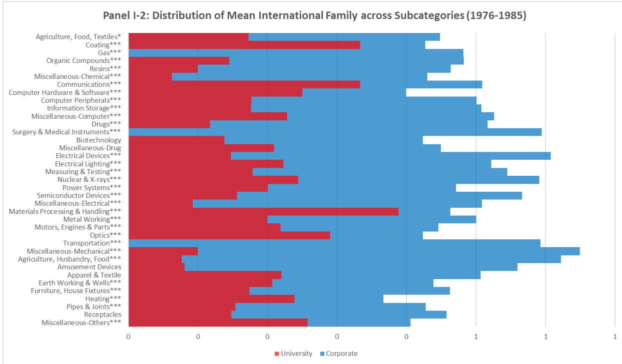


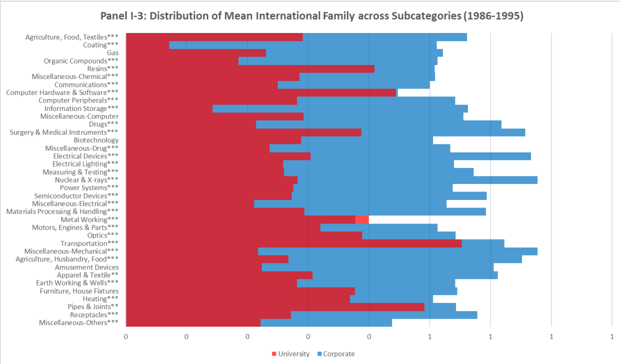


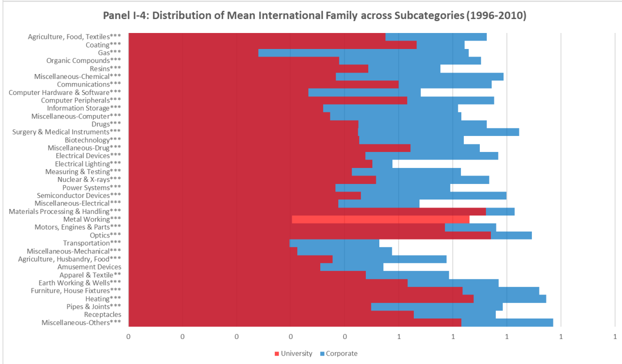
Panel I

Panel I reports the mean of the indicator variables for whether a patent is affiliated with international patent families or not in each subcategory within each category of entities (public firm and university). We report the statistical significance of the difference between public firms and universities in each subcategory with two-sample t-test. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. We also report their distributions in the following four periods: 1976-1985, 1986-1995, 1996-2010, and 1976-2010 (all years).









Online Table 3: Summary Statistics of Lifetime Revenue and Characteristics of Licensed and Unlicensed Patents in a U.S. Research-Oriented University.

Using a patent licensing dataset provided by a prominent research-oriented U.S. university, we report the distribution of lifetime revenue (in millions), estimated patent value (in millions), maximum royalty rate (in percentage), license fee (in millions), exclusivity, number of technologies (patented and unpatented) in the licensing agreement/package, number of patents in the agreement/package, number of inventors, patent quality, patent generality, patent originality, patent basicness, number of claims, and international family of licensed patents in Panel A. To calculate estimated patent value (PatVal), we first adopt regression model (2) in Table 2 and estimate the coefficients on patent characteristics, and then we input the coefficient estimates and patent characteristics of each university patent and compute its PatVal. PatVal is set to be zero if it is estimated as negative. We report the distribution of estimated patent value (in millions), number of inventors, patent quality, patent generality, patent originality, patent basicness, number of claims, and international family of unlicensed patents in Panel B. We also compare these variables' averages across the licensed and unlicensed groups using two-sample t-test. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively. Lifetime revenue and license fee is split evenly to each intellectual property item in the same licensed agreement. Estimated patent value, lifetime revenue, and license fee are winsorized by their 1% and 99% percentiles. Sample period: 1976-2010.

Panel A: Licensed Patents

	Mean	Std	Min	Q1	Median	Q3	Max	#Obs
Actual Patent Lifetime Revenue	0.10	0.23	0.00	0.00	0.01	0.04	1.03	765
Estimated Patent Value (PatVal)	0.37***	0.11	0.09	0.29	0.38	0.45	0.57	765
Max Royalty Rate	3.44	3.49	0.00	0.75	3.00	5.00	25.00	765
License Fee	0.01	0.04	0.00	0.00	0.00	0.01	0.41	765
Exclusitivity	0.61	0.49	0	0	1	1	1	765
#IP in package	17.45	26.87	1	3	7	19	99	765
#Patent in package	13.14	18.53	1	2	6	17	68	765
#Inventor	2.73***	1.43	1	2	2	3	16	765
Quality	7.34***	9.19	0	1	4	11	98	765
Generality	0.41***	0.31	0.00	0.00	0.50	0.64	1.00	765
Originality	0.33***	0.31	0.00	0.00	0.33	0.59	1.00	765
Basicness	0.55***	0.31	0.00	0.31	0.55	0.83	1.00	765
Claims	15.9**	13.20	1.00	7.00	12.00	21.00	104.00	765
International Family	0.69***	0.46	0	0	1	1	1	765

Panel B: Unlicensed Patents

	Mean	Std	Min	Q1	Median	Q3	Max	#Obs
Estimated Patent Value (PatVal)	0.3	0.11	0.08	0.22	0.31	0.38	0.57	821
#Inventor	2.44	1.21	1	2	2	3	12	821
Quality	3.11	5.68	0	0	1	4	93	821
Generality	0.32	0.33	0.00	0.00	0.28	0.60	1.00	821
Originality	0.27	0.33	0.00	0.00	0.00	0.58	1.00	821
Basicness	0.48	0.36	0.00	0.13	0.50	0.83	1.00	821
Claims	14.60	11.69	1.00	6.00	12.00	20.00	86.00	821
International Family	0.39	0.49	0	0	0	1	1	821

Online Table 4: Efficiency of Patent Value Production across U.S. Universities. Across the 147 U.S. universities in Table 5 with non-mising 11 university characteristic variables, we execute non-parametric Data Envelpement Analyses (DEA) to examine the efficiency of patent value production from university inputs of R&D, Faculties, FTE, NSF, NIH, Age, Carnegie, TTO, MedicalSchool, BusinessSchool, and IvyLeague. *Total Inefficiency* is measured by one minus the estimated theta. To measure *Input Inefficiency* of a factor that is free of scale, we use the estimated slack divided by the factor mean across universities.

	Mean	STD
Total Inefficiency	0.42	0.55
Input Inefficiency: R&D	0.09	0.46
Input Inefficiency: Faculty	0.14	0.25
Input Inefficiency: FTE	0.12	0.34
Input Inefficiency: NSF	0.12	0.54
Input Inefficiency: NIH	0.26	0.65
Input Inefficiency: Age	0.16	0.30
Input Inefficiency: Carnegie	0.28	0.66
Input Inefficiency: TTO	0.12	0.50
Input Inefficiency: MedicalSchool	0.30	0.35
Input Inefficiency: BusinessSchool	0.16	0.51
Input Inefficiency: IvyLeague	0.16	1.09