

COMMERCIALIZATION OF UNIVERSITIES' INTELLECTUAL PROPERTY:
EVALUATING PRODUCTIVITY BASED ON STRUCTURE, RESEARCH
FUNDING, AND ENTREPRENEURIAL ASPIRATIONS

Thesis
LB
2321
.P93
2015

02118010110474

A Dissertation

Presented to

The Faculty of the Department of Educational Leadership

Sam Houston State University

In Partial Fulfillment

of the Requirements for the Degree of

Doctor of Education

by

Richard A. Prets

December, 2015

COMMERCIALIZATION OF UNIVERSITIES' INTELLECTUAL PROPERTY:
EVALUATING PRODUCTIVITY BASED ON STRUCTURE, RESEARCH
FUNDING, AND ENTREPRENEURIAL ASPIRATIONS

by

Richard A. Prets

APPROVED:

Dr. John R. Slate
Dissertation Co-chair

Dr. Matthew B. Fuller
Dissertation Co-chair

Dr. Ricardo Montelongo
Committee Member

Approved:

Dr. Stacey L. Edmonson
Dean, College of Education

DEDICATION

I would like to dedicate this dissertation to my three children. Emily, Richie, and Sidney. It is my hope that this dedication is accepted as intended. It is a challenge. I challenge each of my children to dream big. Set lofty goals both educationally and professionally. Work as hard as is necessary to achieve the ostensibly unachievable. Never accept mediocrity. Embrace life-long learning. And, always do what is good and what is right as they are not the same.

ABSTRACT

Prets, Richard A.. *Commercialization of universities' intellectual property: Evaluating productivity based on structure, research funding, and entrepreneurial aspirations*. Doctor of Education (Educational Leadership), December 2015. Sam Houston State University, Huntsville, Texas.

Purpose

The purpose of this journal-ready dissertation was to provide timely information to technology transfer professionals that may lead to more productive policies and practices in the commercialization of universities' intellectual property. This investigation provided insights regarding the sources and the productivity of academic research funding. The characteristics and activities of highly performing Technology Transfer Offices were highlighted in this study. The final objective was to determine the effectiveness of industry-university commercial partnerships.

Method

This study was conducted with non-experimental, causal-comparative, and correlational research designs (Creswell, 2009). Data from the Association of University Technology Managers' 2011, 2012, and recently released 2013 Licensing Activity Survey Questionnaires were obtained and analyzed through use of inferential statistical procedures. Respondents were technology transfer professionals and/or their designees.

Findings

Study one was conducted to identify differences between public and private universities in sourcing research funding and in achieving commercialization success. In this investigation, private universities were more adept at procuring federal research

funding than public universities. In addition, private research universities had generated a greater amount of licensing income for each dollar of research expenditure.

The second study was an investigation of the extent to which the licensing income of U.S. universities could be predicted by five questionnaire items (i.e., Number of Licensing Managers, Number of Licensing Agreements Executed, Number of U.S. Patents Issued, Total Research Expenditures, and Number of Start-Up Companies Initiated) chosen from the surveys. An All Possible Subsets regression analysis revealed that the Number of U.S. Patents Issued was the only statistically significant predictor of licensing income generated from universities' intellectual property for all three survey years analyzed in this investigation.

In study three, universities that had accepted equity in start-up companies had statistically significantly higher licensing revenue, in all three years analyzed in this investigation, than universities that did not accept equity positions in start-up ventures. In addition, the number of universities that accepted equity positions in start-up companies increased in each of the three years analyzed in this investigation. However, cashed-in equity fell, as a percentage of total licensing revenue, for the universities that had accepted equity in start-up ventures.

KEY WORDS: Universities' Intellectual Property, Commercialization, Technology Transfer

ACKNOWLEDGMENTS

My ability to successfully navigate through this doctoral program, which has culminated with this completed dissertation, was made possible through the gratifying, collaborative efforts of Cohort 27, the sage advice from members of my dissertation committee and the loving support from my wife and family. I would like to express my deepest gratitude and admiration for my co-chair, Dr. John R. Slate. In 10 years as a student in higher education, I have never had a more competent and responsive mentor. I want to thank co-chair Dr. Matthew B. Fuller, not only for the time and effort devoted to this committee, but also for leading many of the most thought-provoking and insightful discussions in this doctoral program. I would also like to thank Dr. Ricardo Montelongo for agreeing to devote his valuable time as a committee member.

Most notably, I would like to acknowledge the enormous contribution that my wife has made toward all of my accomplishments in life, personal, academic, and professional. Throughout our marriage, Alice Marie has done the vast majority of the heavy lifting (which is understandable for people who knew our son as a child) in caring for our home, which is actually a small ranch, and in sculpting the characters of our children, Emily, Richie, and Sidney. Alice's selfless devotion to our family has afforded me the opportunity to claim credit for raising three truly remarkable young adults and has also allowed me to pursue, with few distractions, this doctoral degree.

TABLE OF CONTENTS

	Page
DEDICATION	iii
ABSTRACT.....	iv
ACKNOWLEDGEMENTS	vi
TABLE OF CONTENTS.....	vii
LIST OF TABLES	ix
CHAPTERS	
I INTRODUCTION AND LITERATURE REVIEW	1
Statement of the Problem.....	19
Purpose of the Study	20
Significance of the Study	22
Definition of Terms.....	23
Delimitations.....	27
Limitations	28
Assumptions.....	28
Procedures.....	28
Organization of the Study	29
II IDENTIFYING DIFFERENCES BETWEEN PUBLIC AND PRIVATE UNIVERSITIES IN SOURCING RESEARCH FUNDING AND ACHIEVING COMMERCIALIZATION SUCCESS.....	31
Abstract	32
Method	40

Results.....	42
Discussion.....	49
References.....	56
III PREDICTING LICENSING REVENUE GENERATED FROM COMMERCIALIZATION OF UNIVERSITIES' INTELLECTUAL PROPERTY.....	61
Abstract.....	62
Method.....	73
Results.....	75
Discussion.....	79
References.....	83
IV IDENTIFYING ECONOMIC RAMIFICATIONS RESULTING FROM ACCEPTING EQUITY VS. REQUIRING TRADITIONAL LICENSING PAYMENT METHODS.....	90
Abstract.....	91
Method.....	99
Results.....	101
Discussion.....	105
References.....	111
V DISCUSSION.....	116
REFERENCES.....	124
APPENDIX.....	129
VITA.....	130

LIST OF TABLES

TABLE	Page
2.1 Descriptive Statistics for Federally Funded Research Expenditures, Privately Funded Research Expenditures, and Licensing Income per Dollar of Research Expenditure for the AUTM’s 2011 Licensing Survey by University Type	58
2.2 Descriptive Statistics for Federally Funded Research Expenditures, Privately Funded Research Expenditures, and Licensing Income per Dollar of Research Expenditure for the AUTM’s 2012 Licensing Survey by University Type	59
2.3 Descriptive Statistics for Federally Funded Research Expenditures, Privately Funded Research Expenditures, and Licensing Income per Dollar of Research Expenditure for the AUTM’s 2013 Licensing Survey by University Type	60
3.1 Technology Transfer Office Success Factors	86
3.2 Descriptive Statistics for 2011 Licensing Revenue Outcome and Predictor Variables	87
3.3 Descriptive Statistics for 2012 Licensing Revenue Outcome and Predictor Variables	88
3.4 Descriptive Statistics for 2013 Licensing Revenue Outcome and Predictor Variables	89
4.1 Descriptive Statistics for Universities That Accepted Equity or Not by Type of Licensing Revenue for the 2011 Licensing Survey	113

4.2 Descriptive Statistics for Universities That Accepted Equity or Not by Type of Licensing Revenue for the 2012 Licensing Survey.....	114
4.3 Descriptive Statistics for Universities That Accepted Equity or Not by Type of Licensing Revenue for the 2013 Licensing Survey.....	115

CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

Prior to 1980, universities could not easily obtain patents on discoveries resulting from research funded by the federal government (Martin, Gruetzmacher, Lanham, & Brady, 2004). The patenting process was dramatically altered, however, by the passage of the Bayh-Dole Patent and Trademark Amendments Act of 1980. This act gave universities and other research institutions the right to claim title to technologies and inventions that resulted from federally sponsored research and development. The intent of Congress, passing this legislation, was to spur commercialization of universities' intellectual property and to promote collaboration between research institutions and private industry. The Act also ensured that the Federal Government retained limited rights to use inventions arising out of federally sponsored research.

After many years of solid growth, federal funding of academic research may have reached a plateau. Last year, federally funded expenditures for academic research totaled \$39.9 billion, which represents a slight decline of 0.7% below the previous year. In sharp contrast, industry sponsored research soared to \$4.58 billion, which translates to an increase of 11% (Association of University Technology Managers, 2014).

Researchers (Colyvas et al., 2002; Prets & Slate, 2014; Rahal & Rabelo, 2006; Turk-Bicakci & Brint, 2005) have determined that a number of factors have an effect on the successful commercialization of universities' intellectual properties. Profitable commercialization efforts can be abetted by the attributes (e.g., size, wealth) and by the culture of research universities (Turk-Bicakci & Brint, 2005). Fruitful commercialization may depend upon the age, size (i.e., number of licensing managers), personnel and

activities (e.g., number of licensing agreements executed) of a university's Technology Transfer Offices (Prets & Slate, 2014). Additionally, the attributes of the new technologies or inventions can be instrumental in determining if and how quickly a new product or service can be brought to market (Colyvas et al., 2002; Rahal & Rabelo, 2006).

Finally, in an effort to commercialize more of their intellectual property, a limited number of research universities have developed commercialization programs where curricula is designed around intellectual property management and technology commercialization. Courses taught include projects where the goal is to bring these universities' intellectual property to market (Barr, Baker, Markham, & Kingon, 2009; Boni, Weingart, & Evenson, 2009; Phan, Siegel, & Wright, 2009; Thursby, Fuller, & Thursby, 2009). A list of success factors and the corresponding references are compiled in Table 1.1.

Table 1.1

Technology Transfer Office Success Factors

Factors	References
University characteristics (e.g., financial strength, focused on science and engineering, entrepreneurial culture).	Turk-Bicakci & Brint (2005)
Technology Transfer Office characteristics (e.g., university administration support, adequate budget, large staff, marketing efforts).	Colyvas et al. (2002); Prets & Slate (2014); Turk-Bicakci & Brint (2005)
Attributes of the new technology or invention (e.g., patentability and marketability).	Colyvas et al. (2002); Rahal & Rabelo (2006)
Technology management education (e.g., interdisciplinary research professors and interdisciplinary graduate students).	Barr et al. (2009); Boni et al. (2009); Phan et al. (2009); Thursby et al. (2009)

Historically, Technology Transfer Offices engaged in licensing activities. The most prevalent of these endeavors included offering licensing options and licensing agreements to private industry. Licensing fees may have included a set dollar amount paid up front, monthly or yearly and/or running royalties that would have been assessed based on some percentage of sales or profits. In recent years, technology transfer

professionals, with their universities' consent, have added an alternative and potentially lucrative method of receiving payment in exchange for the rights to market technologies or inventions owned by their universities.

Increasingly, research universities are accepting equity positions in spin-off ventures created to commercialize universities' intellectual property. In the Association of University Technology Manager's (AUTM's) 2013 Licensing Survey, university respondents revealed that 818 startup companies were formed around universities' intellectual property. Many of these newly formed companies remained in close proximity to their partner universities creating jobs for the schools' graduates and stimulating the local economies. Willingness to accept equity in lieu of cash payments, as pointed out in the existing literature (Di Gregorio & Shane, 2003; Feldman, Feller, Bercovitz, & Burton, 2002; Marion, Dunlap, & Friar, 2012; Powers & McDougall, 2005), may be predicated upon (a) the policies and culture of the research universities, (b) the predisposition and experience of the researchers/academic inventors, and (c) the characteristics of Technology Transfer Offices' licensing managers.

The Bayh-Dole Patent and Trademark Amendments Act of 1980

The Bayh-Dole Act provides that federal contractors (i.e., grant recipients) may be able to retain title to inventions by fulfilling several obligations required by the statute. A contractor must disclose that an invention has been developed to the federal agency that provided funding for the preceding research. The contractor must notify the agency, in writing, within two years after the initial disclosure of the intent to claim title. Finally, the contractor must file the appropriate patent applications on the subject invention.

The Federal Government also retains rights to federally funded inventions under provisions of the Bayh-Dole Act. Funding agencies receive, from the contractors/grant recipients, nonexclusive, nontransferable, irrevocable, paid-up licenses to use the subject inventions. These federal agencies may also be permitted to grant licenses for the inventions to third parties in instances where the contractors fail to take the appropriate steps to claim title to inventions or where the contractors elect not to exercise the right to claim title to inventions.

Universities, after passage of the Bayh-Dole Act, have held the position that the Act provided definite and automatic ownership rights to the contracting schools for all federally funded inventions. The courts, however, have recently rejected that position. The Federal Circuit Court, in *Board of Trustees of the Leland Stanford Junior University v. Roche Molecular Systems, Inc., et al.* ruled that the Act did not usurp academic inventors' ownership rights to their intellectual property. The Bayh-Dole Act, according to the Court, allows research universities to claim title to inventions only in situations where the institution has already secured ownership rights from the inventor(s) through contractual assignment or employment agreement. On June 6, 2011, the U.S. Supreme Court affirmed the lower court's decision. An implication, resulting from the recent court decisions, is that universities and their technology transfer managers will need to modify intellectual property policies and employment agreements to document the precise percentages of ownership between the institutions, academic inventors, and participating independent third parties with regard to technologies and inventions that arise from federally funded research and development (Sharma, 2011).

Federal Government Sponsored Research

A common concern, among university faculty and others, was that the Bayh-Dole Act could shift research energies and resources away from basic or general research, which was thought to have little ability to generate revenues for universities from commercialization efforts (Rafferty, 2008). University researchers, post passage of the Bayh-Dole Act, may be myopically focused on applied research, which has the greater propensity to generate revenue from licensing fees and royalties paid by industry on patented technologies and inventions (Rafferty, 2008).

Rafferty (2008) examined the funding for basic, applied, and development research to identify trends that may indicate an influence resulting from implementation of provisions of the Bayh-Dole Act. National level data and university level data were provided by the National Science Foundation. Surveys, conducted by the National Science Foundation, were sent to all doctorate granting universities, all historically Black colleges, and a random sample of the remaining higher education institutions. Rafferty (2008) determined that passage of the Bayh-Dole Act did not result in a statistically significant change in the research and development activities at colleges and universities. Rafferty (2008) analyzed trends in the National Science Foundation survey data and discovered that increased industry financing of research and that universities' emerging interest in patenting began in the 1970s and pre-dated the passage of Bayh-Dole. Rafferty's (2008) conclusion, which was consistent with Mowery, Nelson, Sampat, and Ziedonis (2001) and others, was that technological advances in biomedical and pharmaceutical research, during the 1970s, were at least partially responsible for changes in research and development activities at colleges and universities.

The most significant sponsor of universities' research endeavors is the federal government. However, attracting those dollars may, to some extent, be controlled by forces outside the walls of research institutions. Wu (2013) analyzed the effects of research capacity and congressional influence on the distribution of federal funding for academic research and development activities. Data for the study were provided by the National Science Foundation's Survey of Research and Development Expenditures at Universities and Colleges. Wu (2013) supported the hypothesis that research capacity was a statistically significant determinant of federal funding for academic research and development. Research capacity was measured by the number of science and engineering doctorates granted. Wu (2013) discovered that an increase in the number of doctorates received in science- and engineering-related disciplines corresponded to an increase in the amount of federal financing obtained for academic research and development endeavors.

Politics were also determined to influence the distribution of federal funding for academic research. According to Wu (2013), an increase in a state's congressional representation on either the House or Senate Appropriations Committees could lead to a small but statistically significant increase in federal academic research and development funding for that state. A caveat is that the increase in federal research funding for a state only materialized when the state's new members on the Appropriations Committees were also members of the majority party.

Industry Sponsored Research

Industry-university collaborations have become an important vehicle for commercialization of universities' intellectual property. Issues commonly arise, however, concerning the ownership of intellectual property and regarding the management of technologies and inventions resulting from the collaborative, sponsored research. Tensions between academic inventors and sponsoring companies also resulted from disagreements over publication freedom.

Kneller, Mongeon, Cope, Garner, and Ternouth (2014) examined the challenges encountered in the management of the relationship between university researchers and industry research sponsors. The analysis, strictly from the perspective of industry, was based on structured interviews with the representatives of 90 companies from four countries (i.e., Canada, Japan, the U.K., and the United States). Companies, according to the researchers, were disinclined to pay their university partners twice, once to sponsor the initial research and again to license the resulting technology. Kneller et al. (2014) also noted misunderstandings with respect to publication rights. Historically, a fundamental responsibility of universities was the creation and dissemination of new knowledge. Unfortunately, complete publication freedom would result in disclosing trade secrets to potential competitors. A suggestion by Kneller et al. (2014) was for the United States and others to follow the U.K.'s lead and establish a national model for managing collaborative research. Under the Lambert Model Agreements, U.K. companies must pay the full economic costs of research (i.e., attributable salaries, direct and indirect costs, infrastructure costs and even depreciation) to secure intellectual property ownership rights or rights to place limits on publication freedoms.

University and Technology Transfer Office Characteristics

Turk-Bicakci and Brint (2005) conducted a study to identify research universities with the best record of successful collaboration with private industry and to determine how these schools were able to cultivate and maintain those relationships. These researchers also wanted to uncover differences in general characteristics or intellectual property commercialization strategies between the higher and lower performing universities. Data for the study were provided by AUTM, and included industry funding reported by 113 research universities. The AUTM survey data from the decade of the 1990s were examined to identify trends in industry-university collaborations; information from the year 2000 was used to select attributes thought to be connected to high or low performance. The measures used to determine successful collaboration were (a) the dollar amount of industry support provided for university research, (b) the number of licenses sold by universities for their technologies or inventions, and (c) the amount of income generated from those licenses.

Turk-Bicakci and Brint (2005) discovered that the size of the science and engineering departments, as measured by total graduate student population, and the wealth of the school, as measured by operating budget per student, were the two most important factors in determining industry funding of university research. When determining the number of licenses sold, again the size of the science and engineering department coupled with the size of the Technology Transfer Office were the most important factors. Finally, when determining the amount of income generated from licensing, wealthy, private institutions with large commercialization staffs generated more volume than did poorer, public universities with sparsely staffed and inadequately

funded Technology Transfer Offices. According to Turk-Bicakci and Brint (2005), middle- and low-level collaborators, because they are smaller, poorer, public universities with little or no technology licensing staff, may never be able to generate substantial surplus income from intellectual property commercialization.

Technology Transfer Office Efforts - Patent Protection

Studies have also been designed to assess the importance of Technology Transfer Office activities in the commercialization process. In 2002, Colyvas et al. conducted an in-depth case study to determine if intellectual property protection, primarily by patent, or other efforts by universities' licensing professionals were responsible for improved success in bringing new technologies to market. Colyvas et al. (2002) analyzed 11 case studies written about university research projects that culminated in patented inventions. The case studies examined came from two universities, Columbia and Stanford. These schools were chosen because they had Technology Transfer Offices and because they had been successful in commercializing intellectual property. The new inventions or technological advances, which resulted from fruitful research projects, were varied and included pharmaceuticals, biotechnologies, computer software, and medical and electrical devices.

Colyvas et al. (2002) concluded that outside firms were often willing to license new technologies or inventions from universities, even without patent protection, if those technologies were well developed, prototype tested, and ready to go to market. However, when dealing with *embryonic inventions*, where a potentially substantial amount of additional research time and money could be required to commercialize the product, firms required patent protection and exclusive rights to the technologies to recoup their

investment. Another noteworthy observation made by Colyvas et al. (2002) was that the marketing efforts of the two university's Technology Transfer Offices were more important to successful product commercialization where ties between the schools and relevant industries were weak.

Attributes of the New Technology or Invention

In addition to patentability, a number of other intellectual property attributes contribute to successful commercialization. Rahal and Rabelo (2006) conducted a study to develop a methodology for assessing the potential for commercialization of universities' technologies and inventions. They analyzed 108 responses from a web-based survey sent to members of the Licensing Executive Society. A literature review helped the researchers to identify the 43 most significant factors used by licensing professionals to determine the viability of a technology or invention. Rahal and Rabelo (2006) asked the respondents to rank the 43 determining factors for one piece of university intellectual property that they had decided to license and to compile a second ranking for a technology or invention that they had decided to reject.

The survey responses helped the researchers reduce the number of determining factors down from 43 to 12 (Rahal & Rabelo, 2006). The most important factors included the strength, uniqueness, and superiority of the new technology. Licensees also wanted exclusivity, a large potential market, and a clean patent. Rounding out the most significant factors were technical feasibility and a short time to market. The highly-ranked licensing determinants were used to create a model capable of accurately predicting which university intellectual properties have the highest potential for

commercialization. Rahal and Rabelo (2006) noted that additional research, including a survey with a higher response rate, could improve the predictive accuracy of their model.

Intellectual Property Management/Technology Commercialization Education

Although a limited number of business and engineering schools have begun to design courses and curricula around intellectual property management and technology commercialization, newer concepts including interdisciplinary teams of instructors teaching interdisciplinary groups of graduate students are still far from being in the mainstream (Phan, Siegel, & Wright, 2009). Colleges, within universities, have traditionally chosen to remain independent. However, business school professors may lack exposure to the natural sciences and applied technology disciplines. Similarly, instructors from colleges of engineering and of science may not have any practical experience in marketing or management. Research universities that are interested in creating a new technology transfer office or filling a vacancy in an existing office, without a multidisciplinary applicant option, are recruiting licensing managers with narrowly-focused proficiency in patent law or with a specific technical expertise (Phan et al., 2009).

In an effort to commercialize more of their intellectual property, North Carolina State University developed the Technology Entrepreneurship and Commercialization Program (Barr, Baker, Markham, & Kingon, 2009). Development of the program was supported by the National Science Foundation and has since been adopted by Ohio State University and others. The Technology Entrepreneurship and Commercialization Program's process begins with the creation of multidisciplinary teams of graduate

students. The teams can number from five to eight individuals and can come from the colleges of business, engineering, and science.

After the creation of teams, the formal process is comprised of five steps. In the first step, referred to as *ideation*, teams choose at least two technologies from North Carolina State University's cache of intellectual property. Continuing in step one, the students study their two chosen technologies and produce a written statement describing both the technology and any perceived potential markets for the product or service.

Phase I, which is actually the second step in the process, is to identify fatal flaws in the technology that would preclude marketability. Fatal flaws, including better and cheaper products or services already offered in the marketplace, help students to identify bad ideas that can be pushed aside. The single most attractive technology and, at least initially, one start-up product or service can then be carried forward to Phase II, which is also referred to as step three. During this phase, the teams are engaged in product development and market research. Standard management tools, including Michael Porter's "Five Forces," facilitate strategy creation and compel teams to identify and to interact with supplies, competitors, and, most importantly, customers (Porter, 2008).

Creation of a commercialization strategy is the fourth step in the program. The process includes formation of a management team, raising capital, and marketing aimed at early adopters. The product of this step is a formal business plan. Implementation, which is also referred to as start-up, is the fifth and final step. Start-up typically occurs at the end of formal coursework (Barr et al., 2009).

Carnegie Mellon University has also developed an interdisciplinary course on intellectual property commercialization (Boni, Weingart, & Evenson, 2009). The

underlying premise. for the Capstone Course. is that the approach to commercialization should be market-driven rather than engineering-driven. An engineering approach to commercialization begins with a technology and then attempts to find a use for the product or service. In a market first approach. existing customers with specific needs are identified and the appropriate technologies are used to create products and services to satisfy those needs. An additional premise is that an interdisciplinary team of instructors is needed to teach the Capstone Course. Carnegie Mellon professors from three disciplines. entrepreneurship. design. and organizational behavior, are brought together to teach the graduate course. All three instructors attend and contribute to every class meeting. Students selected for the course are also interdisciplinary. Teams are composed of second-year master's degree students from the University's School of Business and their School of Design. The course has an academic component comprised of lectures and workshop discussions on topics ranging from building and leading effective teams to team conflict and conflict management. A project component is also present for the course. A project could stem from university intellectual property or it could be based on a technology from an outside company. If the technology. and therefore the project, is sponsored by a private company. the project sponsor can become an additional expert coach for the team (Boni et al., 2009).

One of the most comprehensive and well defined technology management programs was created in a collaboration between the Georgia Institute of Technology and Emory University. The Technological Innovation: Generating Economic Results, or TI:GER, was created to examine the commercial potential of Georgia Tech PhD students' research (Thursby, Fuller, & Thursby, 2009). The TI:GER two year certificate program,

when completed, provides graduate students with a degree concentration in either Intellectual Property or Technology Law. Instruction is provided by law professors from Emory and by economics and business faculty from Georgia Tech. Graduate students work in teams comprised of one science or engineering PhD student, one MBA student, and two JD students (one specializing in patent law and the other in technology law).

The first semester course is Fundamentals of Innovation I. Innovation I covers topics including team development, intellectual property analysis, and industry analysis. In the second semester, students take Fundamentals of Innovation II. In the course, students are exposed to marketing strategies, company valuation methods, and funding strategies. The course, in semester three, is Special Topics in Technology Commercialization. In the commercialization course students learn about project management and business plan development and writing. The final semester is devoted to independent study. Student teams may participate in a business plan competition or work with their team on a joint venture lab project. In addition, science and engineering PhD students are required to take a business management course. Graduate students, participating in business or law programs, are also required to take additional, program-relevant electives.

One of the aspects that distinguishes the TI:GER program is its assessment component. Assessment, conducted by an independent third party, includes focus group sessions and pre- and post-program surveys. The surveys are designed to help administrators assess student perceptions regarding their multidisciplinary competencies upon entry and exit from the program (Thursby et al., 2009).

Universities' Policies and Culture

In the early years of universities' commercialization efforts, immediately following passage of the Bayh-Dole act, many institutions considered equity positions in spin-off businesses to be excessively risky and a method of last resort for accepting payment in exchange for their intellectual property (Feldman, Feller, Bercovitz, & Burton, 2002). Through their research, however, Feldman et al. (2002) determined that attitudes and policies at research universities had evolved toward a more diversified portfolio of payment options. Feldman et al. (2002) investigated the inclination of Technology Transfer Office professionals to accept equity positions, as an alternative to license agreements, in spin-off companies established for the purpose of commercializing universities' intellectual properties. These researchers analyzed 67 responses to a survey questionnaire sent to the 124 Carnegie I and II research universities that, at that time, had a formal structure for technology transfer. Feldman et al. (2002) concluded that universities were increasingly willing to accept equity, rather than license fees and royalty payments, in companies with the rights to market the universities' new technologies or inventions.

Survey respondents cited three reasons for the shift in policy. First, equity positions could have far more up-side income potential than traditional licensing agreements for universities. As one of the businesses' owners, a university would be entitled to share in all future revenue streams of the new start-up business. In addition, the newly formed company could be acquired by a larger firm or it could sell shares in an initial public offering leading to windfall profits for the owners including the university. The second benefit of putting together an equity deal is that it aligned the interests of the

university and the newly formed business. Both the university and the spin-off company would share a common goal of a quick and successful market launch of the new technology or invention. A third benefit of accepting an equity position is that it set a precedent. A clear signal is sent to other industries and investors that the university was entrepreneurial and ready to create joint venture opportunities for the purpose of commercializing its portfolio of intellectual property (Feldman et al., 2002).

Di Gregorio and Shane (2003) identified universities' policies that influenced university/industry spin-off activity through a survey of 116 universities, of which 101 responses were received from Technology Transfer Office's directors. Di Gregorio and Shane (2003) discovered an inverse relationship between the royalty rates paid to academic inventors and the number of start-up companies formed to commercialize universities' intellectual property. When universities were determined to have a policy of sharing a large portion of royalties with academic inventors, start-up activity was low. Conversely, when the inventors' share of royalty payments was paltry, a corresponding up-tick was present in the number of spin-off companies formed. An implication of this research is that universities may be able to amend royalty policy and directly influence start-up activity.

University Researchers/Academic Inventors

Marion, Dunlap, and Friar (2012) examined the connection between the degree of commercialization success and the entrepreneurial characteristics of the academic inventor. Data for the investigation came from a census of 400 university patent disclosures, an empirical survey, and in-depth interviews with eight academic inventors identified in the census and survey as most successful at intellectual property

commercialization as determined by gross revenue. Through their research, Marion et al. (2012) determined that several factors, all related to universities' academic inventors, were responsible for successfully passing newly developed technologies from universities to the market place through new start-up companies. Successful academic inventors, according to Marion et al. (2012), could generally be described as tenured and productive. They would have previous entrepreneurial experience and would also possess a positive inclination toward commercialization of research. In addition, the most productive inventors excelled in networking with industrial partners and cultivating external resources including knowledge and funding as evidenced by their participation in industry sponsored research agreements (Marion et al., 2012; O'Shea, Allen, Chevalier, & Roche, 2005).

Technology Transfer Offices and Licensing Managers

Although literature on the subject is sparse, one study was identified in which the authors espoused the important role Technology Transfer Offices play in the formation of spin-off companies. Powers and McDougall (2005) identified universities' resources believed to be significant predictors of spin-off company formation. The research team collected and analyzed archival data on 120 universities classified as "research extensive" or "research intensive" as defined by the Carnegie Classification System. Powers and McDougall (2005) discovered that the age of the Technology Transfer Office was a significant predictor of universities' willingness to accept equity positions in spin-off ventures created to commercialize their intellectual property. These researchers also concluded that the amount of research funding received from industry sources, the quality of the faculty, and access to venture capital were also significant predictors of increased

spin-off activity. However, one of the original hypotheses, that the importance of universities' patent portfolios would be positively related to the number of start-up companies formed, was not supported by the data.

Statement of the Problem

One problem with a current source of research funding is the deceleration of federal (grant) dollars available for academic research and development (AUTM, 2014). Industry has increased their contribution toward the commercialization of universities' intellectual property; however, their financial support continues to represent a small fraction of total research expenditures. In addition, industry may require that their research dollars are directed toward applied research. The concern, among some scholars in higher education (Szelenyi & Goldberg, 2011), would be that a shift is occurring at universities toward commercial interests and away from traditional values including transfer of knowledge and promoting the public good. A consequence of that shift would be that research universities may not be able to procure adequate funding for basic research. Private industry may also have very specific goals including focusing research efforts toward very specific market needs in conjunction with a rapid and hefty return on any investment made in universities' research and development budgets (Kneller et al., 2014; Rafferty, 2008; Szelenyi & Goldberg, 2011).

In 2013, 719 new commercial products were created by companies that licensed university developed technology as reported in the most recent AUTM Licensing Survey. Today, even though most research universities have created intellectual property policies and have dedicated licensing managers in place, an astonishing dichotomy is present between economically successful universities and underperforming institutions. This

disparity has been exacerbated by Technology Transfer Offices that have been inadequately resourced. According to Turk-Bicakci and Brint (2005) smaller, poorer, public universities with little or no Technology Transfer Office staff may never be able to create surplus income from the commercialization of their intellectual property.

Finally, in addition to stagnant federal funding for academic research and development, universities' administrators have also been disappointed in the revenues generated through traditional licensing fees and royalty payments (Klein, de Haan, & Goldberg, (2009). Another problem confronts universities' industry partners. Companies that have licensed the rights to develop and market universities' intellectual properties will have start-up costs, but may have no immediate revenues and therefore, may also be strapped for cash. If licensor universities take equity positions in these start-up companies rather than requiring up-front payments, these businesses can conserve the cash that may be necessary for additional product development and for marketing expenses incurred when new products are launched (Feldman et al., 2002).

Purpose of the Study

The purpose of this journal-ready dissertation was to provide timely information to technology transfer professionals that may lead to more productive policies and practices in the commercialization of universities' intellectual property. This investigation provided insights regarding the sources and the productivity of academic research funding. The characteristics and activities of highly performing Technology Transfer Offices were highlighted in this study. The final objective was to determine the effectiveness of industry-university commercial partnerships.

Specifically, the purpose of the first empirical study was to identify differences between public and private universities in their percentage share of both federal research funding and funding from private industry sources. An additional purpose was to identify differences between public and private universities in licensing income generated per dollar of research expenditure. The final purpose of this first investigation was to determine the existence and the strength of the relationship between federal research funding and license income earned and to determine the existence and the strength of the relationship between private industry research funding and licensing income earned.

The purpose of the second study was to identify universities' characteristics and Technology Transfer Offices' activities that result in optimal generation of income produced from commercialization of institutions' intellectual property. An additional purpose was to rank, through regression analysis, the extent to which each of the five predetermined independent variables can be used to predict income production from universities' licensing activities. The final purpose of this investigation was to identify trends in ranking the extent to which the predictor variables can be used to forecast future revenue streams by analyzing response data from the 2011, 2012, and 2013 survey years.

The traditional forms of payment, for the rights to market universities' intellectual property, include licensing fees and running royalties. However, in AUTM's 2013 Licensing Survey, university respondents revealed that 818 startup companies were formed around universities' intellectual property. The purpose of the third and final study was to identify any positive or negative economic ramifications resulting from the acceptance of equity positions in spin-off companies as an alternative to the old-style and more predictable forms of licensing payments.

Significance of the Study

This investigation may constitute the first study, using AUTM's Statistics Access for Technology Transfer database, where research was conducted to identify differences between public and private universities in sourcing research funding and in achieving commercialization success. In addition, if one type of research institution (i.e., public or private universities) is more adept at procuring either federal research funding or funding from private industry sources, it would behoove the underperforming schools to adopt the research funding policies and/or practices of the better performing institutions. Similarly, if either public or private research universities generate a greater amount of licensing income for each dollar of research expenditure, again the policies and practices of the more efficient institutions may need to be examined to determine the extent to which their policies and practices could be adopted.

The second study is relevant in that the ability to identify and to rank Technology Transfer Offices' characteristics and activities that produce the greatest return on investment from universities' intellectual property could facilitate efficiency in resource allocation. University administrators, by amending their commercialization policies and procedures, can ensure future funding is concentrated on those activities that lead to the greatest revenue streams. Conversely, efforts on the part of Technology Transfer Offices that do not yield an acceptable economic benefit to the university and to the community can be scaled back or eliminated.

Since the passage of the Bayh-Dole Act, approximately 5,700 companies have been formed to commercialize universities' intellectual properties (Marion et al., 2012). Today, school administrators, politicians, and business leaders are touting the benefits

derived from university spin-off businesses. Study three is important because these new business ventures have the potential to create windfall revenues for sponsoring research universities as well as the ability to create jobs for the schools' graduates. Spin-off businesses, focused on a single technological innovation, can expedite the time from idea to market. In addition, through changes in culture and new policies covering technological innovation and commercialization, universities participating in alliances and joint ventures with industry are now repositioning to the center of socio-economic development in their respective communities. The commercialization of new university-born innovations and inventions are having a significant, positive impact on regional economies (Hayter, 2013; Nelles & Vorley, 2010; Osiri, McCarty, & Jessup, 2013). However, despite the recent emphasis at research universities on technology transfer and the increasing amount of published research on the subject of commercialization of universities' intellectual property, little consensus is present regarding a specific set of policies and practices that is a demonstrated model for technology transfer success or licensing income maximization.

Definition of Terms

To assist the reader in understanding the framework of this investigation, the following terms are defined.

Association of University Technology Managers (AUTM)

According to AUTMs' website, it is a non-profit organization with approximately 3,200 international members. The majority of AUTM's members are intellectual property managers and/or technology transfer (licensing) managers at research universities and teaching hospitals. The mission of AUTM is to promote academic

technology transfer globally. Member benefits include regional and national conferences to provide colleague networking and professional development opportunities. The AUTM also maintains an online library, member directory, and its research database Statistics Analysis for Technology Transfer (About AUTM; Member Benefits section, para. 1).

Cashed-In Equity

The AUTM's *2012 Instructions and Definitions* publication defined cashed-in equity in this way:

This includes the amount received from cashing in equity holdings, resulting in a cash transfer to the institution. *The amount reported should be reduced by the cost basis, if any, at which the equity was acquired.* Excluded from this amount is any type of analysis or process whereby a value for the equity holdings is determined but a cash transaction does not take place through the sale of these holdings. An internal sale (e.g., to the endowment) will constitute cashing-in if the transaction results in cash being made available for internal distribution. (Definitions section, para. 5)

Equity

Equity is defined in the AUTM's *2012 Instructions and Definitions* publication as: "EQUITY, for the purposes of this Survey, is defined as an institution acquiring an ownership interest in a company (e.g., stock or the right to receive stock" Definitions section, para. 7).

License Income Received

The AUTM's *2012 Instructions and Definitions* publication defined license income received as follows:

LICENSE INCOME RECEIVED includes: license issue fees, payments under options, annual minimums, running royalties, termination payments, the amount of equity received when cashed-in, and software and biological material end user license fees equal to \$1,000 or more, but not research funding, patent expense reimbursement, a valuation of equity not cashed-in, software and biological material end user license fees less than \$1,000, or trademark licensing royalties from university insignia. License Income also does not include income received in support of the cost to make and transfer materials under Material Transfer Agreements. (Definitions section, para. 16)

License/Option Agreements

License/option agreements are defined in the AUTM's *2012 Instructions and Definitions* (AUTM, 2012b) as:

A LICENSE AGREEMENT formalizes the transfer of TECHNOLOGY between two parties, where the owner of the TECHNOLOGY (licensor) permits the other party (licensee) to share the rights to use the TECHNOLOGY. An OPTION AGREEMENT grants the potential licensee a time period during which it may evaluate the TECHNOLOGY and negotiate the terms of a LICENSE AGREEMENT. An OPTION AGREEMENT is *not* constituted by an Option clause in a research agreement that grants rights to future inventions, until an

actual invention has occurred that is subject to that Option. (Definitions section, para. 19)

Licensing FTE

The AUTM's *2012 Instructions and Definitions* publication defined a licensing FTE as:

Person(s) employed in the TECHNOLOGY TRANSFER OFFICE whose duties are specifically involved with the licensing *and* patenting processes as either full or fractional FTE allocations. Licensing examples include licensee solicitation, technology valuation, marketing of technology, license agreement drafting and negotiation, and start-up activity efforts. (Definitions section, para. 23)

Research Expenditures: Federal Government Sources

Research expenditures: federal government sources are defined in the AUTM's *2012 Instructions and Definitions* publication as: "RESEARCH EXPENDITURES: FEDERAL GOVT. SOURCES include expenditures made in by the institution in support of its research activities that are funded by the federal government. Expenditures by State and Local Governments should be excluded" (Definitions section, para. 32).

Research Expenditures: Industrial Sources

The AUTM's *2012 Instructions and Definitions* publication defined research expenditures: industrial sources in this way: "RESEARCH EXPENDITURES:INDUSTRIAL SOURCES include expenditures made in by the institution in support of its research activities that are funded by for-profit *corporations*, but not expenditures supported by other sources such as foundations and other nonprofit organizations" (Definitions section, para. 33).

Technology or Technologies

Technology or technologies are defined in the AUTM's *2012 Instructions and Definitions* publication as:

A TECHNOLOGY is the embodiment of an idea that results from the creative work performed by faculty, students or staff during research or teaching. Multiple TECHNOLOGIES can arise from a single DISCLOSURE or a single TECHNOLOGY can be the result from a combination of DISCLOSURES. A TECHNOLOGY can also take many forms. the most common are compositions of matter, processes, methods, devices, asexually reproduced plants and designs. Also common are works of expression such as software, photos and drawings. A TECHNOLOGY is a single innovative idea, no matter how many patents, copyrights, or disclosures may be included in the TECHNOLOGY. (Definitions section, para. 37)

Technology Transfer Office

The AUTM's *2012 Instructions and Definitions* publication defined a technology transfer office as: "The office(s) that manages and performs the TECHNOLOGY TRANSFER ACTIVITIES. Also referred to as a technology licensing office" (Definitions section, para. 39).

Delimitations

The archival data analyzed for this study were provided by the AUTM. As such, data from alternate sources were not obtained nor analyzed in this research investigation. The data analyses were delimited to the survey responses collected in each of the last three survey years (i.e., 2011, 2012, and 2013).

Limitations

Statistics Access for Technology Transfer. AUTM's searchable and exportable database. is a compilation of survey responses collected from U.S. research universities, medical schools, and other research institutions that respond to the annual Licensing Activity Survey Questionnaire (AUTM, 2015). Therefore, findings may not be generalizable outside of North America. In addition, the individual institutions that respond to the survey differed slightly from year to year. Finally, the responses from Technology Transfer Office managers who participated in the yearly survey may differ from the answers that would have been provided by those individuals who chose not to respond to the questionnaire. For example, underperforming institutions, as a subset of the entire group of research universities, may refrain from responding to the survey at a greater rate than institutions that have a record of successfully commercializing their intellectual property.

Assumptions

For the purposes of this study, an assumption was made that all responses reported to AUTM through the Licensing Activity Survey Questionnaire were correct and truthful. A second assumption was that data collected by AUTM were reviewed and that questionable responses were verified with the respondent technology transfer professional to ensure data accuracy. Finally, it was assumed AUTM compiled and reported the survey data in an accurate and trustworthy manner.

Procedures

Immediately following approval of this journal-ready dissertation by the researcher's doctoral dissertation committee, an application for research approval was

submitted to Sam Houston State University's Institutional Review Board. Subsequent to approval by the Institutional Review Board, the last three years of data (i.e., 2011, 2012, and 2013) from the Statistics Access for Technology Transfer database were downloaded from the AUTM website into an Excel spreadsheet. The compiled survey data, in the Excel spreadsheet, were then loaded into the Statistical Package for the Social Sciences for the purposes of analysis.

In the first investigation differences between public and private universities in sourcing academic research funding were identified. In addition, the strength of the relationship between research funding sources and commercialization success were analyzed. The second investigation was an analysis of the extent to which the licensing income of universities can be predicted by five questionnaire items (i.e., Number of Licensing Managers, Number of Licensing Agreements Executed, Number of U.S. Patents Held, Total Research Expenditures, and Number of Start-Up Companies Initiated) chosen from the survey. The economic ramifications resulting from research universities' acceptance of equity positions in spin-off companies as an alternative to traditional forms of licensing payments (e.g., licensing fees, royalty payments) was the focus of the third investigation.

Organization of the Study

In this study, three journal-ready manuscripts were produced. In the initial investigation, research questions were specifically related to the difference between public and private universities in sourcing and productively spending both federal and private industry research funding. In the second investigation, the research question was specifically related to predicting the amount of income generated from licensing

universities' intellectual property. In the third and final investigation, research questions were related to the economic advantages and disadvantages, for research universities engaged in technology transfer, associated with the emerging trend of accepting start-up company equity in lieu of traditional licensing royalties.

This journal-ready dissertation contains five chapters. Chapter I is comprised of the background of the study, statement of the problem, purpose of the study, significance of the study, definitions of terms, delimitations, and limitations and assumptions. Chapter II, an investigation into federal and industry sponsored academic research, was the first proposed empirical research study. Chapter III, a study of factors for successful academic technology commercialization, was the second proposed research investigation. In Chapter IV, which was the third proposed empirical research investigation, the economic impact of university entrepreneurship was analyzed. Finally, Chapter V is comprised of a discussion of the results discovered in the three research investigations, implications for updates to universities' technology transfer policies and practices particularly by underperforming institutions, and recommendations for future research in the areas of intellectual property commercialization and licensing revenue maximization.

CHAPTER II
IDENTIFYING DIFFERENCES BETWEEN PUBLIC AND PRIVATE
UNIVERSITIES IN SOURCING RESEARCH FUNDING
AND ACHIEVING COMMERCIALIZATION SUCCESS

This dissertation follows the style and format of *Research in the Schools (RITS)*.

Abstract

In this investigation, differences between public and private universities in their percentage share of both federal research funding and funding from private industry sources were examined, along with the extent to which differences might be present between public and private universities in licensing income generated per dollar of research expenditure. A conclusion of this investigation was that private universities were more adept at procuring federal research funding than public universities.

Therefore, it would behoove public schools to adopt the research funding practices of the better performing private universities. In addition, private research universities had generated a greater amount of licensing income for each dollar of research expenditure. Again, the policies and practices of the more efficient, private universities may need to be examined to determine the extent to which their policies and practices could be adopted.

Keywords: Universities' Intellectual Property, Commercialization, Technology Transfer

CHAPTER II

IDENTIFYING DIFFERENCES BETWEEN PUBLIC AND PRIVATE UNIVERSITIES IN SOURCING RESEARCH FUNDING AND ACHIEVING COMMERCIALIZATION SUCCESS

Prior to 1980, universities could not easily obtain patents on discoveries resulting from research funded by the federal government (Martin, Gruetzmacher, Lanham, & Brady, 2004). The patenting process was dramatically altered, however, by the passage of the Bayh-Dole Patent and Trademark Amendments Act of 1980. This act gave universities and other research institutions the right to claim title to technologies and inventions that resulted from federally sponsored research and development. The intent of Congress was to spur commercialization of universities' intellectual property and to promote collaboration between research institutions and private industry. The Act also ensured that the Federal Government retained limited rights to use inventions arising out of federally sponsored research. After many years of solid growth, federal funding of academic research may have reached a plateau. Last year, federally funded expenditures for academic research totaled \$39.9 billion, which represented a slight decline of 0.7% below the previous year. In sharp contrast, industry sponsored research soared to \$4.58 billion, which translated to an increase of 11% (Association of University Technology Managers [AUTM], 2014).

The Bayh-Dole Patent and Trademark Amendments Act of 1980

The Bayh-Dole Act provides that federal contractors (i.e., grant recipients) may be able to retain title to inventions by fulfilling several obligations required by the statute. A contractor must disclose that an invention has been developed to the Federal agency

that provided funding for the preceding research. The contractor must notify the agency, in writing, within two years after the initial disclosure of the intent to claim title. Finally, the contractor must file the appropriate patent applications on the subject invention.

The Federal Government also retains rights to federally funded inventions under provisions of the Bayh-Dole Act. Funding agencies receive, from the contractors/grant recipients, nonexclusive, nontransferable, irrevocable, paid-up licenses to use the subject inventions. These federal agencies may also be permitted to grant licenses for inventions to third parties in instances where the contractors fail to take the appropriate steps to claim title to inventions or where the contractors elect not to exercise the right to claim title to inventions.

Universities, after passage of the Bayh-Dole Act, have held the position that the Act provided definite and automatic ownership rights to the contracting schools for all federally funded inventions. The courts, however, have recently rejected that position. The Federal Circuit Court, in *Board of Trustees of the Leland Stanford Junior University v. Roche Molecular Systems, Inc., et al.* ruled that the Act did not usurp academic inventors' ownership rights to their intellectual property. The Bayh-Dole Act, according to the Court, allows research universities to claim title to inventions only in situations where the institution has already secured ownership rights from the inventor(s) through contractual assignment or employment agreement. On June 6, 2011, the U.S. Supreme Court affirmed the lower court's decision. An implication, resulting from the recent court decisions, is that universities and their technology transfer managers will need to modify intellectual property policies and employment agreements to document the precise percentages of ownership between the institutions, academic inventors, and

participating independent third parties with regard to technologies and inventions that arise from federally funded research and development (Sharma, 2011).

Federal Government Sponsored Research

A common concern, among university faculty and others, was that the Bayh-Dole Act could shift research energies and resources away from basic or general research, which was thought to have little ability to generate revenues for universities from commercialization efforts (Rafferty, 2008). University researchers, after passage of the Bayh-Dole Act, may be myopically focused on applied research, which has the greater propensity to generate revenue from licensing fees and royalties paid by industry on patented technologies and inventions (Rafferty, 2008).

Rafferty (2008) examined the funding for basic, applied, and development research to identify trends that may indicate an influence resulting from implementation of provisions of the Bayh-Dole Act. National level data and university level data were provided by the National Science Foundation. Surveys, conducted by the National Science Foundation, were sent to all doctorate granting universities, all historically Black colleges, and a random sample of the remaining higher education institutions. Rafferty (2008) determined that passage of the Bayh-Dole Act did not result in a statistically significant change in the research and development activities at colleges and universities. Rafferty (2008) analyzed trends in the National Science Foundation survey data and discovered that increased industry financing of research and that universities' emerging interest in patenting began in the 1970s and pre-dated the passage of Bayh-Dole. Rafferty's (2008) conclusion, which was consistent with Mowery, Nelson, Sampat, and Ziedonis (2001) and others, was that technological advances in biomedical and

pharmaceutical research. during the 1970s, were at least partially responsible for changes in research and development activities at colleges and universities.

The most prevalent sponsor of universities' research endeavors is the federal government. However, attracting those dollars may, to some extent, be controlled by forces outside the walls of research institutions. Wu (2013) analyzed the effects of research capacity and congressional influence on the distribution of federal funding for academic research and development activities. Data for the study, were provided by the National Science Foundation's Survey of Research and Development Expenditures at Universities and Colleges. Wu (2013) supported the hypothesis that research capacity was a statistically significant determinant of federal funding for academic research and development. Research capacity was measured by the number of science and engineering doctorates granted. Wu (2013) discovered that an increase in the number of doctorates received in science- and engineering-related disciplines corresponded to an increase in the amount of federal financing obtained for academic research and development endeavors.

Politics were also determined to influence the distribution of federal funding for academic research. According to Wu (2013), an increase in a state's congressional representation on either the House or Senate Appropriations Committees could lead to a small but statistically significant increase in federal academic research and development funding for that state. A caveat is that the increase in federal research funding for a state only materialized when the state's new members on the Appropriations Committees were also members of the majority party.

Industry Sponsored Research

Industry-university collaborations have become an important vehicle for commercialization of universities' intellectual property. Issues commonly arise, however, concerning the ownership of intellectual property and regarding the management of technologies and inventions resulting from the collaborative, sponsored research. Tensions between academic inventors and sponsoring companies also resulted from disagreements over publication freedom.

Kneller, Mongeon, Cope, Garner and Ternouth (2014) examined the challenges encountered in the management of the relationship between university researchers and industry research sponsors. The analysis, strictly from the perspective of industry, was based on structured interviews with the representatives of 90 companies from four countries (i.e., Canada, Japan, the U.K., and the United States). Companies, according to the researchers, were disinclined to pay their university partners twice, once to sponsor the initial research and again to license the resulting technology. Kneller et al. (2014) also noted misunderstandings with respect to publication rights. Historically, a fundamental responsibility of universities was the creation and dissemination of new knowledge. Unfortunately, complete publication freedom would result in disclosing trade secrets to potential competitors. A suggestion by Kneller et al. (2014) was for the United States and other countries to follow the U.K.'s lead and establish a national model for managing collaborative research. Under the Lambert Model Agreements, U.K. companies must pay the full economic costs (i.e., attributable salaries, direct and indirect costs, infrastructure costs and even depreciation) of research to secure intellectual property ownership rights or to limit publication freedoms.

Statement of the Problem

One problem with a current source of research funding is the deceleration of federal (grant) dollars available for academic research and development (AUTM, 2014). Industry has increased their contribution toward the commercialization of universities' intellectual property; however, their financial support continues to represent a small fraction of total research expenditures. In addition, industry may require that their research dollars are directed toward applied research. The concern, among some scholars in higher education (Szelenyi & Goldberg, 2011), would be that a shift is occurring at universities toward commercial interests and away from traditional values including transfer of knowledge and promoting the public good. A consequence of that shift would be that research universities may not be able to procure adequate funding for basic research. Private industry may also have very specific goals including focusing research efforts toward very specific market needs in conjunction with a rapid and hefty return on any investment made in the research and development budgets of universities (Kneller et al., 2014; Rafferty, 2008; Szelenyi & Goldberg, 2011).

Purpose of the Study

The purpose of this study was to identify differences between public and private universities in their percentage share of both federal research funding and funding from private industry sources. An additional purpose was to identify differences between public and private universities in licensing income generated per dollar of research expenditure. The final purpose of this study was to determine the existence and the strength of the relationship between federal research funding and license income earned

and to determine the existence and the strength of the relationship between private industry research funding and licensing income earned.

Significance of the Study

This investigation may constitute the first study, using AUTM's Statistics Access for Technology Transfer database, where research was conducted to identify differences between public and private universities in sourcing research funding and in achieving commercialization success. In addition, if one type of research institution (i.e., public or private universities) is more adept at procuring either federal research funding or funding from private industry sources, it would behoove the underperforming schools to adopt the research funding policies and /or practices of the better performing institutions.

Similarly, if either public or private research universities generate a greater amount of licensing income for each dollar of research expenditure, again the policies and practices of the more efficient institutions may need to be examined to determine the extent to which their policies and practices could be adopted.

Research Questions

The research questions addressed in this study were: (a) What is the difference between public and private universities in their percentage share of federal research funding?: (b) What is the difference between public and private universities in their percentage share of private research funding?: (c) What is the difference between public and private universities in licensing income generated per dollar of research funding expended?: (d) What is the relationship, for both public and private research universities, between federal research funding and license income earned?: and (e) What is the relationship, for both public and private research universities, between private industry

research funding and licensing income earned? This investigation was conducted utilizing data from the Association of University Technology Manager's (AUTM's) 2011, 2012, and 2013 Licensing Activity Survey Questionnaires. Accordingly, these research questions were repeated for each of these three years. Following these three years of analyses, the extent to which any trends were present were examined.

Limitations

Statistics Access for Technology Transfer, AUTM's searchable and exportable database, is a compilation of survey responses collected from U.S. research universities, medical schools, and other research institutions that respond to the annual Licensing Activity Survey Questionnaire (AUTM, 2015). Therefore, findings may not be generalizable outside of North America. In addition, the individual institutions that responded to the survey differed from year to year. Finally, the responses from technology transfer managers who participated in the yearly survey may differ from the answers that would have been provided by those individuals who chose not to respond to the questionnaire. For example, underperforming institutions, as a subset of the entire group of research universities, may refrain from responding to the survey at a greater rate than institutions that have a record of successfully commercializing their intellectual property.

Method

Research Design

This study was conducted with a non-experimental, causal-comparative research design (Creswell, 2009; Johnson & Christensen, 2012). The independent variables for the first three questions in the study include public research universities and private

research universities. In nonexperimental research, no manipulation occurs of the independent variables and no manipulation occurred of the aforementioned variables in this study.

The quantitative dependent variables for the first three questions in this analysis were total dollars received in federal research funding, total dollars received in private research funding, and total licensing income earned. In the first part of this causal-comparative study, differences in the abilities of the two types of research universities (i.e., public and private) to procure research funding and to generate licensing income were analyzed. In the last two questions, the relationship between federal research funding and total licensing income earned were analyzed, as well as the relationship between private industry sponsored research funding and total licensing income produced. The disadvantages of using this design include limited control of extraneous variables and lack of manipulation of the independent variable (Creswell, 2009; Johnson & Christensen, 2012).

Participants

Respondents to AUTM's Yearly Licensing Activity Survey included public and private research universities in the United States. Participating institutions also included medical schools and other research institutions. The database of research universities, compiled by AUTM over more than 20 years, includes institutions that, in the past, have responded to the survey. The database also includes institutions that currently and previously have employed AUTM members. Specifically, the AUTM instructs that the survey be completed by one of the respondent institutions' technology transfer officers, intellectual property managers, or licensing professionals. The range of yearly

participants, for research institutions that completed and returned AUTM's Licensing Activity Survey, was between 199 and 202 for the years covered in the study.

Instrumentation and Procedures

Statistical analysis was conducted using data provided by AUTM. One of the AUTM's primary activities, for each of the last 23 years, has been to conduct their annual U.S. Licensing Activity Survey. The purpose of the survey is to quantify academic technology transfer data. In 2013, the survey was disseminated to 299 U. S. research institutions. Survey recipients included 232 colleges and universities, 61 research hospitals, three national laboratories, and three independent, technology related firms. Of the institutions contacted, 202 returned the survey for a response rate of 68% (AUTM, 2014). The compilation of past survey responses is available in AUTM's Statistics Access for Technology Transfer database (AUTM, 2015). The Statistics Access for Technology Transfer database, available on AUTM's website, was downloaded into an Excel spreadsheet. Then the survey response data, in the Excel spreadsheet, were loaded into the Statistical Package for the Social Sciences to calculate descriptive and inferential statistics.

Results

Prior to conducting inferential statistical procedures to address the research questions previously delineated, descriptive statistics for the dependent variables were calculated. The average dollar amount of federal research funding expended by universities, reported by respondents to the AUTM's licensing survey, decreased by \$7,408,868.01 over the last three years for which data were available (i.e., survey years 2011, 2012, and 2013). This change represented a 3% decrease in federal research

funding to those universities in the three years covered in this investigation. During the same period, the average amount of private research funding expended by the same group of universities increased by \$1,669,177.84, which represented an 8% increase in private research funding for those universities over the same period.

Insert Table 2.1 about here

Prior to conducting inferential statistics to determine whether differences were present between public and private universities in their percentage share of federal research funding, checks were conducted to determine the extent to which the data were normally distributed. An examination of the standardized skewness coefficients (i.e., the skewness value divided by its standard error) and the standardized kurtosis coefficients (i.e., the kurtosis value divided by its standard error), revealed departures from normality for the dependent variable, federal research funding, for both public and private universities for all three years of this investigation (i.e., 2011, 2012, and 2013). Because federal research funding percentages for public and private universities were outside the range of normality, ± 3 (Onwuegbuzie & Daniel, 2002), nonparametric (i.e., Mann-Whitney's U) independent samples t -tests were conducted to answer the research questions.

The nonparametric independent samples t -test, for 2011 survey data, revealed a statistically significant difference between public and private universities in their percentage share of federal research funding, $U = 3548.00, p < .001$. This difference represented a large effect size (Cohen's d) of 0.86 (Cohen, 1988). For the AUTM's 2011

licensing survey data. private universities reported federal research funding expended represented 76.72% of total research funding expended. For public universities, federal research funding expended represented 64.52% of total research funding expended. In addition, private universities reported a 45.89% higher average dollar amount of federal research funding expended than public universities.

The nonparametric independent samples *t*-test, for 2012 survey data, also revealed a statistically significant difference between public and private universities in their percentage share of federal research funding. $U = 3607.00, p < .001$. This difference, which was slightly larger than the prior year, represented a large effect size (Cohen's *d*) of 0.94 (Cohen, 1988). For the AUTM's 2012 licensing survey data, private universities reported federal research funding expended represented 75.57% of total research funding expended. For public universities, federal research funding expended represented 61.57% of total research funding expended. Again, private universities reported a 38.19% higher average dollar amount of federal research funding expended than public universities. Readers can refer to Table 2.2 for the descriptive statistics concerning these variables for the 2012 survey year.

Insert Table 2.2 about here

The nonparametric independent samples *t*-test, for 2013 survey data, revealed a statistically significant difference between public and private universities in their percentage share of federal research funding. $U = 3721.00, p < .001$. This difference, which was consistent with the findings in the previous two years (i.e., 2011 and 2012),

represented a large effect size (Cohen's d) of 0.93 (Cohen, 1988). For the AUTM's 2013 licensing survey data, private universities reported federal research funding expended represented 73.90% of total research funding expended. For public universities, federal research funding expended represented 59.79% of total research funding expended. Analogous to the previous two years, private universities reported a 38.53% higher average dollar amount of federal research funding expended than public universities. Readers can refer to Table 2.2 for the descriptive statistics concerning these variables for the 2013 survey year.

Insert Table 2.3 about here

Prior to conducting inferential statistics to determine whether differences were present between public and private universities in their percentage share of private industry research funding, checks were conducted to determine the extent to which the data were normally distributed. An examination of the standardized skewness coefficients and the standardized kurtosis coefficients revealed departures from normality for the dependent variable, private research funding, for both public and private universities for all three years of this investigation (i.e., 2011, 2012, and 2013). Because the percentages of private research funding for public and private universities were outside the range of normality, ± 3 (Onwuegbuzie & Daniel, 2002), nonparametric (i.e., Mann-Whitney's U) independent samples t -tests were conducted to answer the research questions.

The nonparametric independent samples *t*-test, for 2011 survey data, did not reveal a statistically significant difference between public and private universities in their percentage share of private research funding. $U = 2636.00, p = .235$. The nonparametric independent samples *t*-test, for 2012 survey data, again did not yield a statistically significant difference between public and private universities in their percentage share of private research funding. $U = 2583.00, p = .393$. The nonparametric independent samples *t*-test for 2013 survey data, which was consistent with the results in the previous two years (i.e., 2011 and 2012), did not reveal a statistically significant difference between public and private universities in their percentage share of private research funding. $U = 2571.00, p = .55$. Descriptive statistics for this analysis are depicted in Table 2.1, 2.2, and 2.3.

Prior to conducting inferential statistics to determine whether differences were present between public and private universities in the amount of licensing income generated per dollar of research funding expensed, checks were conducted to determine the extent to which the data were normally distributed. An examination of the standardized skewness coefficients and the standardized kurtosis coefficients, revealed departures from normality for the dependent variable, licensing income earned, for both public and private universities for all three years of this investigation (i.e., 2011, 2012, and 2013). Because the amounts of licensing income earned for public and private universities were outside the range of normality, ± 3 (Onwuegbuzie & Daniel, 2002) nonparametric (i.e., Mann-Whitney's *U*) independent samples *t*-tests were conducted to answer the research questions.

The nonparametric independent samples *t*-test, for 2011 survey data, revealed a statistically significant difference between public and private universities in the amount of licensing income earned per dollar of research funding expended, $U = 3200.00$, $p = .004$. This difference represented a moderate effect size (Cohen's *d*) of 0.54 (Cohen, 1988). For the AUTM's 2011 licensing survey data, private universities earned a 432% greater return on licensing revenue generated per dollar of research funding expended than public universities.

The nonparametric independent samples *t*-test, for 2012 survey data, also revealed a statistically significant difference between public and private universities in the amount of licensing income earned per dollar of research funding expended, $U = 3408.00$, $p < .001$. This difference represented a very nearly moderate effect size (Cohen's *d*) of 0.49. (Cohen, 1988). For the AUTM's 2012 licensing survey data, private universities earned a 342% greater return on licensing revenue generated per dollar of research funding expended than public universities.

The nonparametric independent samples *t*-test, for 2013 survey data, revealed a statistically significant difference between public and private universities in the amount of licensing income earned per dollar of research funding expended, $U = 3719.00$, $p < .001$. This difference, which was consistent with the findings in the previous two years (i.e., 2011 and 2012), represented a moderate effect size (Cohen's *d*) of 0.52 (Cohen, 1988). For the AUTM's 2013 licensing survey data, private universities earned a 410% greater return on licensing revenue generated per dollar of research funding expended than public universities. Descriptive statistics for this analysis are depicted in Table 2.1, 2.2, and 2.3.

Finally, the relationship between federal research funding and license income earned by universities and also the relationship between private research funding and license income earned were examined. Scatterplot graphs suggested the presence of linearity for both sets of variables for each of the three years of data analyzed. The presence of linearity permitted the use of correlation coefficients. An examination of the standardized skewness coefficients and the standardized kurtosis coefficients revealed departures from normality (i.e., +/- 3, Onwuegbuzie & Daniel, 2002) for 100% of the variables in the two relationship questions for each of the three years analyzed. Accordingly, a nonparametric procedure, the Spearman rank order correlation coefficient was performed to address both research questions for each of the three years (i.e., 2011, 2012, and 2013) in this investigation.

The Spearman rho revealed a statistically significant relationship between the dollar amount of federal research funding and license income earned by universities using data from the AUTM's 2011 survey ($r_s[148] = .79, p < .001$). The effect size of this relationship was large (Cohen, 1988). Squaring the correlation coefficient indicated that federal research funding and license income earned overlapped 62.7%. Using 2012 survey data, the Spearman rho revealed a statistically significant relationship between the dollar amount of federal research funding and license income earned by universities ($r_s[148] = .77, p < .001$). Again, the effect size of this relationship was large (Cohen, 1988). Squaring the correlation coefficient indicated that federal research funding and license income earned overlapped 59.6%. Using 2013 survey data, the Spearman rho revealed a statistically significant relationship between the dollar amount of federal research funding and license income earned by universities ($r_s[151] = .77, p < .001$).

Similar to the two previous years, the effect size of this relationship was large (Cohen, 1988). Squaring the correlation coefficient indicated that federal research funding and license income earned overlapped 59.8%.

Analyzing the final question, the Spearman rho revealed a statistically significant relationship between the dollar amount of private research funding and license income earned by universities using data from the AUTM's 2011 survey ($r_s[146] = .65, p < .001$). The effect size of this relationship was large (Cohen, 1988). Squaring the correlation coefficient indicated that private research funding and license income earned overlapped 42.2%. Using 2012 survey data, the Spearman rho revealed a statistically significant relationship between the dollar amount of private research funding and license income earned by universities ($r_s[146] = .67, p < .001$). Again, the effect size of this relationship was large (Cohen, 1988). Squaring the correlation coefficient indicated that private research funding and license income earned overlapped 45.4%. Using 2013 survey data, the Spearman rho revealed a statistically significant relationship between the dollar amount of private research funding and license income earned by universities ($r_s[148] = .67, p < .001$). Similar to the two previous years, the effect size of this relationship was large (Cohen, 1988). Squaring the correlation coefficient indicated that private research funding and license income earned overlapped 45.2%.

Discussion

This study was conducted using the most recent three years (i.e., 2011, 2012, and 2013) of the AUTM's Licensing Activity Survey and may constitute the first investigation, using AUTM's Statistics Access for Technology Transfer database, where research was conducted to identify differences between public and private universities in

sourcing research funding and in achieving commercialization success. In this investigation, private universities were found to be more adept at procuring federal research funding than public universities. In addition, private research universities had generated a greater amount of licensing income for each dollar of research expenditure.

Connection with Existing Literature

According to the AUTM (2014), 2013 federally funded expenditures for academic research totaled \$39.9 billion, which represented a slight decline of 0.7% below the previous year. In sharp contrast, industry sponsored research soared to \$4.58 billion, which translated to an increase of 11%. This investigation revealed the average dollar amount of federal research funding expended by universities decreased by \$7,408,868.01 over the last three years for which data was available (i.e., survey years 2011, 2012, and 2013). This change represented a 3% decrease in federal research funding to those universities in the three years covered in this investigation. During the same period, the average amount of private research funding expended by the same group of universities increased by \$1,669,177.84, which represented an 8% increase in private research funding for those universities over the same period. Therefore, the results of this investigation were, to some extent, consistent with the AUTM's (2014) published statistics.

Rafferty (2008) examined the funding for basic, applied, and development research to identify trends that may indicate an influence resulting from implementation of provisions of the Bayh-Dole Act. A common concern, among university faculty, was that the Bayh-Dole Act could shift research energies and resources away from basic research, which was thought to have little ability to generate revenues for universities

from commercialization efforts. University researchers, after passage of the Bayh-Dole Act, may be myopically focused on applied research, which has the greater propensity to generate revenue from licensing fees and royalties paid by industry on patented technologies and inventions (Rafferty, 2008). However, Rafferty (2008) determined that passage of the Bayh-Dole Act did not result in a statistically significant change in the research and development activities at colleges and universities. In this investigation, using the AUTM's 2011, 2012 and 2013 licensing survey data, private universities received a statistically significantly higher percentage of federal research funding than public universities. An additional discovery, analyzing the licensing survey data, was that private universities generated a statistically significantly higher amount of licensing revenue generated per dollar of research funding expensed than public universities. An implication of these results is that private universities, using a large percentage of federal funding, may be concentrating their efforts on research projects with the highest propensity for commercialization, which would not be congruent with Rafferty's (2008) research.

For the three years (i.e., 2011, 2012, and 2013) of licensing survey data analyzed in this investigation, a statistically significant relationship was discovered between the dollar amount of federal research funding and license income earned by research universities. A statistically significant relationship was also present between the dollar amount of private research funding and license income earned by universities. Although the effect size for both relationships was high (Cohen, 1988), the relationship was slightly stronger between federal research funding and license income earned by universities. An explanation may be that research funded by private industry does not always result in

royalties paid to the university. According to Kneller et al., (2014), companies that funded universities' research were disinclined to pay their university partners twice, once to sponsor the initial research and again to license the resulting technology.

Implications for Policy and Practice

The Bayh-Dole Patent and Trademark Amendments Act of 1980, which gave universities the right to claim title to technologies and inventions that resulted from federally sponsored research and development, has propelled commercialization of universities' intellectual property and has stimulated collaboration between academic inventors and private industry. However, universities can no longer assume that the act is a guarantee of automatic ownership rights to technologies and inventions born under their jurisdiction. The Federal Circuit Court, in *Board of Trustees of the Leland Stanford Junior University v. Roche Molecular Systems, Inc., et al.* ruled that the Act did not usurp academic inventors' ownership rights to their intellectual property. The Bayh-Dole Act, according to the Court, allows research universities to claim title to inventions only in situations where the institution has already secured ownership rights from the academic inventor(s) through contractual assignment or employment agreement.

On June 6, 2011, the U.S. Supreme Court affirmed the lower court's ruling. The implication, resulting from the court's decision, is that universities will need to modify policies enacted to protect their intellectual property. Employment agreements, between universities and research professors, must document precise percentages of intellectual property ownership between the institutions, academic inventors, and potential joint venture partners from private industry.

This investigation may constitute the first study, using AUTM's Statistics Access for Technology Transfer database, where research was conducted to identify differences between public and private universities in sourcing research funding and in achieving commercialization success. This investigation revealed that private universities were more adept at procuring federal research funding. Therefore, it would behoove public schools to adopt the research funding practices of the better performing private universities. It was also determined, through analysis of data for the most recent three years of the licensing survey, that private research universities have generated a greater amount of licensing income for each dollar of research expenditure. Again, the policies and practices of the more efficient, private universities may need to be examined to determine the extent to which their policies and practices could be adopted.

Suggestions for Future Research

In this investigation, during which three years (i.e., 2011, 2012, and 2013) of licensing survey data were analyzed, it was discovered that private universities generated a statistically significantly higher amount of licensing revenue per dollar of research funding than public universities. A suggestion for future research would be to conduct a qualitative or mixed method study to determine how private universities have been more successful than public universities in generating higher amounts of licensing revenue per dollar of research funding from commercialization of their intellectual property. The investigation could include a questionnaire and licensing professionals from both public and private universities could be asked to identify parameters for deciding which research and development projects are selected to transition forward into the commercialization process. The licensing professionals could also be asked to outline the procedural steps for

taking a new technology or invention from idea validation through the commercialization process to market launch. Differences could then be identified in both the method of project selection and the steps taken to ensure success through the commercialization process.

Conclusion

The purpose of this study was to identify differences between public and private universities in their percentage share of both federal research funding and funding from private industry sources. An additional purpose was to identify differences between public and private universities in licensing income generated per dollar of research expenditure. The final purpose of this study was to determine the existence and the strength of the relationship between federal research funding and license income earned and to determine the existence and the strength of the relationship between private industry research funding and licensing income earned. The study was conducted using the most recent three years (i.e., 2011, 2012, and 2013) of the Licensing Activity Survey, conducted by the AUTM. This investigation may constitute the first study, using AUTM's Statistics Access for Technology Transfer database, where research was conducted to identify differences between public and private universities in sourcing research funding and in achieving commercialization success. A conclusion of this investigation was that private universities were more adept at procuring federal research funding than their public counterpart. Therefore, it would behoove public schools to adopt the research funding practices of the better performing private universities. In addition, private research universities had generated a greater amount of licensing income for each dollar of research expenditure. Again, the policies and practices of the more

efficient. private universities may need to be examined to determine the extent to which their policies and practices could be adopted.

References

- Association of University Technology Managers. (2012a). *Instructions and definitions*. Retrieved from <http://www.autm.net/home.htm>
- Association of University Technology Managers. (2012b). *Licensing activity survey questionnaire*. Retrieved from <http://www.autm.net/home.htm>
- Association of University Technology Managers. (2014). *Highlights of AUTM's U.S. Licensing Survey FY2013*. Retrieved from <http://www.autm.net/home.htm>
- Association of University Technology Managers. (2015). *STATT (3.6)* [software]. Retrieved from <http://www.autm.net/home.htm>
- Bayh-Dole Patent and Trademark Amendments Act of 1980. Pub. L. 96-517. 94 Stat. 3015-3029 (1980).
- Board of Trustees of the Leland Stanford Junior University, Petitioner v. Roche Molecular Systems, Inc., et al., 131 S. Ct. 2188 (2011).
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.
- Cohen, J. (1994). The earth is round ($p < .05$). *American Psychologist*, 49, 997-1003.
- Creswell, J. W. (2009). *Qualitative inquiry and research design* (3rd ed.). Thousand Oaks, CA: Sage.
- Johnson, B., & Christensen, L. (2012). *Educational research: Quantitative, qualitative, and mixed approaches* (4th ed.). Thousand Oaks, CA: Sage.
- Kneller, R., Mongeon, M., Cope, J., Garner, C., & Ternouth, P. (2014). Industry-university collaborations in Canada, Japan, the UK and USA – with emphasis on

publication freedom and managing the intellectual property lock-up problem.

PLOS ONE, 9(3), 1-19. doi:10.1371/journal.pone.0090302

Martin, M., Gruetzmacher, R. R., Lanham, R., & Brady, J. (2004). Assessing technology transfer and business development potential: Technology cluster analysis.

Economic Development Quarterly, 18, 168-173. doi:10.1177/0891242403261088

Mowery, D., Nelson, R., Sampat, B., & Ziedonis, A. (2001). The growth of patenting and licensing by U.S. universities: An assessment of the effects of the Bayh-Dole Act of 1980. *Research Policy*, 99-119. doi:10.1016/s0048-7333(99)00100-6

Onwuegbuzie, A. J., & Daniel, L. G. (2002). Uses and misuses of the correlation coefficient. *Research in the Schools*, 9(1), 73-90.

Rafferty, M. (2008). The Bayh-Dole Act and university research and development.

Research Policy, 37, 29-40. doi:10.1016/j.respol.2007.06.010

Sharma, S. (2011). The Bayh-Dole Act and allocation of ownership rights in inventions arising out of federally funded research. *Intellectual Property & Technology Law Journal*, 23(8), 23-28.

Szelenyi, K., & Goldberg, R. A. (2011). Commercial funding in academe: Examining the correlates of faculty's use of industrial and business funding for academic work.

The Journal of Higher Education, 82(6), 775-802. doi:10.1353/jhe.2011.0040

Wu, Y. (2013). The cross-state distribution of federal funding in the USA: The case of financing academic research and development. *Science and Public Policy*, 40, 316-326. doi:10.1093/scipol/scs107

Table 2.1

Descriptive Statistics for Federally Funded Research Expenditures, Privately Funded Research Expenditures, and Licensing Income per Dollar of Research Expenditure for the AUTM's 2011 Licensing Survey by University Type

Year, Expenditures, and Licensing Income	<i>M</i>	<i>SD</i>
Federal Research Expenditures		
Public Universities	\$208,931,735.22	\$349,261,510.22
Private Universities	\$304,819,134.17	\$305,226,311.25
Private Research Expenditures		
Public Universities	\$21,358,224.87	\$44,653,522.72
Private Universities	\$27,704,759.38	\$44,634,594.25
Licensing Income Generated per Dollar of Research Expenditure		
Public Universities	\$0.0132	\$0.0198
Private Universities	\$0.0570	\$0.1140

Note. In the 2011 licensing year, the number of respondents for Federal Research Expenditures was 101 for Public Universities and 48 for Private Universities. The number of respondents for Private Research Expenditures was 100 for Public Universities and 47 for Private Universities.

Table 2.2

Descriptive Statistics for Federally Funded Research Expenditures, Privately Funded Research Expenditures, and Licensing Income per Dollar of Research Expenditure for the AUTM's 2012 Licensing Survey by University Type

Year, Expenditures, and Licensing Income	<i>M</i>	<i>SD</i>
Federal Research Expenditures		
Public Universities	\$213,587,093.91	\$352,846,582.81
Private Universities	\$295,158,913.74	\$299,050,290.73
Private Research Expenditures		
Public Universities	\$22,407,070.32	\$46,783,471.39
Private Universities	\$26,481,323.73	\$43,800,993.72
Licensing Income Generated per Dollar of Research Expenditure		
Public Universities	\$0.0170	\$0.0350
Private Universities	\$0.0581	\$0.1144

Note. In the 2012 licensing year, the number of respondents for Federal Research Expenditures was 100 for Public Universities and 49 for Private Universities. The number of respondents for Private Research Expenditures was 99 for Public Universities and 48 for Private Universities.

Table 2.3

Descriptive Statistics for Federally Funded Research Expenditures, Privately Funded Research Expenditures, and Licensing Income per Dollar of Research Expenditure for the AUTM's 2013 Licensing Survey by University Type

Year, Expenditures, and Licensing Income	<i>M</i>	<i>SD</i>
Federal Research Expenditures		
Public Universities	\$206,420,812.68	\$339,663,773.62
Private Universities	\$285,956,194.56	\$312,820,338.32
Private Research Expenditures		
Public Universities	\$24,464,404.42	\$50,298,524.29
Private Universities	\$26,277,146.45	\$47,080,876.03
Licensing Income Generated per Dollar of Research Expenditure		
Public Universities	\$0.0150	\$0.0271
Private Universities	\$0.0615	\$0.1246

Note. In the 2013 licensing year, the number of respondents for Federal Research Expenditures was 103 for Public Universities and 50 for Private Universities. The number of respondents for Private Research Expenditures was 101 for Public Universities and 49 for Private Universities.

CHAPTER III

PREDICTING LICENSING REVENUE GENERATED FROM
COMMERCIALIZATION OF UNIVERSITIES' INTELLECTUAL PROPERTY

This dissertation follows the style and format of *Research in the Schools (RITS)*.

Abstract

The most recent three years (i.e., 2011, 2012, and 2013) of the Licensing Activity Survey, conducted by the Association of University Technology Managers, were used to investigate the extent to which the licensing income of U.S. universities ($n = 140$, $n = 142$, $n = 147$, respectively) could be predicted by five questionnaire items (i.e., Number of Licensing Managers, Number of Licensing Agreements Executed, Number of U.S. Patents Issued, Total Research Expenditures, and Number of Start-Up Companies Initiated) chosen from the surveys. An All Possible Subsets regression analysis revealed that the Number of U.S. Patents Issued was the only statistically significant predictor of licensing income generated from universities' intellectual property for all three survey years analyzed in this investigation. The ability to identify university characteristics and Technology Transfer Office efforts that may lead to maximization of licensing revenue should result in a more efficient allocation of universities' resources.

Keywords: Universities' Intellectual Property, Commercialization, Technology Transfer

CHAPTER III

PREDICTING LICENSING REVENUE GENERATED FROM COMMERCIALIZATION OF UNIVERSITIES' INTELLECTUAL PROPERTY

Researchers (Colyvas et al., 2002; Prets & Slate, 2014; Rahal & Rabelo, 2006; Turk-Bicakci & Brint, 2005) have determined that a number of factors have an effect on the successful commercialization of universities' intellectual properties. Profitable commercialization efforts can be abetted by the attributes (e.g., size, wealth) and by the culture of research universities (Turk-Bicakci & Brint, 2005). Fruitful commercialization may depend upon the age, size (i.e., number of licensing managers), personnel and activities (e.g., number of licensing agreements executed) of a university's Technology Transfer Offices (Prets & Slate, 2014). Additionally, the attributes of the new technologies or inventions can be instrumental in determining if and how quickly a new product or service can be brought to market (Colyvas et al., 2002; Rahal & Rabelo, 2006).

Finally, in an effort to commercialize more of their intellectual property, a limited number of research universities have developed commercialization programs where curricula is designed around intellectual property management and technology commercialization. Courses taught include projects where the goal is to bring these universities' intellectual property to market (Barr, Baker, Markham, & Kingon, 2009; Boni, Weingart, & Evenson, 2009; Phan, Siegel, & Wright, 2009; Thursby, Fuller, & Thursby, 2009). A list of success factors and the corresponding references are compiled in Table 3.1.

Insert Table 3.1 about here

University and Technology Transfer Office Characteristics

Turk-Bicakci and Brint (2005) conducted a study to identify research universities with the best record of successful collaboration with private industry and to determine how these schools were able to cultivate and maintain those relationships. These researchers also wanted to uncover differences in general characteristics or intellectual property commercialization strategies between the higher and lower performing universities. Data for the study were provided by the Association of University Technology Managers (AUTM) and included industry funding reported by 113 research universities. The AUTM survey data from the decade of the 1990s were examined to identify trends in industry-university collaborations; information from the 2000 academic year was used to select attributes thought to be connected to high or low performance. The measures used to determine successful collaboration were (a) the dollar amount of industry support provided for university research, (b) the number of licenses sold by universities for their technologies or inventions, and (c) the amount of income generated from those licenses.

Turk-Bicakci and Brint (2005) discovered that the size of the science and engineering departments, as measured by total graduate student population, and the wealth of the school, as measured by operating budget per student, were the two most important factors in determining industry funding of university research. When determining the number of licenses sold, again the size of the science and engineering

department coupled with the size of the Technology Transfer Office were the most important factors. Finally, when determining the amount of income generated from licensing, wealthy, private institutions with large technology transfer staffs generated more volume than did poorer, public universities with sparsely staffed and inadequately funded Technology Transfer Offices. According to Turk-Bicakci and Brint (2005), middle- and low-level collaborators, because they are smaller, poorer, public universities with little or no technology transfer staff, may never be able to generate substantial surplus income from intellectual property commercialization.

Technology Transfer Office Efforts - Patent Protection

Researchers have also assessed the importance of technology transfer professionals' efforts in the commercialization process. In 2002, Colyvas et al. conducted an in-depth case study to determine if intellectual property protection, primarily by patent, or other efforts by technology transfer staff were responsible for improved success in bringing new technologies to market. Colyvas et al. (2002) analyzed 11 case studies written about university research projects that culminated in patented inventions. The case studies examined came from two universities, Columbia and Stanford. These schools were chosen because they had Technology Transfer Offices and because they had been successful in commercializing intellectual property. The new inventions or technological advances, which resulted from fruitful research projects, were varied and included pharmaceuticals, biotechnologies, computer software, and medical and electrical devices.

Colyvas et al. (2002) concluded that outside firms were often willing to license new technologies or inventions from universities, even without patent protection, if those

technologies were well developed, prototype tested, and ready to go to market. However, when dealing with *embryonic inventions*, where a potentially significant amount of additional research time and money could be required to commercialize the product, firms required patent protection and exclusive rights to the technologies to recoup their investment. Another noteworthy observation made by Colyvas et al. was that the marketing efforts of the two university Technology Transfer Offices were more important to successful product commercialization where ties between the schools and relevant industries were weak.

Attributes of the New Technology or Invention

In addition to patentability, a number of other intellectual property attributes contribute to successful commercialization. Rahal and Rabelo (2006) conducted a study to develop a methodology for assessing the potential for commercialization of university technologies and inventions. They analyzed 108 responses from a web-based survey sent to members of the Licensing Executive Society. A literature review helped the researchers to identify the 43 most significant factors used by licensing professionals to determine the viability of a technology or invention. Rahal and Rabelo (2006) asked the respondents to rank the 43 determining factors for one piece of university intellectual property that they had decided to license and to compile a second ranking for a technology or invention that they had decided to reject.

Survey responses helped the researchers reduce the number of determining factors down from 43 to 12 (Rahal & Rabelo, 2006). The most important factors included the strength, uniqueness, and superiority of the new technology. Licensees also wanted exclusivity, a large potential market, and a clean patent. Rounding out the most

significant factors were technical feasibility and a short time to market. The highly-ranked licensing determinants were used to create a model capable of accurately predicting which university intellectual properties have the highest potential for commercialization. Rahal and Rabelo (2006) noted that additional research, including a survey with a higher response rate, could improve the predictive accuracy of their model.

Intellectual Property Management/Technology Commercialization Education

Although a limited number of business and engineering schools have begun to design courses and curricula around intellectual property management and technology commercialization, newer concepts including interdisciplinary teams of instructors teaching interdisciplinary groups of graduate students are still far from being in the mainstream (Phan et al., 2009). Colleges, within universities, have traditionally chosen to remain independent. However, business school professors may lack exposure to the natural sciences and applied technology disciplines. Similarly, instructors from colleges of engineering and of science may not have any practical experience in marketing or management. Research universities that are interested in creating a new technology transfer office or filling a vacancy in an existing office, without a multidisciplinary applicant option, are recruiting licensing managers with narrowly-focused proficiency in patent law or with a specific technical expertise (Phan et al., 2009).

In an effort to commercialize more of their intellectual property, North Carolina State University developed the Technology Entrepreneurship and Commercialization Program (Barr et al., 2009). Development of the program was supported by the National Science Foundation and has since been adopted by Ohio State University and others. The Technology Entrepreneurship and Commercialization Program's process begins with the

creation of multidisciplinary teams of graduate students. The teams can number from five to eight and can come from the colleges of business, engineering, and science.

After the creation of teams, the formal process is comprised of five steps. In the first step, referred to as ideation, teams choose at least two technologies from North Carolina State University's cache of intellectual property. Continuing in step one, the students study their two chosen technologies and produce a written statement describing both the technology and any perceived potential markets for the product or service. Phase I, which is actually the second step in the process, is to identify fatal flaws in the technology that would preclude marketability. Fatal flaws, including better and cheaper products or services already offered in the marketplace, help students to identify bad ideas that can be pushed aside. The single most attractive technology and, at least initially, one start-up product or service can then be carried forward to Phase II, which is also referred to as step three. During this phase, the teams are engaged in product development and market research. Standard management tools, including Michael Porter's "Five Forces," facilitate strategy creation and compel teams to identify and to interact with supplies, competitors, and, most importantly, customers (Porter, 2008). Creation of a commercialization strategy is the fourth step in the program. The process includes formation of a management team, raising capital, and marketing aimed at early adopters. The product of this step is a formal business plan. Implementation, which is also referred to as start-up, is the fifth and final step. Start-up typically occurs at the end of formal coursework (Barr et al., 2009).

Carnegie Mellon University has also developed an interdisciplinary course on intellectual property commercialization (Boni et al., 2009). The underlying premise, for

the Capstone Course. is that the approach to commercialization should be market-driven rather than engineering-driven. An engineering approach to commercialization begins with a technology and then attempts to find a use for the product or service. In a market first approach, existing customers with specific needs are identified and the appropriate technologies are used to create products and services to satisfy those needs. An additional premise is that an interdisciplinary team of instructors is needed to teach the Capstone Course. Carnegie Mellon professors from three disciplines, entrepreneurship, design, and organizational behavior, are brought together to teach the graduate course. All three instructors attend and contribute to every class meeting. Students selected for the course are also interdisciplinary. Teams are composed of second-year master's degree students from the University's School of Business and their School of Design. The course has an academic component comprised of lectures and workshop discussions on topics ranging from building and leading effective teams to team conflict and conflict management. A project component is also present for the course. A project could stem from university intellectual property or it could be based on a technology from an outside company. If the technology, and therefore the project, is sponsored by a private company, the project sponsor can become an additional expert coach for the team (Boni et al., 2009).

One of the most comprehensive and well defined technology management programs was created in a collaboration between the Georgia Institute of Technology and Emory University. The Technological Innovation: Generating Economic Results, or TI:GER, was created to examine the commercial potential of Georgia Tech PhD students' research (Thursby et al., 2009). The TI:GER two year certificate program, when

completed. provides graduate students with a degree concentration in either Intellectual Property or Technology Law. Instruction is provided by law professors from Emory and by economics and business faculty from Georgia Tech. Graduate students work in teams comprised of one science or engineering PhD student, one MBA student, and two JD students (one specializing in patent law and the other in technology law).

The first semester course is Fundamentals of Innovation I. Innovation I covers topics including team development, intellectual property analysis, and industry analysis. In the second semester, students take Fundamentals of Innovation II. In the course, students are exposed to marketing strategies, company valuation methods, and funding strategies. The course, in semester three, is Special Topics in Technology Commercialization. In the commercialization course students learn about project management and business plan development and writing. The final semester is devoted to independent study. Student teams may participate in a business plan competition or work with their team on a joint venture lab project. In addition, science and engineering PhD student are required to take a business management course. Graduate students, participating in business or law programs, are also required to take additional, program-relevant electives.

One of the aspects that distinguishes the TI:GER program is its assessment component. Assessment, conducted by an independent third party, includes focus group sessions and pre- and post-program surveys. The surveys are designed to help administrators assess student perceptions regarding their multidisciplinary competencies upon entry and exit from the program (Thursby et al., 2009).

Statement of the Problem

In 2013, 719 new commercial products were created by companies that licensed university developed technology as reported in the most recent AUTM Licensing Survey (AUTM, 2014). Today, even though most research universities have created intellectual property policies and have dedicated licensing managers in place, an astonishing dichotomy is present between economically successful universities and underperforming institutions. This disparity has been exacerbated by Technology Transfer Offices that have been inadequately resourced. According to Turk-Bicakci and Brint (2005), smaller, poorer, public universities with little or no Technology Transfer Office staff may never be able to create surplus income from the commercialization of their intellectual property.

Purpose of the Study

The purpose of this study was to identify universities' characteristics and Technology Transfer Offices' activities that result in optimal generation of income produced from commercialization of institutions' intellectual property. An additional purpose was to rank, through regression analysis, the extent to which each of the five predetermined independent variables can be used to predict income production from universities' licensing activities. The final purpose of this study was to identify trends in ranking the extent to which the predictor variables can be used to forecast future revenue streams by analyzing response data from the 2011, 2012, and 2013 survey years.

Significance of the Study

The ability to identify and to rank Technology Transfer Offices' characteristics and activities that produce the greatest return on investment from universities' intellectual property could facilitate efficiency in resource allocation. University administrators, by

amending their commercialization policies and procedures, can ensure future funding is concentrated on those activities that lead to the greatest revenue streams. Conversely, efforts on the part of Technology Transfer Offices that do not yield an acceptable economic benefit to the university and to the community can be scaled back or eliminated.

Research Questions

The research question addressed in this investigation was: How much do survey items (a) Number of Licensing Managers, (b) Number of Licensing Agreements Executed, (c) Number of U.S. Patents held, (d) Total Research Expenditures, and (e) Number of Start-Up Companies Initiated contribute to predicting the amount of income generated from licensing universities' intellectual property? To answer this research question, data were obtained from the Association of University Technology Manager's (AUTM's) 2011, 2012, and 2013 Licensing Activity Survey Questionnaires. As such, this research question was repeated for each of these three years. Following these three years of analyses, the extent to which any trends were present were examined.

Limitations

The Licensing Activity Survey Questionnaire, conducted yearly by AUTM, is disseminated to research universities, medical schools, and other research institutions inside the U.S. Responses are compiled into AUTM's searchable and exportable database Statistics Access for Technology Transfer (AUTM, 2015). Therefore, the results from this study may not be generalizable outside of the U.S. In addition, respondent institutions differed from year to year. Finally, the responses from Technology Transfer Office professionals who participated in the survey during the years

captured in this study may differ from the answers that would have been provided by those individuals who chose not to respond to the questionnaire.

Method

Research Design

This study was conducted with a non-experimental, correlational research design (Creswell, 2009; Johnson & Christensen, 2012). Five predictor variables were chosen for this study. The first predictor variable “Number of Licensing Managers” includes all personnel engaged in licensee solicitation, technology valuation, license agreement drafting and negotiation, and business start-up activities, but does not include Technology Transfer Office support staff. Predictor variable “Number of Licensing Agreements Executed” includes both licensing and option agreements. The “Number of U.S. Patents Issued,” predictor variable number three, includes only domestic patents. Predictor variable “Total Research Expenditures” is defined by AUTM as: “all expenditures made by the institution in the survey year in support of its research activities that are funded by all sources including the federal government, local government, industry, foundations, voluntary health organizations (e.g., AHA, ACS), and other nonprofit organizations.” The fifth predictor variable “Start-Up Companies” are firms that were dependent upon licensing the institution's technology for initiation. In nonexperimental research, no manipulation of the predictor variables occurs. In this investigation, the five predictor variables were not manipulated.

The single, quantitative outcome variable for this study was “Licensing Revenue Received.” License revenue received includes: license issue fees, payments for options, annual minimums, running royalties, termination payments, and the amount of equity

received when cashed-in. The outcome variable did not include a valuation for equity not cashed-in. In this correlational research, the relationship between the five predictor variables and the one outcome variable (i.e., licensing revenue received) were examined. The disadvantages of using this design include limited control of extraneous variables and lack of manipulation of the predictor variables (Creswell, 2009; Johnson & Christensen, 2012).

Participants

The Yearly Licensing Activity Survey (AUTM, 2012a), produced by AUTM, is disseminated to public and private research universities, medical schools, and other research institutions in the United States. The database, used to reach AUTM's target market with the survey questionnaire, includes past respondents and institutions that currently employ or previously employed AUTM members. Specifically, the AUTM's researchers prefer that the questionnaire be completed by one of the respondent institutions' intellectual property managers or technology licensing professionals. The range of yearly participants, for research institutions that completed and returned the survey, was between 199 and 202 for the years included in this study.

Instrumentation and Procedures

Statistical analysis was conducted on data provided by AUTM. One of AUTM's primary activities, for each of the last 23 years, has been to conduct their annual U.S. Licensing Activity Survey. The purpose of the survey is to quantify academic technology transfer data. In 2013, the survey was disseminated to 299 U. S. research institutions. Survey recipients included 232 colleges and universities, 61 research hospitals, three national laboratories, and three independent, technology related firms. Of the

organizations contacted. 202 institutions returned the survey for a response rate of 68% (AUTM, 2014). The compilation of past survey responses is available in AUTM's Statistics Access for Technology Transfer database (AUTM, 2015). The Yearly Licensing Activity Survey, conducted by AUTM in 2011, in 2012, and in 2013, was used to investigate the extent to which the licensing income of universities can be predicted by five questionnaire items (i.e., Number of Licensing Managers, Number of Licensing Agreements Executed, Number of U.S. Patents Held, Total Research Expenditures, and Number of Start-Up Companies Initiated) chosen from the survey.

Results

The most recent three years (i.e., 2011, 2012, and 2013) of the Licensing Activity Survey, conducted by the AUTM, were used to investigate the extent to which the licensing income of universities could be predicted by five questionnaire items (i.e., Number of Licensing Managers, Number of Licensing Agreements Executed, Number of U.S. Patents Issued, Total Research Expenditures, and Number of Start-Up Companies Initiated) chosen from the surveys. Prior to conducting the multiple regression analysis on the data from the 2011 survey, the standardized skewness coefficients (i.e., the skewness value divided by its standard error) and the standardized kurtosis coefficients (i.e., the kurtosis value divided by its standard error) were calculated to determine the normality of data. All of the standardized skewness coefficients and the standardized kurtosis coefficients were outside the range of normality, ± 3 (Onwuegbuzie & Daniel, 2002). However, Field (2009) contends regression is robust and can withstand assumption violations.

Analysis of the scatterplot graphs revealed linear relationships in all five cases. In addition, the Durbin-Watson statistic value of 2.18 did not violate the assumption for the presence of significant residual autocorrelation. Therefore, an All Possible Subsets regression analysis (Tabachnick & Fidell, 2007; Thompson, 1995) was conducted to answer the research question on predicting licensing income generated from universities' intellectual property. Statisticians (Tabachnick & Fidell, 2007; Thompson, 1995) recommend use of an All Possible Subsets regression over stepwise regression procedures. Descriptive statistics for the licensing income predictor and outcome variables based on the data from the 2011 licensing survey are present in Table 3.2.

Insert Table 3.2 about here

The All Possible Subsets regression analysis (Tabachnick & Fidell, 2007; Thompson, 1995) revealed that the Number of U.S. Patents Issued was a statistically significant predictor of licensing income generated from universities' intellectual property, $F(1, 138) = 93.37, p < .001$. The adjusted R^2 value of .40 explained 40% of the total variance and was indicative of a large effect size (Cohen, 1988). Survey item Start-Up Companies Initiated was also a statistically significant predictor of licensing income generated. The adjusted R^2 value of .02 explained slightly less than 2% of the total variance and was indicative of a small effect size (Cohen, 1988). The remaining three predictor variables (i.e., Number of Licensing Managers, Total Research Expenditures, and Number of Licensing Agreements Executed) did not contribute to explaining the variance in the income generated from licensing universities' intellectual property. The

information provided by these three variables, in some cases, may be redundant with the variance accounted for by the Number of U.S. Patents Issued and Start-Up Companies Initiated.

Prior to conducting the multiple regression analysis on the data from the 2012 survey, data normality was checked. All of the standardized skewness coefficients and the standardized kurtosis coefficients were outside the range of normality, ± 3 (Onwuegbuzie & Daniel, 2002). However, Field (2009) contends regression is robust and can withstand assumption violations. Analysis of the scatterplot graphs revealed linear relationships in all five cases. In addition, the Durbin-Watson statistic value of 2.23 did not violate the assumption for the presence of significant residual autocorrelation. Therefore, an All Possible Subsets regression analysis (Tabachnick & Fidell, 2007; Thompson, 1995) was conducted to answer the research question on predicting licensing income generated from universities' intellectual property. Table 3.3 can be referred to for the descriptive statistics for the licensing income predictor and outcome variables calculated from data obtained from the 2012 licensing survey.

Insert Table 3.3 about here

The All Possible Subsets regression analysis (Tabachnick & Fidell, 2007; Thompson, 1995) revealed that the Number of U.S. Patents Issued was the only statistically significant predictor of licensing income generated from universities' intellectual property, $F(1, 140) = 57.90, p < .001$. The adjusted R^2 value of .29 explained 29% of the total variance and was indicative of a large effect size (Cohen, 1988). The

remaining four predictor variables (i.e., Number of Licensing Managers, Total Research Expenditures, Number of Licensing Agreements Executed, and Number of Start-Up Companies Initiated) did not contribute to explaining the variance in the income generated from licensing universities' intellectual property. The information provided by these four variables, in some cases, may be redundant with the variance accounted for by the survey item Number of U.S. Patents Issued.

Again, prior to conducting the multiple regression analysis on the data from the AUTM's 2013 survey, data normality was checked. All of the standardized skewness coefficients and the standardized kurtosis coefficients were outside the range of normality, +/-3 (Onwuegbuzie & Daniel, 2002). However, Field (2009) contends regression is robust and can withstand assumption violations. Analysis of the scatterplot graphs revealed linear relationships in all five cases. In addition, the Durbin-Watson statistic value of 2.21 did not violate the assumption for the presence of significant residual autocorrelation. Therefore, an All Possible Subsets regression analysis (Tabachnick & Fidell, 2007; Thompson, 1995) was conducted to answer the research question on predicting licensing income generated from universities' intellectual property. Revealed in Table 3.4 are the descriptive statistics for the licensing income predictor and outcome variables related to the 2013 licensing survey data.

Insert Table 3.4 about here

The All Possible Subsets regression analysis (Tabachnick & Fidell, 2007; Thompson, 1995) revealed that the Number of U.S. Patents Issued was the only

statistically significant predictor of licensing income generated from universities' intellectual property, $F(1, 145) = 46.48, p < .001$. The adjusted R^2 value of .24 explained 24% of the total variance and was indicative of a large effect size (Cohen, 1988). The remaining four predictor variables (i.e., Number of Licensing Managers, Total Research Expenditures, Number of Licensing Agreements Executed, and Number of Start-Up Companies Initiated) did not contribute to explaining the variance in the income generated from licensing universities' intellectual property. The information provided by these four variables, in some cases, may be redundant with the variance accounted for by the survey item Number of U.S. Patents Issued.

Discussion

The most recent three years (i.e., 2011, 2012, and 2013) of the AUTM's Licensing Activity Survey were used to investigate the extent to which the licensing income of U.S. universities could be predicted by five questionnaire items (i.e., Number of Licensing Managers, Number of Licensing Agreements Executed, Number of U.S. Patents Issued, Total Research Expenditures, and Number of Start-Up Companies Initiated) chosen from the surveys. An All Possible Subsets regression analysis revealed that the Number of U.S. Patents Issued was the only statistically significant predictor of licensing income generated from universities' intellectual property for all three survey years analyzed in this investigation.

Connection with Existing Literature

According to Turk-Bicakci and Brint (2005), when determining the amount of income generated from licensing intellectual property, wealthy, private institutions with large technology transfer staffs generated more revenue than did poorer, public

universities with sparsely staffed and inadequately funded Technology Transfer Offices. Wealthy universities with well-funded Technology Transfer Offices are also in a position to produce large numbers of U.S. patents. Therefore, Turk-Bicakci and Brint's (2005) results are analogous with the conclusion herein that the Number of U.S. Patents Issued was a statistically significant predictor of licensing income generated from universities' intellectual property.

Researchers have also analyzed the effect of patent protection on universities' commercialization efforts. Colyvas et al. (2002) conducted an in-depth case study to determine if intellectual property protection, primarily by patent, was responsible for improved success in bringing new technologies to market. Following the analysis of 11 case studies written about university research projects that culminated in patented inventions, Colyvas et al. (2002) concluded that outside firms may be willing to license new technologies or inventions from universities, even without patent protection, if those technologies were well developed, prototype tested, and ready to go to market. However, when dealing with embryonic inventions, where a potentially significant amount of additional research time and money could be required to commercialize products, licensee firms required patent protection and exclusive rights to the technologies to recoup their investment. Results from this empirical investigation, at least in part, support the conclusions of Colyvas et al. (2002).

Finally, Rahal and Rabelo (2006) conducted a study to develop a methodology for assessing the potential for commercialization of university technologies and inventions. The researchers compiled a list of the most essential factors in reaching a positive licensing decision. The list included the strength, uniqueness, and superiority of the new

technology. Licensees also wanted exclusivity, a large potential market, and a clean patent. Rounding out the most crucial factors were technical feasibility and a short time to market. Again, the conclusion that the Number of U.S. Patents Issued was a statistically significant predictor of licensing income generated from universities' intellectual property is congruent with Rahal and Rabelo's (2006) research.

Implications for Policy and Practice

The ability to identify and to rank Technology Transfer Offices' characteristics and activities that produce the greatest return on investment from universities' intellectual property could facilitate efficiency in resource allocation. University administrators, by amending their commercialization policies and procedures, can ensure future funding is concentrated on those activities that lead to the greatest revenue streams. Conversely, efforts on the part of Technology Transfer Offices that do not yield an acceptable economic benefit to the university and to the community can be scaled back or eliminated. An implication emanating from this research is that an increase in the number of patents issued to a university may result in an increased level of licensing revenue for the institution.

Suggestions for Future Research

The archival data analyzed for this study were provided by the AUTM. As such, data from alternate sources were not obtained nor analyzed in this research investigation. In addition, a comprehensive review of the existing literature pertaining to commercialization of universities' intellectual property revealed that the AUTM is often the primary source for data analyzed in published research. A suggestion for future research would be to source alternate datasets and to conduct comparative analyses.

An alternative to locating and analyzing additional archival datasets would be to conduct a qualitative or mixed method study. The investigation could include a questionnaire and licensing professionals could be directly queried about specific instances where issued patents on intellectual properties lead directly to successful licensing agreements with industry partners. Conversely, the respondents could also be asked about instances where the lack of patents on universities' technologies or inventions resulted in the loss of potentially lucrative licensing agreements.

Conclusion

The purpose of this study was to identify universities' characteristics and Technology Transfer Offices' activities that result in optimal generation of income produced from commercialization of institutions' intellectual property. Specifically, the most recent three years (i.e., 2011, 2012, and 2013) of the Licensing Activity Survey, conducted by the AUTM, were used to investigate the extent to which the licensing income of universities might be predicted. Results of the data analysis revealed that the Number of U.S. Patents Issued was the only statistically significant predictor of licensing income generated from universities' intellectual property for all three survey years analyzed in this investigation. Congruent with the findings of previous researchers (Colyvas et al., 2002; Rahal & Rabelo, 2006; Turk-Bicakci & Brint, 2005), the size of a university's patent portfolio may be an important predictor of the institution's ability to generate licensing revenue.

References

- Association of University Technology Managers. (2012). *Licensing activity survey questionnaire*. Retrieved from <http://www.autm.net/home.htm>
- Association of University Technology Managers. (2014). *Highlights of AUTM's U.S. Licensing Survey FY2013*. Retrieved from <http://www.autm.net/home.htm>
- Association of University Technology Managers. (2015). *STATT (3.6)* [software]. Retrieved from <http://www.autm.net/home.htm>
- Barr, S. H., Baker, T., Markham, S. K., & Kingon, A. I. (2009). Bridging the valley of death: Lessons learned from 14 years of commercialization of technology education. *Academy of Management Learning & Education*, 8(3), 370-388. doi:10.5465/AMLE.2009.44287937
- Boni, A. A., Weingart, L. R., & Evenson, S. (2009). Innovation in an academic setting: Designing and leading a business through market-focused, interdisciplinary teams. *Academy of Management Learning & Education*, 8(3), 407-417. doi:10.5465/AMLE.2009.44287939
- Colyvas, J., Crow, M., Gelijns, A., Mazzoleni, R., Nelson, R. R., Rosenberg, N., & Sampat, B. N. (2002). How do university inventions get into practice? *Management Science*, 48(1), 61-72. doi:10.1287/mnsc.48.1.61.14272
- Creswell, J. W. (2009). *Qualitative inquiry and research design* (3rd ed.). Thousand Oaks, CA: Sage.
- Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). Thousand Oaks, CA: Sage.
- Johnson, B., & Christensen, L. (2012). *Educational research: Quantitative, qualitative, and mixed approaches* (4th ed.). Thousand Oaks, CA: Sage.

- Onwuegbuzie, A. J., & Daniel, L. G. (2002). Uses and misuses of the correlation coefficient. *Research in the Schools*, 9(1), 73-90.
- Phan, P. H., Siegel, D. S., & Wright, M. (2009). New developments in technology management education: Background issues, program initiatives, and a research agenda. *Academy of Management Learning & Education*, 8(3), 324-336. doi:10.5465/AMLE.2009.44287934
- Porter, M. E. (2008). The five competitive forces that shape strategy. *Harvard Business Review*, 86(1), 78-93.
- Prets, R. A., & Slate, J. R. (2014). Predicting income generated from licensing universities' intellectual property. *International Journal of University Teaching and Faculty Development*, 4(1), 1-7.
- Rahal, A. D., & Rabelo, L. C. (2006). Assessment framework for the evaluation and prioritization of university inventions for licensing and commercialization. *Engineering Management Journal*, 18(4), 28-36.
- Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Boston, MA: Pearson.
- Thompson, B. (1995). Stepwise regression and stepwise discriminant analysis need not apply here: A guidelines editorial. *Educational and Psychological Measurement*, 55(4), 525-534.
- Thursby, M. C., Fuller, A. W., & Thursby, J. (2009). An integrated approach to educating professionals for careers in innovation. *Academy of Management Learning & Education*, 8(3), 389-405. doi:10.5465/AMLE.2009.44287938

Turk-Bicakci, L., & Brint, S. (2005). University-industry collaboration: Patterns of growth for low- and middle-level performers. *Higher Education*, 49, 61-89.
doi:10.1007/s10734-004-2914-6

Table 3.1

Technology Transfer Office Success Factors

Factors	References
University characteristics (e.g., financial strength, focused on science and engineering, entrepreneurial culture).	Turk-Bicakci & Brint (2005)
Technology Transfer Office characteristics (e.g., university administration support, adequate budget, large staff, marketing efforts).	Colyvas et al. (2002); Prets & Slate (2014); Turk-Bicakci & Brint (2005)
Attributes of the new technology or invention (e.g., patentability and marketability).	Colyvas et al. (2002); Rahal & Rabelo (2006)
Technology management education (e.g., interdisciplinary research professors and interdisciplinary graduate students).	Barr et al. (2009); Boni et al. (2009); Phan et al. (2009); Thursby et al. (2009)

Table 3.2

Descriptive Statistics for 2011 Licensing Revenue Outcome and Predictor Variables

Survey Items	<i>M</i>	<i>SD</i>
Licensing Revenue Received	\$12,309,394.39	\$31,118,201.27
Number of Licensing Managers	5.98	7.81
Total Research Expenditures	\$378,945,845.30	\$566,543,631.20
Number of Licensing Agreements	29.19	38.44
Number of U.S. Patents Issued	29.71	42.01
Start-up Companies	4.31	6.31

Note. The number of respondents was 140.

Table 3.3

Descriptive Statistics for 2012 Licensing Revenue Outcome and Predictor Variables

Survey Items	<i>M</i>	<i>SD</i>
Licensing Revenue Received	\$12,911,677.63	\$30,490,511.29
Number of Licensing Managers	6.08	7.40
Total Research Expenditures	\$380,134,014.40	\$571,303,981.80
Number of Licensing Agreements	29.29	39.84
Number of U.S. Patents Issued	30.42	45.47
Start-up Companies	4.39	5.96

Note. The number of respondents was 142.

Table 3.4

Descriptive Statistics for 2013 Licensing Revenue Outcome and Predictor Variables

Variables	<i>M</i>	<i>SD</i>
Licensing Revenue Received	\$14,051,548.58	\$36,024,815.05
Number of Licensing Managers	6.11	7.58
Total Research Expenditures	\$380,609,466.50	\$584,347,738.70
Number of Licensing Agreements	30.18	40.06
Number of U.S. Patents Issued	34.71	49.37
Start-up Companies	4.93	7.05

Note. The number of respondents was 147.

CHAPTER IV

IDENTIFYING ECONOMIC RAMIFICATIONS RESULTING FROM ACCEPTING EQUITY VS. REQUIRING TRADITIONAL LICENSING PAYMENT METHODS

This dissertation follows the style and format of *Research in the Schools (RITS)*.

Abstract

The purpose of this study was to analyze the economic ramifications resulting from research universities' acceptance of equity positions in spin-off companies as an alternative to traditional forms of licensing payments. The study was conducted using the most recent three years (i.e., 2011, 2012, and 2013) of the Licensing Activity Survey conducted by the Association of University Technology Managers. Universities that had accepted equity in start-up companies had statistically significantly higher licensing revenue, in all three years, than universities that did not accept equity positions in start-up ventures. However, higher total licensing revenue earned by universities could be attributed to increases in running royalty revenues received in each of those same years. Revenues from cashed-in equity positions fell precipitously in years 2011, 2012, and 2013. Universities may continue to take equity positions in start-up, joint venture companies despite decreasing revenues from cashed-in equity positions because the potential exists to create (a) a positive impact on regional economies, (b) new jobs for the schools' graduates and, (c) windfall profits for equity holders if the companies' technologies or inventions become commercially successful.

Keywords: Universities' Intellectual Property, Commercialization, Technology Transfer

CHAPTER IV

IDENTIFYING ECONOMIC RAMIFICATIONS RESULTING FROM ACCEPTING EQUITY VS. REQUIRING TRADITIONAL LICENSING PAYMENT METHODS

Historically, Technology Transfer Offices engaged in licensing activities. The most prevalent of these endeavors included offering licensing options and licensing agreements to private industry. Licensing fees may have included a set dollar amount paid up front, monthly or yearly and/or running royalties that would have been assessed based on some percentage of sales or profits. In recent years, technology transfer professionals, with their universities' consent, have added an alternative and potentially lucrative method of receiving payment in exchange for the rights to market technologies or inventions owned by their universities (Di Gregorio & Shane, 2003; Feldman, Feller, Bercovitz, & Burton, 2002; Marion, Dunlap, & Friar, 2012; Powers & McDougall, 2005).

Increasingly, research universities are accepting equity positions in spin-off ventures created to commercialize universities' intellectual property. In the Association of University Technology Managers' (AUTM's) 2013 Licensing Survey, university respondents revealed that 818 startup companies were formed around universities' intellectual property. Many of these newly formed companies remain in close proximity to their partner universities creating jobs for the schools' graduates and stimulating the local economies. Willingness to accept equity in lieu of cash payments, as pointed out in the existing literature (Di Gregorio & Shane, 2003; Feldman et al., 2002; Marion et al., 2012; Powers & McDougall, 2005), may be predicated upon (a) the policies and culture of the research universities, (b) the predisposition and experience of the

researchers/academic inventors, and (c) the characteristics of Technology Transfer Offices' licensing managers.

Universities' Policies and Culture

In the early years of universities' commercialization efforts, immediately following passage of the Bayh-Dole Patent and Trademark Amendments Act of 1980, many institutions considered equity positions in spin-off businesses to be excessively risky and a method of last resort for accepting payment in exchange for their intellectual property (Feldman et al., 2002). Through their research, however, Feldman et al. (2002) determined that attitudes and policies at research universities had evolved toward a more diversified portfolio of payment options. Feldman et al. (2002) investigated the inclination of Technology Transfer Office professionals to accept equity positions, as an alternative to license agreements, in spin-off companies established for the purpose of commercializing universities' intellectual properties. These researchers analyzed 67 responses to a survey questionnaire sent to the 124 Carnegie I and II research universities that, at that time, had a formal structure for technology transfer. Feldman et al. (2002) concluded that universities were increasingly willing to accept equity, rather than license fees and royalty payments, in companies with the rights to market the universities' new technologies or inventions. Survey respondents cited three reasons for the shift in policy. First, equity positions could have far more up-side income potential than traditional licensing agreements for universities. As one of the businesses' owners, a university would be entitled to share in all future revenue streams of the new start-up business. In addition, the newly formed company could be acquired by a larger firm or it could sell shares in an initial public offering leading to windfall profits for the owners including the

university. The second benefit of putting together an equity deal is that it aligned the interests of the university and the newly formed business. Both the university and the spin-off company would share a common goal of a quick and successful market launch of the new technology or invention. A third benefit of accepting an equity position is that it set a precedent. A clear signal is sent to other industries and investors that the university was entrepreneurial and ready to create joint venture opportunities for the purpose of commercializing its portfolio of intellectual property (Feldman et al., 2002).

Di Gregorio and Shane (2003) identified university policies that influenced university/industry spin-off activity through a survey of 116 universities, of which 101 responses were received from Technology Transfer Offices' directors. Di Gregorio and Shane (2003) discovered an inverse relationship between the royalty rates paid to academic inventors and the number of start-up companies formed to commercialize universities' intellectual property. When universities were determined to have a policy of sharing a large portion of royalties with academic inventors, start-up activity was low. Conversely, when the inventors' share of royalty payments was paltry, a corresponding up-tick was present in the number of spin-off companies formed. An implication of this research is that universities may be able to amend royalty policy and directly influence start-up activity.

University Researchers/Academic Inventors

Marion. Dunlap. and Friar (2012) examined the connection between the degree of commercialization success and the entrepreneurial characteristics of the academic inventor. Data for the investigation came from a census of 400 university patent disclosures, an empirical survey, and in-depth interviews with eight academic inventors

identified in the census and survey as most successful at intellectual property commercialization as determined by gross revenue. Through their research, Marion et al. (2012) determined that several factors, all related to universities' academic inventors, were responsible for successfully passing newly developed technologies from universities to the market place through new start-up companies. Successful academic inventors, according to Marion et al. (2012), could generally be described as tenured and productive. They would have previous entrepreneurial experience and would also possess a positive inclination toward commercialization of research. In addition, the most productive inventors excelled in networking with industrial partners and cultivating external resources including knowledge and funding as evidenced by their participation in industry sponsored research agreements (Marion et al., 2012; O'Shea, Allen, Chevalier, & Roche, 2005).

Technology Transfer Offices and Licensing Managers

Although literature on the subject is sparse, one study was identified in which the authors espoused the important role Technology Transfer Offices play in the formation of spin-off companies. Powers and McDougall (2005) identified universities' resources believed to be significant predictors of spin-off company formation. The research team collected and analyzed archival data on 120 universities classified as "research extensive" or "research intensive" as defined by the Carnegie Classification System. Powers and McDougall (2005) discovered that the age of the Technology Transfer Office was a significant predictor of universities' willingness to accept equity positions in spin-off ventures created to commercialize their intellectual property. These researchers also concluded that the amount of research funding received from industry sources, the quality

of the faculty, and access to venture capital were also significant predictors of increased spin-off activity. However, one of the original hypotheses, that the importance of universities' patent portfolios would be positively related to the number of start-up companies formed, was not supported by the data.

Statement of the Problem

A problem, from the perspective of the universities, is that federal funding for academic research and development is stagnant. At the same time, universities' administrators have been disappointed in the revenues that have been generated through traditional licensing fees and royalty payments (Klein, de Haan, & Goldberg, (2009). Another problem confronts universities' industry partners. Companies that have licensed the rights to develop and market universities' intellectual properties will have start-up costs, but may have no immediate revenues and therefore, may also be strapped for cash. If licensor universities take equity positions in these start-up companies rather than requiring up-front payments, these businesses can conserve the cash that may be necessary for additional product development and for marketing expenses incurred when new products are launched (Feldman et al., 2002).

Purpose of the Study

The traditional forms of payment, for the rights to market the intellectual property of universities, include licensing fees and running royalties. However, in AUTM's 2013 Licensing Survey, university respondents revealed that 818 startup companies were formed around universities' intellectual property. The purpose of this investigation was to identify any positive or negative economic ramifications resulting from the acceptance

of equity positions in spin-off companies as an alternative to the old-style and more predictable forms of licensing payments.

Significance of the Study

Since the passage of the Bayh-Dole Act, approximately 5,700 companies have been formed to commercialize universities' intellectual properties (Marion et al., 2012). Today, school administrators, politicians, and business leaders are touting the benefits derived from university spin-off businesses. These businesses have the potential to create windfall revenues for sponsoring research universities as well as the ability to create jobs for the schools' graduates. Spin-off businesses, focused on a single technological innovation, can expedite the time from idea to market. In addition, through changes in culture and new policies covering technological innovation and commercialization, universities participating in alliances and joint ventures with industry are now repositioning to the center of socio-economic development in their respective communities. The commercialization of new university-born innovations and inventions are having a significant, positive impact on regional economies (Hayter, 2013; Nelles & Vorley, 2010; Osiri, McCarty, & Jessup, 2013). However, despite the recent emphasis at research universities on technology transfer and the increasing amount of published research on the subject of commercialization of universities' intellectual property, little consensus is present regarding a specific set of policies and practices that is a demonstrated model for technology transfer success or licensing income maximization.

Research Questions

The research questions addressed in this investigation were: (a) What are the economic advantages and disadvantages for research universities engaged in technology

transfer associated with the emerging trend of accepting start-up company equity in lieu of traditional licensing royalties?; (b) What percentages of universities' licensing income is generated from running royalties?; (c) What percentage of universities' licensing income is generated from cashed-in equity?; and (d) What is the difference in the ability of the two types of research universities (i.e., universities that have accepted equity positions in start-up companies and universities that have not accepted equity) to maximize total licensing revenue? The research questions were addressed utilizing data from each of the last three years of the AUTM's Licensing Activity Survey Questionnaire. As such, these research questions were repeated for each of these three years (i.e., 2011, 2012, and 2013). Following these three years of analyses, the extent to which any trends were present were examined.

Limitations

For over 20 years, the AUTM has conducted its annual Licensing Activity Survey Questionnaire. The Statistics Access for Technology Transfer database is the compilation of survey responses collected from research universities, medical schools, and other research institutions in the U.S. (AUTM, 2015). Therefore, results from this study may not be generalizable outside of North America. Furthermore, respondent institutions differed from year to year. Lastly, the responses from Technology Transfer Office professionals who participated in the AUTM's yearly survey may differ from the answers that would have been provided by those individuals who chose not to complete and return the questionnaire. For example, licensing professionals from research universities that have a record of successfully commercializing their intellectual property

may respond to the survey at a different rate than their counterparts at underperforming institutions.

Method

Research Design

This study was conducted with a non-experimental, causal-comparative research design (Creswell, 2009; Johnson & Christensen, 2012). The two categorical independent variables for this study were universities that have a policy and a practice of accepting equity as payment for the right to market a particular technology or invention and universities that, as a strictly enforced policy, only accept licensing fees and running royalties as payment for their intellectual property. In nonexperimental research, no manipulation occurs of the independent variables, which was the case in this empirical investigation.

The quantitative dependent variable in this analysis was total license income received. In this causal-comparative study, the difference in the ability of the two types of research universities (i.e., universities that are willing to accept equity and universities that will not accept equity) to maximize total licensing revenue was analyzed. The disadvantages of using this design include limited control of extraneous variables and lack of manipulation of the independent variable (Creswell, 2009; Johnson & Christensen, 2012).

Participants

For over 20 years, the AUTM (2012a) has conducted their Yearly Licensing Activity Survey. Respondents have included public and private research universities, medical schools, and other research institutions. The AUTM's database, used to reach

institutions that were believed to engage in commercialization of their intellectual property, includes approximately 350 institutions that, in the past, have responded to the survey. The database also includes institutions that currently employ or that previously have employed AUTM members. Specifically, the intent of the AUTM's Licensing Activity Survey Committee is that the survey be completed by one of the respondent institutions' Technology Transfer Office officers, intellectual property managers, or licensing professionals. The range of yearly participants who completed and returned the survey questionnaire was between 199 and 202 for the years covered in the study.

Instrumentation and Procedures

Statistical analysis was conducted using data provided by the AUTM. One of the AUTM's primary activities, for each of the last 23 years, has been to conduct their annual U.S. Licensing Activity Survey. The purpose of the survey was to quantify academic technology transfer data. In 2013, the survey was disseminated to 299 U. S. research institutions. Survey recipients included 232 colleges and universities, 61 research hospitals, three national laboratories, and three independent, technology related firms. Of the institutions contacted, 202 institutions returned the survey for a response rate of 68% (AUTM, 2014). The compilation of past survey responses is available in the AUTM's Statistics Access for Technology Transfer database (AUTM, 2015). The Statistics Access for Technology Transfer database was downloaded from the AUTM website into an Excel spreadsheet. The compiled survey data, in the Excel spreadsheet, were loaded into the Statistical Package for the Social Sciences to calculate descriptive and inferential statistics.

Results

The average dollar amount of total licensing revenue, calculated using data from the AUTM's 2011 licensing survey, collected by universities that also accepted an equity position in at least one start-up company during the 2011 fiscal year was \$16,905,196.87. For those same universities, the average dollar amount of running royalties was \$10,603,286.51, which was 63% of average total licensing revenue. The average dollar amount of cashed-in equity was \$730,472.16, which was 4% of average total licensing revenue. By comparison, the average total licensing revenue collected by universities that did not accept equity in the 2011 survey year was \$6,606,741.27. The "no equity" universities, produced average running royalties of \$4,674,646.72, which was 71% of total licensing revenue. Their average dollar amount of cashed-in equity was \$84,820.93, which was 1% of total licensing revenue. Readers can refer to Table 4.1 for the descriptive statistics concerning these variables.

Insert Table 4.1 about here

Prior to conducting inferential statistics to determine whether differences were present between universities that accepted equity in start-up companies and institutions that did not accept start-up equity in their ability to maximize total licensing revenue, checks were conducted to determine the extent to which the data were normally distributed. Of the standardized skewness coefficients (i.e., the skewness value divided by its standard error) and the standardized kurtosis coefficients (i.e., the kurtosis value divided by its standard error), all were outside the range of normality, +/-3 (Onwuegbuzie

& Daniel, 2002). Accordingly, a nonparametric (i.e., Mann-Whitney's U) independent samples t -test was conducted to answer the research question.

The nonparametric independent samples t -test revealed a statistically significant difference between universities that accepted equity in start-up companies and those universities that did not accept equity in start-up companies in their ability to maximize total licensing revenue, $U = 3340.00$, $p < .001$. This difference represented a small effect size (Cohen's d) of 0.34. (Cohen, 1988). For the AUTM's 2011 licensing survey data, universities that had accepted equity in start-up companies had statistically significantly higher licensing revenue than universities that did not accept equity positions in start-up ventures.

The average dollar amount of total licensing revenue, calculated using data from the AUTM's 2012 licensing survey, collected by universities that also accepted an equity position in at least one start-up company during the 2012 fiscal year was \$17,797,659.05. For those same universities, the average dollar amount of running royalties was \$11,785,336.66, which was 66% of average total licensing revenue. The average dollar amount of cashed-in equity was \$641,180.61, which was less than 4% of average total licensing revenue. By comparison, the average total licensing revenue collected by universities that did not accept equity in the 2012 survey year was \$5,996,500.31. The "no equity" universities, produced average running royalties of \$5,533,974.12, which was 92% of total licensing revenue; and their average dollar amount of cashed-in equity was \$5,412.11, which was 0.1% of total licensing revenue. Readers are referred to Table 4.2 for the descriptive statistics concerning these variables.

Insert Table 4.2 about here

Prior to conducting inferential statistics to determine whether differences were present between universities that accepted equity in start-up companies and universities that did not accept equity in start-up companies in their ability to maximize total licensing revenue, checks were conducted to determine the extent to which the data were normally distributed. Of the standardized skewness coefficients and the standardized kurtosis coefficients, all were outside the range of normality, ± 3 (Onwuegbuzie & Daniel, 2002). Therefore, a nonparametric (i.e., Mann-Whitney's U) independent samples t -test was conducted to answer the research question.

The nonparametric independent samples t -test revealed a statistically significant difference between universities that accepted equity in start-up companies universities that did not accept equity in start-up companies in their ability to maximize total licensing revenue, $U = 3805.00$, $p < .001$. The Cohen's d effect size associated with this difference was 0.41. Using Cohen's (1988) criteria, this result represented a small-to-moderate effect size. Universities that accepted equity in start-up companies had statistically significantly higher licensing revenue than universities that did not accept equity positions in start-up ventures.

The average dollar amount of total licensing revenue, calculated using data from the AUTM's 2013 licensing survey, collected by universities that also accepted an equity position in at least one start-up company during the 2013 fiscal year was \$20,957,296.19. For those same universities, the average dollar amount of running royalties was

\$15,124,780.23, which was 72% of average total licensing revenue. The average dollar amount of cashed-in equity was \$367,207.86, which was slightly less than 2% of average total licensing revenue. By comparison, the average total licensing revenue collected by universities that did not accept equity in survey year 2013 was \$2,287,790.40. The “no equity” universities, produced average running royalties of \$1,815,123.53, which was 79% of total licensing revenue; and their average dollar amount of cashed-in equity was \$6,711.62, which was 0.3% of total licensing revenue. Presented in Table 4.3 are the descriptive statistics for these variables.

Insert Table 4.3 about here

Prior to conducting inferential statistics to determine whether differences were present between universities that accepted equity in start-up companies and universities that did not accept equity in start-up companies in their ability to maximize total licensing revenue, checks were conducted to determine the extent to which the data were normally distributed. Of the standardized skewness coefficients and the standardized kurtosis coefficients, all were outside the range of normality, ± 3 (Onwuegbuzie & Daniel, 2002). Accordingly, a nonparametric (i.e., Mann-Whitney's U) independent samples t -test was conducted to answer the research question.

The nonparametric independent samples t -test revealed a statistically significant difference between universities that accepted equity in start-up companies and universities that did not accept equity in start-up companies in their ability to maximize total licensing revenue. $U = 3851.50, p < .001$. This difference represented a moderate

effect size (Cohen's d) of 0.60 (Cohen, 1988). Universities that responded to the AUTM's 2013 licensing survey and accepted equity in start-up companies had statistically significantly higher licensing revenue than universities that did not accept equity positions in start-up ventures during that same year.

Discussion

Statistical analysis, conducted using the most recent three years of the AUTM's licensing survey data (i.e., 2011, 2012, and 2013), revealed that universities that had accepted equity in start-up companies had statistically significantly higher licensing revenue, in all three years analyzed in this investigation, than universities that did not accept equity positions in start-up ventures. In 2011, the average dollar amount of total licensing revenue earned by universities that had taken equity positions in start-up companies was \$16,905,196.86. Two years later, in 2013, the average licensing revenue generated by these universities had risen to \$20,957,296.19. In contrast, the 2011 average licensing revenue total by universities that had taken no equity positions in start-up ventures was \$6,606,741.27. By 2013, the average licensing revenue generated by these universities had dwindled to just \$2,287,790.40.

In addition, the number of universities that accepted equity positions in start-up companies increased in each of the three years analyzed in this investigation. In 2011, 76 universities acquired one or more equity positions in start-up ventures. By 2013, the number of universities that had accepted equity positions had increased to 92. Conversely, the number of universities that did not accept equity positions in start-up companies during the same period decreased in each of the three years. In 2011, 64

universities had not accepted equity in any start-up companies in that year. By 2013, the number of universities that had not accepted equity positions had fallen to 58.

However, in each of the three years analyzed in this investigation, running royalty revenue, as a percentage of total licensing revenue, increased for the universities that had accepted equity positions in start-up companies. In 2011, average running royalties for the schools that had accepted equity were \$10,603,286.51 or 63% of average total licensing revenue. By 2013, those same universities had earned \$15,124,780.23 in running royalties, which represented 72% of their average total licensing revenue. At the same time, cashed-in equity fell, as a percentage of total licensing revenue, for the universities that had accepted equity in each of the three years analyzed in this investigation. In 2011, average cashed-in equity was \$730,472.16 or 4% of average total licensing revenue and by the year 2013 average cashed-in equity had fallen to \$367,207.86, which represented slightly less than 2% of average total licensing revenue for those universities.

It is counter-intuitive that the universities that had accepted increasing numbers of equity positions in each of the most recent three years of the AUTM licensing survey had also generated less in total average cashed-in equity revenue in each of the same three years. However, sound explanations exist for the unexpected results. First, licensing professionals who have demonstrated success in generating licensing revenue from all sources may have been granted, by their universities' administrators, greater latitude in decisions regarding the acceptance of equity in lieu of requiring running royalty payments from start-up ventures. An alternate explanation may be that universities were only cashing in their equity positions in companies that had shown little up-side potential.

This group would include companies with products that have not performed well in the market place. Conversely, universities may hold indefinitely equity positions in companies that have performed well financially and that have, at least potentially, great up-side potential. This group might include companies that have earned the opportunity to offer stock to the public through initial public offerings or companies that could be sold at great profit to larger competitors.

Connection with Existing Literature

In the years immediately following passage of the Bayh-Dole Act of 1980, many institutions considered equity positions in spin-off businesses to be excessively risky and a method of last resort for accepting payment in exchange for their intellectual property (Feldman et al., 2002). However, Feldman et al. (2002) determined that attitudes and policies at research universities had evolved toward a more diversified portfolio of payment options. Feldman et al. (2002) concluded that universities were increasingly willing to accept equity, rather than the more traditional forms of licensing payment methods (i.e., licensing fees and royalty payments), in companies with the rights to market the universities' new technologies or inventions. The reasons for the change in policy, cited in Feldman et al. (2002), included more up-side income potential and the belief that universities would be viewed as entrepreneurial and ready to create joint venture opportunities by potential industry partners (Feldman et al., 2002). Results from this empirical investigation, which include evidence of an increasing number of universities accepting equity in start-up companies coupled with a 3-year upward trajectory for the average total licensing revenue earned by those institutions, support the conclusions of Feldman et al. (2002).

Implications for Policy and Practice

Di Gregorio and Shane (2003) analyzed universities' policies that were thought to influence university/industry spin-off activity. They discovered an inverse relationship between the royalty rates paid to academic inventors and the number of start-up companies formed to commercialize universities' intellectual property. When universities' policies espoused sharing a large portion of royalties with academic inventors, start-up activity was low. Conversely, when the inventors' share of royalty payments was paltry, a corresponding up-tick occurred in the number of spin-off companies formed. An implication of the Di Gregorio and Shane (2003) study was that universities may be able to amend their royalty payment policies and directly influence start-up activity. An implication of this investigation is that universities that spur start-up activity could require running royalty payments from start-up companies resulting in immediate economic benefit as measured by the increase in total licensing revenue for those schools. As an alternative, universities could take equity positions in these new joint venture companies, which may create (a) a positive impact on regional economies, (b) new jobs made available for the schools' graduates and, (c) windfall profits for the universities if their technologies or inventions become commercially successful.

Suggestions for Future Research

Since the passage of the Bayh-Dole Act, approximately 5,700 companies have been formed to commercialize universities' intellectual properties (Marion et al., 2012). Respondents to the AUTM's 2013 Licensing Survey confirmed that 818 start-up companies were formed around universities' intellectual property in that year alone. A suggestion for future research would be to conduct a qualitative or mixed method study

with the purpose of identifying economic benefits, in addition to cashed-in equity, which did not appear to be an economically sufficient factor in the three years covered by this investigation, associated with university start-up activity. The investigation could include a questionnaire and licensing professionals could be asked to confirm economic benefits provided by investing in start-up companies. Potential respondents could be asked to quantify instances where newly formed companies stimulated regional economies by locating their facilities along with the corresponding job opportunities in close proximity to their partner universities. Of particular interest to universities' stakeholders would be the number of jobs filled by the schools' graduates.

Conclusion

The purpose of this study was to analyze the economic ramifications resulting from the acceptance by research universities of equity positions in spin-off companies as an alternative to traditional forms of licensing payments (e.g., royalties). Statistical analysis revealed that universities that had accepted equity in start-up companies had statistically significantly higher licensing revenue, in all three years analyzed in this investigation, than universities that did not accept equity positions in start-up ventures. However, higher total licensing revenue in each of the three years analyzed could be attributed to increases in running royalty revenues earned in each of those same years. In fact, revenues from cashed-in equity fell precipitously in 2011, 2012, and 2013. Universities may continue to take equity positions in in start-up, joint venture companies despite decreasing revenues from cashed-in equity positions in recent years because there is the potential to create (a) a positive impact on regional economies, (b) new jobs for the

schools' graduates and. (c) windfall profits for equity holders if the companies' technologies or inventions become commercially successful.

References

- Association of University Technology Managers. (2012). *Licensing activity survey questionnaire*. Retrieved from <http://www.autm.net/home.htm>
- Association of University Technology Managers. (2014). *Highlights of AUTM's U.S. Licensing Survey FY2013*. Retrieved from <http://www.autm.net/home.htm>
- Association of University Technology Managers. (2015). *STATT* (3.6) [software]. Retrieved from <http://www.autm.net/home.htm>
- Bayh-Dole Patent and Trademark Amendments Act of 1980, Pub. L. 96-517. 94 Stat. 3015-3029 (1980).
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.
- Cohen, J. (1994). The earth is round ($p < .05$). *American Psychologist*, 49, 997-1003.
- Creswell, J. W. (2009). *Qualitative inquiry and research design* (3rd ed.). Thousand Oaks, CA: Sage.
- Di Gregorio, D., & Shane, S. (2003). Why do some universities generate more startups than others? *Research Policy*, 32, 209-227.
- Feldman, M., Feller, I., Bercovitz, J., & Burton, R. (2002). Equity and the technology transfer strategies of American research universities. *Management Science*, 48(1), 105-121. doi:10.1287/mnsc.48.1.105.14276
- Hayter, C. S. (2013). Harnessing university entrepreneurship for economic growth: Factors of success among university spin-offs. *Economic Development Quarterly*, 27(1), 18-28. doi:10.1177/0891242412471845

- Johnson, B., & Christensen, L. (2012). *Educational research: Quantitative, qualitative, and mixed approaches* (4th ed.). Thousand Oaks, CA: Sage.
- Klein, R., de Haan, U., & Goldberg, A. I. (2010). Overcoming obstacles encountered on the way to commercialize university IP. *Journal of Technology Transfer*, 35, 671-679. doi:10.1007/s10961-009-9143-1
- Marion, T. J., Dunlap, D. R., & Friar, J. H. (2012). The university entrepreneur: A census and survey of attributes and outcomes. *R&D Management*, 42(5), 401-419.
- Nelles, J., & Vorley, T. (2011). Entrepreneurial architecture: A blueprint for entrepreneurial universities. *Canadian Journal of Administrative Sciences*, 28(3), 341-353. doi:10.1002/CJAS.186
- Onwuegbuzie, A. J., & Daniel, L. G. (2002). Uses and misuses of the correlation coefficient. *Research in the Schools*, 9(1), 73-90.
- O'Shea, R. P., Allen, T. J., Chevalier, A., & Roche, F. (2005). Entrepreneurial orientation, technology transfer and spin-off performance of U.S. universities. *Research Policy*, 34(7), 994-1009.
- Osiri, J. K., McCarty, M. M., & Jessup, L. (2013). Entrepreneurial culture in institutions of higher education: Impact on academic entrepreneurship. *Journal of Entrepreneurship Education*, 16, 1-11.
- Powers, J. B., & McDougall, P. P. (2005). University start-up formation and technology licensing with firms that go public: A resource-based view of academic entrepreneurship. *Journal of Business Venturing*, 29(3), 291-311.

Table 4.1

Descriptive Statistics for Universities That Accepted Equity or Not by Type of Licensing Revenue for the 2011 Licensing Survey

Accepted Equity or Not. License Income by Category	<i>M</i>	<i>SD</i>	<i>SUM</i>
Accepted Equity			
Total Licensing Income	\$16,905,196.87	\$38,465,670.05	\$1,284,794,962.00
Running Royalties	\$10,603,286.51	\$25,722,366.70	\$731,626,769.00
Earned			
Cashed-In Equity Earned	\$730,472.16	\$2,081,668.19	\$50,402,579.00
Did Not Accept Equity			
Total Licensing Income	\$6,606,741.27	\$17,877,325.17	\$422,831,441.00
Running Royalties	\$4,674,646.72	\$16,474,469.85	\$285,153,450.00
Earned			
Cashed-In Equity Earned	\$84,820.93	\$351,627.75	\$5,174,077.00

Table 4.2

Descriptive Statistics for Universities That Accepted Equity or Not by Type of Licensing Revenue for the 2012 Licensing Survey

Accepted Equity or Not, License Income by Category	<i>M</i>	<i>SD</i>	<i>SUM</i>
Accepted Equity			
Total Licensing Income	\$17,797,659.05	\$35,486,726.02	\$1,477,205,701.00
Running Royalties Earned	\$11,785,336.66	\$29,176,633.46	\$907,470,923.00
Cashed-In Equity Earned	\$641,180.61	\$2,383,188.73	\$49,370,907.00
Did Not Accept Equity			
Total Licensing Income	\$5,996,500.31	\$19,454,224.88	\$371,783,019.00
Running Royalties Earned	\$5,533,974.12	\$19,778,040.56	\$315,436,525.00
Cashed-In Equity Earned	\$5,412.11	\$26,680.66	\$308,490.00

Table 4.3

Descriptive Statistics for Universities That Accepted Equity or Not by Type of Licensing Revenue for the 2013 Licensing Survey

Accepted Equity or Not, License Income by Category	<i>M</i>	<i>SD</i>	<i>SUM</i>
Accepted Equity			
Total Licensing Income	\$20,957,296.20	\$44,022,064.31	\$1,928,071,250.00
Running Royalties	\$15,124,780.23	\$34,562,589.94	\$1,300,731,100.00
Earned			
Cashed-In Equity Earned	\$367,207.86	\$946,927.58	\$31,579,876.00
Did Not Accept Equity			
Total Licensing Income	\$2,287,790.40	\$4,875,568.16	\$132,691,843.00
Running Royalties	\$1,815,123.53	\$4,588,462.75	\$105,277,165.00
Earned			
Cashed-In Equity Earned	\$6,711.62	\$32,355.73	\$389,274.00

CHAPTER V

DISCUSSION

The intent of this journal-ready dissertation was to provide timely information to technology transfer professionals resulting in more productive policies and practices in the commercialization of universities' intellectual property. New information, reported in this study, came from analyzing and interpreting compiled responses to the AUTM's 2011, 2012, and recently released 2013 Licensing Activity Survey Questionnaire. This investigation provided insights regarding the sources and the productivity of academic research funding according to type of university (i.e., public and private). The characteristics and activities of highly performing Technology Transfer Offices were highlighted in this study. Finally, the economic ramifications resulting from the acceptance by research universities of equity positions in spin-off companies as an alternative to traditional forms of licensing payments were investigated.

Discussion of Results for all Three Studies

Study One was conducted to identify differences between public and private universities in sourcing research funding and in achieving commercialization success. In this investigation, private universities were determined to be more adept at procuring federal research funding than public universities. In addition, private research universities had generated a greater amount of licensing income for each dollar of research expenditure.

Study Two was an investigation of the extent to which the licensing income of U.S. universities could be predicted by five questionnaire items (i.e., Number of Licensing Managers, Number of Licensing Agreements Executed, Number of U.S.

Patents Issued, Total Research Expenditures, and Number of Start-Up Companies Initiated) chosen from the surveys. An All Possible Subsets regression analysis revealed that the Number of U.S. Patents Issued was the only statistically significant predictor of licensing income generated from universities' intellectual property for all three survey years analyzed in this investigation.

Statistical analysis, conducted in Study Three, revealed that universities that had accepted equity in start-up companies had statistically significantly higher licensing revenue, in all three years analyzed in this investigation, than universities that did not accept equity positions in start-up ventures. In addition, the number of universities that accepted equity positions in start-up companies increased in each of the three years analyzed in this investigation. However, cashed-in equity fell, as a percentage of total licensing revenue, for the universities that had accepted equity in start-up ventures. An explanation may be that universities were only cashing in their equity positions in companies that had shown little up-side potential. Conversely, universities may hold, indefinitely, equity positions in companies that have performed well financially and that have, at least potentially, great up-side potential.

Implications for Policy and Practice

The Bayh-Dole Patent and Trademark Amendments Act of 1980, which gave universities the right to claim title to technologies and inventions that resulted from federally sponsored research and development, has propelled commercialization of universities' intellectual property and has stimulated collaboration between academic inventors and private industry. However, universities can no longer assume that the act is a guarantee of automatic ownership rights to technologies and inventions born under their

jurisdiction. The Federal Circuit Court, in *Board of Trustees of the Leland Stanford Junior University v. Roche Molecular Systems, Inc., et al.* ruled that the Act did not usurp academic inventors' ownership rights to their intellectual property. The Bayh-Dole Act, according to the Court, allows research universities to claim title to inventions only in situations where the institution has already secured ownership rights from the academic inventor(s) through contractual assignment or employment agreement.

On June 6, 2011, the U.S. Supreme Court affirmed the lower court's ruling. The implication, resulting from the court's decision, is that universities will need to modify policies enacted to protect their intellectual property. Employment agreements, between universities and research professors, must document precise percentages of intellectual property ownership between the institutions, academic inventors, and potential joint venture partners from private industry.

This investigation may constitute the first study, using the AUTM's Statistics Access for Technology Transfer database, where research was conducted to identify differences between public and private universities in sourcing research funding and in achieving commercialization success. In this investigation, private universities were more adept at procuring federal research funding. Therefore, it would behoove public schools to adopt the research funding practices of the better performing private universities. It was also determined, through analysis of data for the most recent three years of the licensing survey, that private research universities generated a greater amount of licensing income for each dollar of research expenditure. Again, the policies and practices of the more efficient, private universities may need to be examined to determine the extent to which their policies and practices could be adopted.

The ability to identify and to rank Technology Transfer Offices' characteristics and activities that produce the greatest return on investment from universities' intellectual property could facilitate efficiency in resource allocation. University administrators, by amending their commercialization policies and procedures, can ensure future funding is concentrated on those activities that lead to the greatest revenue streams. Conversely, efforts on the part of Technology Transfer Offices that do not yield an acceptable economic benefit to the university and to the community can be scaled back or eliminated. An implication emanating from Study Two is that an increase in the number of patents issued to a university may result in an increased level of licensing revenue for the institution.

Di Gregorio and Shane (2003) analyzed universities' policies that were thought to influence university/industry spin-off activity. They discovered an inverse relationship between the royalty rates paid to academic inventors and the number of start-up companies formed to commercialize universities' intellectual property. When universities' policies espoused sharing a large portion of royalties with academic inventors, start-up activity was low. Conversely, when the inventors' share of royalty payments was paltry, a corresponding up-tick occurred in the number of spin-off companies formed. An implication from Di Gregorio and Shane (2003) was that universities may be able to amend their royalty payment policies and directly influence start-up activity. An implication of the third investigation is that universities that spur start-up activity could require running royalty payments from start-up companies resulting in immediate economic benefit as measured by the increase in total licensing revenue for those schools. As an alternative, universities could take equity positions in

these new joint venture companies, which may create (a) a positive impact on regional economies, (b) new jobs made available for the schools' graduates and, (c) windfall profits for the universities if their technologies or inventions become commercially successful.

Suggestions for Future Research

In the first investigation, during which three years (i.e., 2011, 2012, and 2013) of licensing survey data were analyzed, private universities generated a statistically significantly higher amount of licensing revenue per dollar of research funding than public universities. A suggestion for future research would be to conduct a qualitative or mixed method study to determine how private universities were more successful than public universities in generating higher amounts of licensing revenue per dollar of research funding from commercialization of their intellectual property. The investigation could include a questionnaire in which licensing professionals from both public and private universities could be asked to identify parameters for deciding which research and development projects are selected to transition forward into the commercialization process. Licensing professionals could also be asked to outline the procedural steps for taking a new technology or invention from idea validation through the commercialization process to market launch. Differences could then be identified in both the method of project selection and the steps taken to ensure success through the commercialization process.

The archival data analyzed for Study Two were provided by the AUTM. As such, data from alternate sources were not obtained nor analyzed in this research investigation. In addition, a comprehensive review of the existing literature pertaining to

commercialization of universities' intellectual property revealed that the AUTM is often the primary source for data analyzed in published research. A suggestion for future research would be to locate or to generate alternate datasets and to conduct comparative analyses.

An alternative to locating and analyzing additional archival datasets would be to conduct a qualitative or mixed method study. The investigation could include a questionnaire in which licensing professionals could be directly queried about specific instances where issued patents on intellectual properties led directly to successful licensing agreements with industry partners. Conversely, respondents could also be asked about instances where the lack of patents on universities' technologies or inventions resulted in the loss of potentially lucrative licensing agreements.

Since the passage of the Bayh-Dole Act, approximately 5,700 companies have been formed to commercialize universities' intellectual properties (Marion et al., 2012). Respondents to the AUTM's 2013 Licensing Survey confirmed that 818 start-up companies were formed around universities' intellectual property in that year alone. A suggestion for future research, emanating from Study Three, would be to conduct a qualitative or mixed method study with the purpose of identifying economic benefits, in addition to cashed-in equity, which did not appear to be an economically sufficient factor in the three years covered by this investigation, associated with university start-up activity. The investigation could include a questionnaire in which licensing professionals could be asked to confirm economic benefits provided by investing in start-up companies. Respondents could be asked to quantify instances where newly formed companies stimulated regional economies by locating their facilities along with the

corresponding job opportunities in close proximity to their partner universities. Of particular interest to universities' stakeholders would be the number of jobs filled by the schools' graduates.

Conclusions

In this journal-ready dissertation, private universities were more adept at procuring federal research funding than their public counterpart. Accordingly, public universities are encouraged to examine the research funding practices of the better performing private universities to ascertain the extent to which their funding practices might be transferable. Private research universities also generated a greater amount of licensing income for each dollar of research expenditure. Again, the policies and practices of the more efficient, private universities may need to be examined to determine the extent to which their policies and practices could be adopted.

Also established in this journal-ready dissertation was that the Number of U.S. Patents Issued was the only statistically significant predictor of licensing income generated from universities' intellectual property for all three survey years analyzed in this investigation. Congruent with the findings of previous researchers (Colyvas et al., 2002; Rahal & Rabelo, 2006; Turk-Bicakci & Brint, 2005), the size of a university's patent portfolio may be an important predictor of the institution's ability to generate licensing revenue. Finally, universities that had accepted equity in start-up companies had statistically significantly higher licensing revenue, in all three years analyzed in this investigation, than universities that did not accept equity positions in start-up ventures. However, higher total licensing revenue in each of the three years analyzed could be attributed to increases in running royalty revenues earned in each of those same years. In

fact. revenues from cashed-in equity fell precipitously in 2011, 2012, and 2013.

Universities may continue to take equity positions in in start-up, joint venture companies despite decreasing revenues from cashed-in equity positions in recent years because there is the potential to create (a) a positive impact on regional economies. (b) new jobs for the schools' graduates and. (c) windfall profits for equity holders if the companies' technologies or inventions become commercially successful.

REFERENCES

Association of University Technology Managers. (n.d.). About AUTM: Member benefits.

Retrieved from <http://www.autm.net/home.htm>

Association of University Technology Managers. (2012a). *Instructions and definitions*.

Retrieved from <http://www.autm.net/home.htm>

Association of University Technology Managers. (2012b). *Licensing activity survey*

questionnaire. Retrieved from <http://www.autm.net/home.htm>

Association of University Technology Managers. (2014). *Highlights of AUTM's U.S.*

Licensing Survey FY2013. Retrieved from <http://www.autm.net/home.htm>

Association of University Technology Managers. (2015). *STATT* (3.6) [software].

Retrieved from <http://www.autm.net/home.htm>

Barr, S. H., Baker, T., Markham, S. K., & Kingon, A. I. (2009). Bridging the valley of

death: Lessons learned from 14 years of commercialization of technology

education. *Academy of Management Learning & Education*, 8(3), 370-388.

doi:10.5465/AMLE.2009.44287937

Bayh-Dole Patent and Trademark Amendments Act of 1980, Pub. L. 96-517, 94 Stat.

3015-3029 (1980).

Board of Trustees of the Leland Stanford Junior University, Petitioner v. Roche

Molecular Systems, Inc., et al., 131 S. Ct. 2188 (2011).

Boni, A. A., Weingart, L. R., & Evenson, S. (2009). Innovation in an academic setting:

Designing and leading a business through market-focused, interdisciplinary

teams. *Academy of Management Learning & Education*, 8(3), 407-417.

doi:10.5465/AMLE.2009.44287939

- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.
- Cohen, J. (1994). The earth is round ($p < .05$). *American Psychologist*, *49*, 997-1003.
- Colyvas, J., Crow, M., Gelijns, A., Mazzoleni, R., Nelson, R. R., Rosenberg, N., & Sampat, B. N. (2002). How do university inventions get into practice? *Management Science*, *48*(1), 61-72. doi:10.1287/mnsc.48.1.61.14272
- Creswell, J. W. (2009). *Qualitative inquiry and research design* (3rd ed.). Thousand Oaks, CA: Sage.
- Di Gregorio, D., & Shane, S. (2003). Why do some universities generate more startups than others? *Research Policy*, *32*, 209-227.
- Feldman, M., Feller, I., Bercovitz, J., & Burton, R. (2002). Equity and the technology transfer strategies of American research universities. *Management Science*, *48*(1), 105-121. doi:10.1287/mnsc.48.1.105.14276
- Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). Thousand Oaks, CA: Sage.
- Hayter, C. S. (2013). Harnessing university entrepreneurship for economic growth: Factors of success among university spin-offs. *Economic Development Quarterly*, *27*(1), 18-28. doi:10.1177/0891242412471845
- Johnson, B., & Christensen, L. (2012). *Educational research: Quantitative, qualitative, and mixed approaches* (4th ed.). Thousand Oaks, CA: Sage.
- Klein, R., de Haan, U., & Goldberg, A. I. (2010). Overcoming obstacles encountered on the way to commercialize university IP. *Journal of Technology Transfer*, *35*, 671-679. doi:10.1007/s10961-009-9143-1

- Kneller, R., Mongeon, M., Cope, J., Garner, C., & Ternouth, P. (2014). Industry-university collaborations in Canada, Japan, the UK and USA – with emphasis on publication freedom and managing the intellectual property lock-up problem. *PLOS ONE*, 9(3), 1-19. doi:10.1371/journal.pone.0090302
- Marion, T. J., Dunlap, D. R., & Friar, J. H. (2012). The university entrepreneur: A census and survey of attributes and outcomes. *R&D Management*, 42(5), 401-419.
- Martin, M., Gruetzmacher, R. R., Lanham, R., & Brady, J. (2004). Assessing technology transfer and business development potential: Technology cluster analysis. *Economic Development Quarterly*, 18, 168-173. doi:10.1177/0891242403261088
- Mowery, D., Nelson, R., Sampat, B., & Ziedonis, A. (2001). The growth of patenting and licensing by U.S. universities: An assessment of the effects of the Bayh-Dole Act of 1980. *Research Policy*, 99-119. doi:10.1016/s0048-7333(99)00100-6
- Nelles, J., & Vorley, T. (2011). Entrepreneurial architecture: A blueprint for entrepreneurial universities. *Canadian Journal of Administrative Sciences*, 28(3), 341-353. doi:10.1002/CJAS.186
- Onwuegbuzie, A. J. (2003). Expanding the framework of internal and external validity in quantitative research. *Research in Schools*, 10(1), 71-89.
- Onwuegbuzie, A. J., & Daniel, L. G. (2002). Uses and misuses of the correlation coefficient. *Research in the Schools*, 9(1), 73-90.
- O'Shea, R. P., Allen, T. J., Chevalier, A., & Roche, F. (2005). Entrepreneurial orientation, technology transfer and spin-off performance of U.S. universities. *Research Policy*, 34(7), 994-1009.

- Osiri, J. K., McCarty, M. M., & Jessup, L. (2013). Entrepreneurial culture in institutions of higher education: Impact on academic entrepreneurship. *Journal of Entrepreneurship Education, 16*, 1-11.
- Phan, P. H., Siegel, D. S., & Wright, M. (2009). New developments in technology management education: Background issues, program initiatives, and a research agenda. *Academy of Management Learning & Education, 8*(3), 324-336.
doi:10.5465/AMLE.2009.44287934
- Porter, M. E. (2008). The five competitive forces that shape strategy. *Harvard Business Review, 86*(1), 78-93.
- Powers, J. B., & McDougall, P. P. (2005). University start-up formation and technology licensing with firms that go public: A resource-based view of academic entrepreneurship. *Journal of Business Venturing, 29*(3), 291-311.
- Prets, R. A., & Slate, J. R. (2014). Predicting income generated from licensing universities' intellectual property. *International Journal of University Teaching and Faculty Development, 4*(1), 1-7.
- Rafferty, M. (2008). The Bayh-Dole Act and university research and development. *Research Policy, 37*, 29-40. doi:10.1016/j.respol.2007.06.010
- Rahal, A. D., & Rabelo, L. C. (2006). Assessment framework for the evaluation and prioritization of university inventions for licensing and commercialization. *Engineering Management Journal, 18*(4), 28-36.
- Sharma, S. (2011). The Bayh-Dole Act and allocation of ownership rights in inventions arising out of federally funded research. *Intellectual Property & Technology Law Journal, 23*(8), 23-28.

- Szelenyi, K., & Goldberg, R. A. (2011). Commercial funding in academe: Examining the correlates of faculty's use of industrial and business funding for academic work. *The Journal of Higher Education*, 82(6), 775-802. doi:10.1353/jhe.2011.0040
- Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Boston, MA: Pearson.
- Thompson, B. (1995). Stepwise regression and stepwise discriminant analysis need not apply here: A guidelines editorial. *Educational and Psychological Measurement*, 55(4), 525-534.
- Thursby, M. C., Fuller, A. W., & Thursby, J. (2009). An integrated approach to educating professionals for careers in innovation. *Academy of Management Learning & Education*, 8(3), 389-405. doi:10.5465/AMLE.2009.44287938
- Turk-Bicakci, L., & Brint, S. (2005). University-industry collaboration: Patterns of growth for low- and middle-level performers. *Higher Education*, 49, 61-89. doi:10.1007/s10734-004-2914-6
- Wu, Y. (2013). The cross-state distribution of federal funding in the USA: The case of financing academic research and development. *Science and Public Policy*, 40, 316-326. doi:10.1093/scipol/scs107

APPENDIX



Institutional Review Board Office of Research and Sponsored Programs 903 Bowers Blvd, Huntsville, TX 77341-2448 Phone: 936.294.4875 Fax: 936.294.3622 irb@shsu.edu www.shsu.edu/~rgs_www/irb/

DATE: August 7, 2015

TO: Richard Prets [Faculty Supervisor: Dr. John Slate]
 FROM: Sam Houston State University (SHSU) IRB

PROJECT TITLE: Commercialization of Universities' Intellectual Property: Evaluating Productivity Based on Structure, Research Funding, and Entrepreneurial Aspirations [T/D]

PROTOCOL #: 2015-08-25043
 SUBMISSION TYPE: INITIAL REVIEW

ACTION: DETERMINATION OF EXEMPT STATUS
 DECISION DATE: August 7, 2015

REVIEW CATEGORY: Category 4—research involving existing, publicly available data usually has little, if any, associated risk, particularly if subject identifiers are removed from the data or specimens.

Thank you for your submission of Initial Review materials for this project. The Sam Houston State University (SHSU) IRB has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will retain a copy of this correspondence within our records.

*** What should investigators do when considering changes to an exempt study that could make it nonexempt?**

It is the PI's responsibility to consult with the IRB whenever questions arise about whether planned changes to an exempt study might make that study nonexempt human subjects research. In this case, please make available sufficient information to the IRB so it can make a correct determination.

If you have any questions, please contact the IRB Office at 936-294-4875 or irb@shsu.edu. Please include your project title and protocol number in all correspondence with this committee.

Sincerely,

Donna Desforges
 IRB Chair, PHSC
 PHSC-IRB

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Sam Houston State University IRB's records

Vita was removed during scanning