

Increasing Diversity among Women Entrepreneurs in High Growth High Tech Using HBCU Female Academic Entrepreneurs

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Executive Summary

There is a concentrated number of potential women entrepreneurs of diverse races among faculty in the United States' Historically Black Colleges and Universities (known as HBCUs and are called 'Black Colleges' herein). This study describes the potential for developing university technology transfer in these Black Colleges as a strategy for increasing diversity among women entrepreneurs in high growth, high tech fields using female academic entrepreneurs. Currently, Black Colleges lag behind their peer non-Black Colleges in technology transfer because historically they have been under, served and were originally established largely as teaching and blue-collar trade schools. Although Black female STEM faculty comprised less than 2% of the US faculty, they are 22% at HBCUs (Mack, 2011).

Using a novel theoretical framework, 24 Black Colleges with doctoral programs were compared to five (5) non-Black Colleges' technology transfer programs. The results of a correlation analysis support hypotheses regarding the relationships between tech transfer resource inputs and outputs. It was discovered that the size of technology transfer support and licensing staff relates to the number of invention disclosures and startup formations. The amount of legal support investments did not relate to the number of licensing

agreements. Further, the amount of legal support investments or patent applications filed did not relate to faculty size per program.

The number of licensing agreements did positively relate to faculty size per program. Further, faculty size per program and total research expenditures positively related to total licensing agreements. There was no support for the hypothesis that the relationship between non-tenured faculty would be negatively correlated to the number of licensing agreements and start-up business formations. Publications, honors and awards are some measures of faculty quality. Gross licensing income did not correlate to the amount of faculty publications or percent of faculty with honors and awards. Interestingly, the number of invention disclosures, patent applications filed, or percent of faculty with honors and awards did not correlate to faculty with research grants. Instead, revenue from licensing and publication citations were related positively to faculty with research grants. Lastly, the more female faculty researchers there are, the more faculty honors and awards, gross licensing income and number of start-ups.

These findings were used to develop a model intellectual property (IP) policy for Black Colleges. The Model IP policies can help these institutions improve their technology transfer and academic entrepreneurship endeavors. Ultimately, this will likely increase the diversity of women researchers, inventors and academic entrepreneurs in high growth, high tech fields.

Keywords: technology transfer, management of innovation, management of new technologies, R&D management, academic entrepreneurs, high tech diversity, female STEM professors, academic inventors, faculty quality, Black Colleges, HBCUs, MSIs

The Federal Demonstration Partnership (FDP) of the National Academies is a program convened by the Government–University–Industry Research Roundtable which is an organization housed in the Policy and Global Affairs Division of the National Research Council (NAS, 2014). As defined by the FDP, emerging research institutions are institutions that are relatively new to managing federal funds and

have less than \$20 million annually in federal R&D funding as listed in the National Science Foundation (NSF)'s National Center for Science and Engineering Statistics website (formerly, the Science Resources Statistics website). In addition, emerging research institutions are at least funded by two (2) federal FDP federal agencies (Wright, 2008). Black Colleges are emerging research institutions.

There is a concentrated number of potential women entrepreneurs of diverse races among the Black Colleges' faculty. With regards to university technology transfer, Black Colleges lag behind their peer non-Black Colleges because historically they have been under-served and were originally established largely as teaching and blue-collar trade schools. Increased involvement in research-oriented activities such as technology transfer will likely enable Black Colleges to grow into new or stronger research institutions. Increased involvement will also increase the diversity of women researchers, inventors and entrepreneurs in high growth high tech fields.

In general, there is little or no current research available about Black Colleges' willingness to engage in university tech transfer. Much of the literature reveals the state of affairs of Black College finances. In 2006, 900 Black female STEM faculty comprised less than 2% of the US faculty and 22% at Black Colleges (Mack, 2011). In the top ranked STEM departments, under-represented female STEM faculty are virtually non-existent. The few that are in these departments were not born in the U.S. (Nelson & Brammer, 2010). Besides the importance of their own research and careers, Black female STEM professors nurture, mentor and influence Black students in STEM fields (Mack, 2011; Nelson & Brammer, 2010).

Black Colleges graduate 60% of America's black engineering students (Bagley, 2013) and are becoming increasingly threatened financially (Garibaldi, 1984). Black Colleges once were funded at more than 50% by industrial partners which ended with the Great Depression in the 1930s (Gasman & Tudico, 2008). These colleges have grown increasingly dependent on government assistance and need new revenue sources (Grimes-Robinson, 1998). These schools are heavily teaching oriented (Brown II, 2013; Brown II, Freeman & Jones, 2004); and they lack patents and lack tech transfer operations (Bagley, 2013). In comparison, over the past 25 years, non-Black Colleges have increased their licensing revenues (AUTM, 2013).

Thus, Black Colleges can learn from these non-Black Colleges.

Systems dynamics is the process of combining the theory, method and philosophy necessary to analyze the behavior of a system in order to provide a common foundation that can be applied whenever it is desired to understand and influence how things change over time. Applying the systems dynamics approach, a theoretical framework comprised of tight linkages between the social comparison theory (Festinger, 1954), resource-based view (Barney, 1991), and Forrester's theory of distribution management related to supply chain management (Mentzer, 2001) was developed. Using this theoretical framework, Model Intellectual Property Policies for Black Colleges were culled from an analysis of correlations among success factors for technology transfer. Increasing Black College participation in tech transfer will represent a paradigm shift. When old paradigms lose their effectiveness, one of the reasons leaders do not solve problems right away is the lack of technological tools (Barker, 1992, p. 48–54). Using technology to conduct this statistical analysis, Model Intellectual Property (IP) Policies can help Black Colleges and other emerging research institutions better compete for licensing revenues. As a result, the number of diverse female academic entrepreneurs in high growth high tech fields will increase.

Exploring University Technology Transfer from the Resource Based View

The resource-based view teaches the importance of firm resource internal endowments on the creation of competitive advantages; and if resources are not imitable (i.e. so good or unique that they are impossible to copy), then they are sources of sustainable competitive advantage (Barney, 1991). The resource-based view has been studied in relation to understanding the internal resources involved in creating university spin-offs (Lockett & Wright, 2005; Mustar, et al., 2006; Powers & McDougall, 2005) in the UK. Further, although the resource-dependency theory and resource-based view was combined into an integrative theory and applied to the process of how universities commercialize technology (Powers, 2003), this theoretical framework has not been widely mentioned and adopted in scholarly research. The resources of the university tech transfer office include human, physical and organizational resources.

Human Resources – Tech Transfer Staffing

The tech transfer staff members are charged with soliciting invention disclosures from faculty researchers, evaluating the invention disclosures, and selecting inventions to patent and license. They typically manage the patent filing and maintenance process. They also market inventions to industries and negotiate licensing deals with well-established corporations, small start-up businesses, or university spin-off businesses. An ideal tech transfer office has adequately educated and experienced staff (Mowery & Shane, 2002). Universities with larger, experienced tech transfer staff create more contract research and inadequately trained staff is the reason for delayed, slow tech commercialization (Wright, 2013). An inadequate tech transfer staff slows the tech transfer process down. Slow invention evaluations, decisions, or negotiations; and incompetent technical advice frustrate faculty researchers and may result in a reduction of invention disclosures and faculty participation in the technology commercialization undertaking.

Siegel, Waldman, and Link (2003) studied the “environmental and organizational factors” that illustrate differences in university tech transfer production. They found that tech transfer staffing, tech transfer staff compensation, and cultural barricades between industrial organizations and universities impact tech transfer productivity and performance success. These researchers identified barriers to tech transfer which included conflicting cultures, inflexible bureaucracies, inadequate reward systems, and problematic tech transfer office management (Siegel, et al., 2003).

Siegel et al. (2003) attributes the tension and inefficiency in university tech transfer to increases in number of and types of research partnerships. They found that the know-how and practices of tech transfer offices are critical factors in the implementation of university tech transfer. They recommended that these offices address issues, set goals and priorities to determine the appropriate resource amounts to invest in: (1) removing cultural and communication barricades that impede the process; (2) developing more flexible technology transfer policies; (3) developing better staffing practices; (4) allocating more resources to these offices; (5) enhancing rewards; and (6) encouraging improved social relationships and networking opportunities (Siegel, et al., 2003). To this end, a model IP policy in support of Black College

technology transfer activities would need language in support of adequate investments in tech transfer staffing. The hiring of such staff would be justified and impacted by time and money investments in invention disclosures and patenting.

Hypothesis 1. For the smaller non-Black Colleges research institutions that Black Colleges can compare themselves to, the relationship between the tech transfer staff full time equivalents (FTEs) is positively related to the tech transfer inputs of invention disclosures and patent applications filed.

Human Resources – Legal Counsel

University tech transfer office investments in outside legal counsel is imperative. A model IP policy in support of emerging research institutions' tech transfer programs would need adequate legal human resources. The hiring of such legal counsel would be justified since the investment should correlate positively with the output of licensing deals.

Hypothesis 2. For the smaller non-Black College research institutions that Black Colleges can compare themselves to, the relationship between the legal fees is positively related to licensing agreement outputs.

Physical and Human Resources – Quality Faculty and Medical Schools

The existence of a medical school and biomedical inventions has been cited among several environmental and institutional factors that positively impact university tech transfer productivity (Siegel, et al., 2003). The reason that the existence of a medical school is recognized as helping university technology transfer offices to be successful, is that the licensing royalties on pharmaceutical and other biomedical inventions are hefty. However, the venture capital required to commercialize these technologies is higher than for other industries such as software. Also, to keep abreast of cutting-edge research, biomedical corporations desire to work closely with and sponsor

faculty medical researchers (Siegel, et al., 2003).

Interestingly, with respect to universities that have a medical school, Younhee Kim assessed productivity in technology transfer for 90 universities and found that the average output of those universities is only one percent (1%) greater than research universities that do not have a medical school (Kim, 2013). In addition, it is important to note that the Chapple, Lockett, Siegel, & Wright (2005) team found that the existence of a medical school impacts the state or quality of being efficient negatively (Chapple, et al., 2005).

With respect to medical schools, biomed and health research, faculty quality is a key success factor. Faculty quality based on the National Academies of Science's National Research Council (NRC) faculty research quality data is significantly related to tech transfer performance (Powers, 2003). University tech transfer success is largely dependent on faculty quality and the engagement of the more experienced faculty as mentors to others may create a more trusting culture which will enhance tech transfer performance (Wright, 2013). Their expertise makes them ideal to serve as business partners or technical advisors in start-ups using their research results (Siegel, et al, 2003).

Further with regards to faculty quality, continued involvement of the faculty inventor is required for successful technology commercialization programs in research universities. Invention disclosure quality is influenced by faculty quality (Friedman & Silberman, 2003). Increasing faculty quality will result in a return that is a one-to-one return on the invention disclosure amount. This will foster an increase in the amount of licensing deals from university tech transfer offices (Friedman & Silberman, 2003). Thus, investments in quality faculty should be made part of the proposed model IP policy in support of emerging research institution's fledgling tech transfer programs.

Hypothesis 3. For the smaller non-Black College research institutions that Black Colleges can compare themselves to, the relationship between the faculty quality positively relates to faculty research funding and expenditures and licensing outputs.

Human Resources – Tenured versus Non-Tenured Faculty

There is a perception by some faculty that faculty involvement with university tech commercialization might harm their careers. It is more likely for tenured faculty inventors to participate in university tech commercialization than faculty inventors that do not have tenure. Link et al. (2007) suspects that industry representatives might be more interested in working with faculty inventors that have more successful research programs. Two additional interpretations for the lack of non-tenured faculty include that technologies might be “going out the back door” and universities are not realizing adequate earnings from their patent portfolios. Further, university reward programs such as royalty sharing need be more aligned with keeping tenured faculty members involved in university tech commercialization tasks (Link, Siegel & Bozeman, 2007). This begs the question of whether the proposed model IP policy should be more or less in support of non-tenured assistant professors or tenured professors in terms of the type of professor who would be more likely to be actively engaged in tech transfer related activities.

Hypothesis 4. For the smaller non-Black College research institutions that Black Colleges can compare themselves to, the relationship between the non-tenured faculty is negatively related to licensing agreements and start-up business formation.

There was an eight-fold increase in university technology licensing from 1980 to 2002 (Mowery & Shane, 2002). This was due to an increase in start-up and small tech intensive business formations and the growth of venture capital backed tech firms founded by university students and faculty. Important variables for measuring university tech transfer and entrepreneurship include the: (1) impact of university public research on manufacturing R&D based on the publications and conferences leading to knowledge flow; (2) connection between research universities, other public research organizations, and non-public biotech firms; (3) use of patents and publications by private sector organizations; and (4) whether patents and executed licensing agreements aid university technology commercialization (Colyvas, et al., 2002). Thus, with respect to

faculty publications, a model IP policy in support of emerging research institutions' technology transfer activities would need quality faculty as evidenced by publication citations and faculty size. This should correlate positively with faculty honors and awards which is another measure of quality, and with licensing agreement outputs.

Hypothesis 5. For the smaller non-Black College research institutions that Black Colleges can compare themselves to, the relationship between the tech transfer staff full time equivalents (FTEs) is positively related to faculty quality as measured by the number of publication citations the faculty obtain and their honors and awards.

Hypothesis 6. For the smaller non-Black College research institutions that Black Colleges can compare themselves to, the relationship between the faculty quality as measured by the size of the faculty per program is positively related to licensing agreement outputs.

In summary, research universities need ways to fund the tech transfer inputs (Friedman & Silberman, 2003). These inputs include funding for quality research faculty, tech transfer staff, faculty incentives, and patenting. Licensing agreements yield up front and ongoing licensing revenues. The licensing revenues are used to continue and grow the technology transfer activities. In some cases, the licensing revenues are used to increase the R&D activities of the university in general. This may include R&D administrative costs and the cost to improve R&D infrastructure.

In O' Shea, Allen, Chevalier, & Roche (2005), it was hypothesized that being successful at creating university spinoffs increases at research universities: (1) that already have a history of success at doing this; (2) with science and engineering departments that have high quality ratings; (3) with a large amount of postdoctoral research staff and faculty; (4) with research funded by private industry sponsors; (5) that have great research budgets in their science and engineering departments (6) with greater computer science, engineering and life science related federally funded research budgets; (7) with greater full

time tech transfer staff; and (8) that have an university based incubator (O'Shea, et al., 2005). Empirically, O'Shea et al. (2005) concluded that increasing any of the following variables will likely increase the amount of university spinoff companies: (1) history of university tech transfer success; (2) a high NRC rating of faculty quality; (3) a high amount of life science, chemistry, IT and engineering research funding; (4) and a high percentage of funding from industry.

Aside from the tech licensing rewards and incentive debate, participating in university technology transfer will likely increase faculty's exposure and personal branding among research funding agency decision makers. Thus, the real reward may be increased research funding. The increased research funding should increase licensing deals and vice versa.

Hypothesis 7. For the smaller non-Black College research institutions that Black Colleges can compare themselves to, the relationship between the total research expenditures is positively related to tech transfer licensing agreements outputs.

Examining university tech transfer from the resource-based view is only one link in the proposed theoretical framework for this study. All of the resource inputs and outputs fit within a proposed university tech transfer supply chain network. This is a novel perspective and requires an exploration of the Theory of Distribution Management.

Exploring University Tech Transfer from the Theory of Distribution Management Lens

The Theory of Distribution Management is a business management theory that states that because institutions are so interlaced, system dynamics influences the function of product R&D, promotion and sales (Mentzer, 2001). *System dynamics* is the process of combining the theory, method and philosophy necessary to analyze the behavior of a system in order to provide a common foundation that can be applied whenever it is desired to understand and influence how things change over time (Forrester, 1993, p. 199–240). Forrester's 1958 introduction of the Theory of Distribution Management is believed to be the first instance of a reference to Supply Chain Management (Mentzer, 2001). This system dynamics idea as applied

to production distribution was noted in Forrester's 1961 book *Industrial Dynamics* (Forrester, 1961, pp. 119, 128).

Supply chains are "networks" of three (3) or more organizations involved in downstream and upstream linkages. The supply chain includes value producing activities and processes. The valuables are products and services delivered to consumers that enhance performance (Ketchen, Rebarick, Hult, & Meyer, 2008; Kumar, 2001; Mentzer, 2001). Although the traditional supply chain management view is to move goods or services in a tactical manner as a cost center, few organizations track their total supply chain performance (Ketchen, et al., 2008). Supply chain management can be viewed as a management philosophy that includes viewing the supply chain as a whole systematically; a strategic adaptation to align intra and interfirm operational and strategic capabilities with tactical activities; and a customer clear visual that forges customer value propositions that are new and customized (Mentzer, 2001).

Although product development is recognized as a fundamental link in the technology supply chain (Tatikonda & Stock, 2003), surprisingly, very little seems to have been written about university tech transfer as a supply chain network. Further, it has been proposed that product tech transfer effectiveness is greatest when companies delicately match the technology types that they want to transfer with their industrial supplier relationships in inter-organizational interactions (Tatikonda & Stock, 2003). If tech transfer is viewed from this supply chain lens, the demand for invention disclosure evaluations are related to supply chain processes such as the demand forecast methods and demand arrival processes. In this context, the proposed Black College tech managers would be supply chain managers aiming for efficiency to maximize licensing revenues.

So, what does a university tech transfer supply chain look like? Traditional supply chain nodes can be compared to university tech transfer processes and activities that impact licensing revenues. In a traditional supply chain, there are suppliers, manufacturing plants, distribution centers, inventory, inventory costs and customers. In the university tech transfer supply chain, there are tech transfer specialists (suppliers), faculty inventor research labs (plants) and tech transfer office distribution centers. There is also invention disclosures and patents (inventory) and legal fees (inventory costs). Further, the final

customer is part of the supply chain (Mentzer, 2001). These final customers are faculty inventors and industry partners (customers). Whether or not to include customers in the definition of supply chain has been much debated (Corominas, 2013). From this lens, and for the purposes of this study, industry and government partnerships and collaborations in the university tech transfer arena would be a part of a university tech transfer supply chain network. This is particularly true since industry and government sponsored research is driven by end-user's decision processes (Dai, Popp & Bretschneider, 2005).

In addition, university tech transfer supply chains are complex networks because tech transfer offices are impacted by inventory reduction and fill rates, customers' satisfaction, and revenue loss. So, the costs for inventory, managing resources are the most significant tasks of a capable supply chain manager.

Figure 1 depicts the university tech transfer process flow from the Resource Based View and showcases university tech transfer as a supply chain network with a system dynamic. The Theory of Distribution Management states that theory, method, and philosophy are required to analyze the behavior of this system to provide a common foundation. The system dynamics will influence research production, the generation of inventions, design engineering, promotions and sales.

Lastly, the use of the Social Comparison Theory for improving university tech transfer is explored as the third link in the proposed theoretical framework. The overarching impetus for engaging in this exploration is to discover which universities Black Colleges should compare themselves to.

Exploring University Technology Transfer from the Social Comparison Theory Lens

As per the social comparison theory (Festinger, 1954), individuals satisfy their fundamental need for accurate certainty and cognitive limpidness by finding information about the accurate certainty of their opinions and the accuracy of their abilities by sizing themselves up to others (Suls & Wheeler, 2000). Black Colleges can learn technology transfer from non-Black Colleges. They can compare themselves to the non-Black Colleges and improve. According to Leon Festinger, the need for comparisons to similar others leads to affiliation, pressure toward uniformity in groups, and a unidirectional drive upward that

leads to competition. Upward comparisons are with individuals or groups that are believed to be better, and downward comparisons are with those that are believed to be worse off (Buunk & Gibbons, 2007). If a group believes that their own abilities and efforts do not measure up, they may be motivated to make improvements.

With respect to the social comparison of ability, individuals compare themselves to others that have similar abilities (Festinger, 1954) mainly because this allows them to reduce uncertainty; and enhance or preserve their self-esteem. These comparisons are based on others who are physically present since these people are likely to be similar in keyways (Greenberg, Ashton-James, & Ashkanasky, 2007; Suls & Wheeler, 2000). This is why physical geographic location matters.

Social comparisons can be biased because individuals see themselves in a positive light that is unrealistic. This bias is called a better than average (BTA) effect. Specific, objectively measured attributes reduce bias in social comparisons (Dunning, 1999; Dunning, Meyerowitz, & Holzberg, 1989). Specific, public, objectively measured attributes show weak or little BTA effect (Allison, Messick, & Goethals, 1989; Van Lange, 1991). For example, a Black College representative would be more likely to state that their performance is above average on subjective and unclear attributes such as idealism than on more specific attributes such as licensing revenues generated. Thus, any tool that is developed for Black Colleges to compare themselves to, should be specific with objectively measurable attributes. Note that the bias effect may be exaggerated and individuals believe that they are less likely than average to reveal rare, unusual abilities and more likely to display ability that is common (Moore, 2007).

Social comparisons provide an ideal theoretical framework for researching the financial plight of Black Colleges because according to social comparison theory, threatening conditions motivate people to compare themselves to others who are facing a similar threat (Legg, Occhipinti, Ferguson, Dunn, & Chambers, 2011). Thus, Black Colleges would more likely benefit from comparing themselves to non-Black Colleges that are smaller research institutions with smaller tech transfer programs and perhaps similar financial threats rather than

larger research institutions with more robust and advanced tech transfer programs.

When individuals ask themselves if they can perform a task, they compare themselves to other people who already are performing that job (Greenberg, et al., 2007). This comparison occurs if the proxy surrogate's performance on the initial job is perceived to be similar to the comparer's performance and (2) if the surrogate is believed to have put in a lot of effort on the initial job. If the comparer does not see similarities, the comparer may reject skills training or diagnostic information about performance. This is important to note when moving forward with a useful tool for Black Colleges to use.

Toward a Novel Theoretical Framework

Theory Triangulation and Integration

Theoretical frameworks provide a structure to support explanations for why research problems exist. The literature review for this study reveals that since there is currently no theoretical framework for university tech transfer, it follows that there is no theoretical framework for researching Black Colleges' technology transfer activities and tool development. I argue that an ideal theoretical framework for Black Colleges should make use of theory integration and triangulation. Theoretical integration occurs when two or more theories are joined because the integrated theories work more effectively than any one of the premises alone in explaining the phenomenon. There are examples in cognitive psychodynamic therapy. Although it is difficult to integrate theories when there are differences in philosophies, ideas, constructs and presumptions (Kock, 2009), it is not impossible to do so. In contrast, theory triangulation is the analysis of data from more than one perspective, hypotheses and/or theories (Ammenwerth, 2003); and although it is rarely used (Holloway & Wheeler, 2002), it is applicable in this study. Nevertheless, using theory triangulation and integration, the Resource Based View, Social Comparison Theory and Theory of Distribution Management are joined. The research method is structured within this novel theoretical framework.

Beginning with lessons learned from the social comparison theory, instead of studying what a top ranked well-established research

university such as Stanford, MIT, University of California Berkeley, University of Illinois-Urbana Champaign, or Georgia Tech is doing, this study will focus on what the non-Black Colleges with smaller tech transfer programs and student bodies are doing with their tech transfer programs. Three (3) of the primary lessons learned from the social comparison theory follows:

Black Colleges should be compared to non-Black Colleges of similar ability and geographic location. With respect to the social comparison of ability, individuals compare themselves with others that have similar abilities (Festinger, 1954). This comparison allows them to lessen their uncertainty and enhance or preserve their self-esteem. These comparisons are based on others who are in close physical proximity because such individuals are likely to be similar in keyways (Greenberg, et al. 2007; Suls & Wheeler, 2000). Thus, physical geographic location also matters.

1. Competition, cooperation and conforming are social evaluation strategies related to social rules for distributing rewards; and competitive social comparison is greatest when the comparer and other person are similar in ability (Dakin & Arrowood, 1981).

2. To diminish biasness, any comparison needs to be specific with objectively measurable attributes (Allison, et al., 1989; Van Lange, 1991).

The Resource Based View teaches that if resources are so unique and not easy to copy, then they are sources of competitive advantage (Barney, 1991). In university technology transfer, these resources include but are not limited to the expertise of quality faculty and their issued patents, adequate tech transfer staff, adequate investment in legal services, and organizational resources such as support for research funding grantsmanship as evidenced by research expenditures.

The Theory of Distribution Management provides the glue to meld these theories together into a framework with tight linkages. This theory teaches that because institutions are so interweaved, system dynamics influence product research, engineering, sales, and promotion Systems Dynamics is the process of combining the theory, method and philosophy required to analyze the behavior of a system to provide a common foundation (Forrester, 1961, pp. 119, 128; Forrester, 1993, pp. 199–240). University technology transfer can be

viewed as supply chain distribution networks and therefore, are systems (Hamilton, 2016; Hamilton, 2017a; Hamilton, 2017b). The behavior of these systems needs to be analyzed from a common foundation.

Method

Data and Sample

A sample of 24 accredited Black Colleges offering Carnegie classified Research Doctoral degree programs was drawn from the list of Black Colleges reported by the White House Initiative on Black Colleges. The US Department of Education's National Center for Education Statistics (NCES) search tool for schools and colleges was used to identify non-Black College schools for the Black Colleges to compare themselves to. NCES provides student enrollment, type school (whether public or private), and geographic location. The selection criteria were based on the lessons gleaned from the social comparison theory: (1) groups compare themselves to others that have similar abilities; (2) groups compare themselves to others who are physically present in the same geographic location; and (3) the measures need to be specific and objective. Here, the similar ability is based on student enrollment and the school's ability to attract and enroll a certain number of students. It is also based on having lower licensing revenues. Non-Black Colleges were selected in the same 17 states that the 24 Black Colleges were located in. Lastly, the variables used for comparison that have been chosen are measurable and objective.

The following four (4) criteria was used to select the targeted non-Black Colleges for Black Colleges to compare themselves to:

1. Located in a state where the Black Colleges with Doctoral programs are located;
2. Have student enrollment within the same range as the Black Colleges with Doctoral programs as identified in a NCES database search;
3. Actively engaged in research and technology transfer; and participated in the Association of University Technology Managers (AUTM) Annual licensing survey for each of the five (5) years from 2010–2014; and

4. Considered to be 'emerging in tech transfer' licensing revenues as compared to all higher education institutions that participate in the AUTM Annual licensing survey with emergence defined as being in the lower quartile of gross licensing revenues.

The AUTM STATT database provides 20 years of data for the following data fields of information related to university tech transfer resources and licensing performance. AUTM data from 2010–2014 was used in this study. In addition, the NRC's faculty quality survey was used. The NRC assessed American doctoral programs for years 2000–2006 and published its findings in 2011 (NRC, 2011). The data includes objective measures of faculty quality per university program as measured by productivity and diversity. In addition, the NSF Academic Research and Development Expenditures FY 2009 (NSF, 2014) data was used for R&D expenditures.

A sample of nine non-Black College Comparison Schools were selected: (1) Baylor College of Medicine; (2) Georgia Regents University; (3) Medical University of South Carolina; (4) Rice University; (5) University of Alabama in Huntsville; (6) University of North Texas Health Science Center; (7) Wake Forest University; (8) Eastern Virginia Medical School; and (9) Louisiana Tech University. However, both AUTM licensing and NRC faculty quality data were not available for Georgia Regents, the Medical University of South Carolina, Eastern Virginia Medical School and Louisiana Tech. It is important to note that the remaining five (5) universities are not emerging research institutions as defined by the Federal Demonstration Partnership because their total annual federal research expenditures are more than \$20 million (Wright, 2008).

Analysis

To test the hypotheses, I conducted a correlation analysis of several factors that purportedly contributes to university technology transfer success as per the findings in the literature review. A Model IP policy tool can be created using a combination of information from the comprehensive literature review and statistical inferences gleaned from the correlation analysis.

Correlations were computed from data about the non-Black Colleges that participated in both the NRC assessment of faculty

quality and AUTM licensing surveys. Median values from the select non-Black Colleges were used based on AUTM data 2010–2014 per school and NRC data per school. In correlation research, the alpha level is the willingness to be wrong when a relationship between two (2) variables is stated and a common alpha level is 0.05 in educational research (Siegle, 2009). To assess whether the correlation coefficients listed in Table 1 meet this requirement, a Pearson's Correlation Coefficient table of critical values was used to find the intersection of the alpha 0.05 and 3 degrees of freedom (i.e., five (5) non-Black Colleges less 2). This exercise revealed a minimum correlation coefficient of .88 which is necessary to state with 95% confidence that a relationship exists (Siegle, 2009). The correlation coefficients of that are $\geq (+)$ 0.878 and $\leq (-)$ 0.878 were also studied.

It was discovered that the size of technology transfer support (i.e., 'Other staff') and licensing staff relates to the number of invention disclosures and startup formations. This makes sense given that the more invention disclosures and start-ups to be managed by the tech transfer staff, having more staff will be required. In addition, the number of 'Other staff' positively relates to patent applications filed for the same reason as with the aforementioned relationship. These findings support Hypothesis 1.

The amount of legal support investments did not relate to the number of licensing agreements. This is probably because in-house tech transfer staff are likely to negotiate and close licensing deals; and the outside legal counsel is primarily utilized for patent prosecution. Further, faculty publications are evidence of faculty quality. Legal fees for patenting do not relate to the number of faculty publications. The amount of legal support investments or patent applications filed did not relate to faculty size per program. These findings support Hypothesis 2.

Like publications, faculty honors and awards are evidence of faculty quality. Interestingly, the number of invention disclosures, patent applications filed, or percent of faculty with honors and awards did not correlate to faculty with research grants. This supports Hypothesis 3 and supports Hypothesis 5 in part.

Total research expenditures positively relate to the total license agreements executed. Therefore, technology transfer managers can expect that having more sponsored research can result in more

licensing agreements. The number of Start-ups formed positively relate to the percent of faculty engaged in inter-disciplinary research, and to the percent of Assistant Professors. Ideally, when faculty earn tenure, they have proven their worthiness as a colleague to have around for the long term and their research is impactful. The relationship between the number of start-ups formed and the Assistant Professors is stronger than their relationship to the percent of Tenured Professors at these select non-Black Colleges. In addition, legal fees positively relate to the percent of Tenured Professors. This is quite fascinating and may be due to the tenured faculty having more experience, and more or less engagement with the intellectual property legal counsel.

Further, having a lower or higher percent of tenured professors does not correlate to an increase or decrease in the number of licensing contracts, number of publications, research dollars, percent of faculty with honors or awards, or the number of invention disclosures. This conflicts with Link et al. (2007) which found that tenured faculty inventors are more likely to participate in university technology transfer than non-tenured faculty inventors. There is a medium strength negative relationship (-.60) between the percentage of faculty with research funding and the percent of tenured professors. Thus, for example, the more tenured professors, the less the percent of faculty with research grants. The number of 'Other staff' in the tech transfer staff is negatively related to the percent of tenured professors. This r value has a medium strength (-.57). This suggests that an increase in the number of tenured professors would justify a decrease in 'Other staff'. The tenured professors do not relate to licensing agreements or invention disclosures. So, there would be no need for the increased tech transfer support if there were an increase in the percent of tenured professors. There was no support for Hypothesis 4, that the relationship between non-tenured faculty would be negatively correlated to the number of licensing agreements and start-up business formations.

The number of Licensing staff positively relate to the number of publication citations and the percent of faculty engaged in interdisciplinary research. Thus, it can be surmised that the more a faculty member is engaged and creating significant research results worthy of citation, the more tech transfer licensing staff that will be

required to support the increased level of research engagement. In addition, the number of publications per the number of allocated faculty members per program positively relates to the percent of faculty with honors and awards.

More interesting is that the percent of faculty with honors and awards, gross licensing income and the number of start-ups positively relate to the percent of female faculty researchers. So, more female faculty researchers may result in more faculty honors and awards, gross licensing income and the number of start-ups. The gross licensing income does not correlate to the number of faculty publications or percent of faculty with honors and awards. These findings support Hypothesis 5.

In support of Hypothesis 6, the number of licensing agreements positively relates to faculty size per program. With respect to Hypothesis 7, it was discovered that the more licensing agreements that are desired, more research faculty are required. Also, total research expenditures positively relate to the total license agreements executed. Therefore, having more sponsored research results in more licensing agreements.

Additional findings included that the number of invention disclosures do not correlate to gross licensing income. However, the number of start-up companies do relate to licensing income positively. Also, the only variable related to the percent of non-Asian minorities is the number of faculty publications and the number of start-ups formed. The relationship is a positive one. There is a negative relationship (-.57) between the licensing income and percent of non-Asian minority faculty. This is especially important to Black Colleges. As licensing income increases the number of non-Asian minority faculty would decrease. Although the *r* value is of medium strength, this phenomenon would be interesting to track.

In summary, these findings are significant because they can inform the language that Black Colleges use in their model IP policies to better support, develop and grow their technology transfer programs. A model IP policy should have the following policy statements gleaned from the correlation study:

1. Black colleges should commit to having adequately staffed TTO since this positively relates to invention disclosures, start-up business formations, publications and patent applications filed.

2. Black colleges should assertively work to increase their R&D grants and contracts since these expenditures positively related to the number of licensing agreements executed.

3. Black colleges need an increase of faculty size per program since this positively relates to licensing deals.

4. Black colleges need to encourage faculty engagement in interdisciplinary research since this positively relates to start-up business formations.

5. Black colleges need to encourage diversity in their faculty hiring. Gender matters. The percentage of female faculty is positively related to the percentage of honors and awards (measures of faculty quality), gross licensing income, and the number of start-up businesses that are formed.

6. Black colleges need to encourage start-up business formations since this is positively related to the gross licensing income.

A model IP policy may improve technology transfers. Given that most black female STEM professors are at Black Colleges, increased Black College involvement in university tech commercialization and academic entrepreneurship will likely increase the diversity of women researchers, inventors and academic entrepreneurs in high growth, high tech fields.

Discussion

Implications for Management

Race and gender equality should be important to high education administrators. Gender equality has not been achieved in the Academy. Masculinity in higher education is still dominant despite more than 50 years of advocacy for gender equality (David, 2015). There is a need to increase the hiring of female STEM faculty (Carnes et al., 2015; Moss-Racusin et al., 2016). Women accounted for 38% of science and engineering doctorates employed in academia in 2017, up from 25% in 1997, and accounted for 32% of full-time senior faculty (including full professors and associate professors) in 2017, up from 17% in 1997 (NSF, 2019).

While hiring women professors can help reduce gender bias, it does not negate existing structural and cultural problems in the Academy. They do not disappear. Unfortunately, policies that promote gender equity in the Academy have failed due to the cultural and

structural problems. These problems include failure by leadership to implement policies; patriarchy and male dominated cultural values; differences between gender on how academic work is understood and carried out; and biased performance evaluations and promotions (O'Meara & Stromquist, 2015). Three ways to alleviate some of these problems include: (1) diversity training that help reduce gender and racial bias (Buitendijk & Curry, 2019; Devine, Forscher, Austin, & Cox, 2012; Rudman, Ashmore, & Gary, 2001); (2) networking; and (3) mentoring (Blackmore, Sanchez-Moreno, & Sawers, 2015). More importantly, any implemented strategy to increase gender equity in higher learning needs to be grounded in theory and motivated by past data. Implementation will require managed routine processes and accountability from the top down (Valian, 2005).

For Black females, campus racial climates come into play. University accreditors need to examine college campus' racial climates because the lack of diversity in the Academy is egregious. "For everyone White faculty member, there are 16 White students; for every Black faculty member, there are 49 Black students, and for every Latino faculty member, there are 89 Latino students" (Jones & Nichols, 2020). There are countless research studies focused on the need for faculty diversity and multiculturalism. Turner, Gonzalez & Wood (2008) published a literature review of 20 years of scholarship about faculty of color in the Academy. It included 252 works by 300 scholars. The themes included job satisfaction, teaching challenges, bias in hiring, unjust work expectations, language and accent discrimination, student diversity, collegiality, support programs, lack of diversity, lack of recruitment, isms (race, ethnicity, gender, class, and sexual orientation), affirmative action, salary inequality, pipeline issues, history of exclusion, diversity goals, recruitment and retention plans, mentoring programs, and tenure and promotion (Turner, et al., 2008).

In addition, with the COVID 19 pandemic, we witness the need for diversity in addressing societal health disparities. The Academy need to graduate workers that can serve diverse populations. To this end, the tenure and promotion of diverse faculty is critical to their advancement into leadership roles. Diverse hiring and retention in the Academy are critical for: (1) the representation of diversity as being valued; (2) development of diverse forms of knowledge; (3)

relationship building with diverse communities; (4) improving informed decision making related to diverse communities; (5) creating more desirable workplaces; and (6) increasing the availability of diverse role models (Smith, 2012).

Some reasons diversity in higher education is necessary include Fortune 500 corporations advocating the need for diverse student bodies that demonstrate a variety of key skills crucial in the USA workplace. Enabling students to interact with people of different backgrounds is essential in humanistic, liberal education (Bollinger, 2003). Many Fortune 500 companies supported the University of Michigan's affirmative action student admissions practices because they wanted an available diverse workforce that is highly culturally competent (Clark, 2011). Given our increasingly diverse society, the economic reality is that employers seek a diverse workforce. Cultural diversity needs to be mentioned in institutions' missions (Abdul-Raheem, 2016; Hurtado, 2007); and minority students need to see themselves in tenured minority faculty represented in leadership roles that advocate for equity and diversity (Abdul-Raheem, 2016). Thus, diversification of *both* faculty and students needs to be reflective in higher education institutions' commitments to diversity (Brown, 2004). With respect to educational missions, there needs to be institutional changes in curriculum, pedagogy, and research. Higher education governance (i.e., management and leadership) needs to be examined for diversity related opinions and priorities (Caldani, 2020).

Two programs that have been tried to remedy the diversity problem is color blindness and multiculturalism. However, respectively, these have resulted in underrepresented populations feeling devalued and slighted; and in predominantly White workers feeling threatened. One solution for crafting inclusive environments is better communicating an organization's stance on diversity (Stevens, Plaut, & Sanchez-Burks, 2008). Ultimately, what is necessary is a shift in the public perception of diversity. Instead of the view being that it is a shameful burden, it needs to be perceived as an opportunity to embrace the inherent differences in race and gender (Clayton-Pedersen & Clayton-Pedersen, 2008). President Bill Clinton has a famous 1998 quote: "The greatest challenge facing Americans is to accept and take pride in defining ourselves as a multiracial democracy" (Hurtado,

2007). This is imperative for the advancement of Black females and other diverse populations.

Minority race doctoral STEM faculty are barely visible. And once hired as STEM faculty, they are likely to hold the rank of full professor or to be tenured. There is a 'stunted', dead-end pipeline (Chubin, May, & Babco, 2005). In contrast, nearly 90% of tenured, full professors are White (Jones & Nichols, 2020). In 2018, US faculty were 40% White males; 35% White females; 7% Asian/Pacific Islander males; and 5% Asian/Pacific Islander females (NCES, 2020). Combined, in science and engineering, Blacks, Hispanics, and American Indians or Alaskan Natives constituted 9.3% of total academic doctoral employment and 9.0% of full-time faculty positions in 2017, up from about 6% of both these positions in 1997 (NSF, 2019).

In 2005, the low numbers contrasted with 26% Asians in tenured electrical engineering faculty positions and 16.6 % of Caucasian women in biomedical engineering (Chubin et al., 2005). The higher numbers of Asians are related to the 'model minority myth' which is the presumption that all Asians are math and science geniuses. The problem with this assumption is that Asians are assumed to not need support or resources (Hartlep, 2013). This is certainly true for Asian American students (Harper & Davis, 2016) and perhaps Asian faculty.

The pipeline flows from students at the precollege, undergraduate, and graduate levels; and then from junior faculty onto tenured leading faculty levels. Increasing PhDs to increase Black, Hispanic, and Indian faculty, has been studied. It is not the central cause of continued underrepresentation of minority faculty (Myers & Turner, 2004). There needs to be a pipeline of 'nurtured and supported' diverse students and faculty. There is a need for integrative faculty development to cultivate institutional transformation and sustainable STEM diversity (Whittaker & Montgomery, 2014).

Many underrepresented minority students are interested in STEM. In 2005, the same percent of Black and White college bound high school students indicated a desire to enter STEM fields (Summers & Hrabrowski III, 2006). In addition, although White undergraduates enter college with an intention to major in a STEM field at the same rate Black and Latino students do, the Whites are much more likely to earn a STEM degree (Chang, Sharpness, Hurtado & Newman, 2014).

There is a need to recruit the most active research faculty to work with these students (Summers & Hrabrowski III, 2006).

Most of the published research about affirmative action in higher education is focused on increasing diversity in student admissions. In a study of 428 faculty members, their attitudes toward affirmative action principles applied to students and faculty were favorable. The study participants embraced increasing campus diversity (Flores & Rodriguez, 2006). Yet, little has been written about or discussed related to the use of affirmative action programs for increasing the hiring of diverse faculty. While these programs are viewed favorably, the 'target of opportunity' programs that target faculty of a particular sex or races have been challenged as legally risky set asides (Yachee, 2020). Yet, set asides are quite beneficial to underrepresented groups in government contracting and are not considered illegal. Affirmative action programs for students and faculty go hand in hand. When more minority students are admitted into a predominately White institution of higher education, they need to feel welcomed and supported. The campus culture needs to be inclusive. This requires both a diverse student and diverse faculty community.

Given all of this, Black Colleges such as HBCUs ideally have institutional normative structures that support the advancement of Blacks. However, this does not mean that all predominantly White institutions, uniformly, are harmful to Blacks. The reality is that no matter the type of institution, students benefit from diversity (Hurtado, 2007). Students at more selective institutions typically have less frequent, less personal interactions with faculty. However, Black students at the HBCUs report having more support and frequent interactions with faculty (Hurtado et al., 2011). Black Colleges graduate 60% of America's black engineering students (Bagley, 2013) and are becoming increasingly threatened financially (Garibaldi, 1984).

My research greatly impacts higher education management because it provides an objective way to forge model technology transfer policies at Black Colleges. The idea for increasing technology commercialization is that if successful, it can be a revenue source. A 1973 study by Thompson revealed that in 1969, HBCUs received a mere three (3) percent of the total federal funds granted to American schools of higher education. The low funding level was arguably an

unfair amount for the following reasons: (1) the students were the most economically-deprived and required special assistance to be able to adequately compete; (2) the HBCUs had few wealthy alumni; and (3) the HBCU philanthropic foundation and industry support waned (Thompson, 1973). Garibaldi published that in 1975, federal funding was at 38 percent (Garibaldi, 1984). Marybeth Gasman at Rutgers has a Center that studies these Minority Serving Institutions. She published that Beginning with President Carter in 1980, each U.S. president has providing federal funding to HBCUs (Gasman & Tudico, 2008). The Clinton Administration awarded \$13 million to 29 HBCUs and mandated federal assistance from all federal departments and agencies under Executive Order 12876. Five (5) percent of federal grants and contracts awarded went to HBCUs. HBCUs grew increasingly dependent on government assistance and need new revenue sources (Grimes-Robinson, 1998).

In 2019, the US Congress authorized \$255 million a year for minority serving universities. It includes \$85 million a year for HBCUs, \$100 million for Hispanic serving institutions, \$30 million for tribal schools and \$40 million for a variety of other minority serving schools (Associated Press, 2019). These schools are heavily teaching oriented (Brown II, 2013; Brown II, Freeman & Jones, 2004); and they lack patents and lack tech transfer operations (Bagley, 2013). While these institutions could certainly benefit from federal funding for R&D, they should work toward becoming less financially dependent on government assistance. In fact, over the past 25 years, non-Black Colleges have increased their licensing revenues (AUTM, 2013). Thus, Black Colleges can learn from these non-Black Colleges.

To this end, I examined the development of a novel theoretical framework that can be used in a new method designed to help emerging research institutions of higher education grow their technology transfer programs. Given that Black Colleges graduate 60% of America's black engineering students; and the heaviest concentration of black female STEM professors is at Black Colleges, increased Black College involvement in university tech commercialization and academic entrepreneurship will likely increase the diversity of women researchers, inventors and academic entrepreneurs in high growth, high tech fields. I proposed that an ideal theoretical framework for these smaller colleges and universities

should integrate and triangulate the Resource Based View, Social Comparison Theory and Theory of Distribution Management. I used the 24 Historically Black Colleges and Universities with doctoral programs. Using the new theoretical framework, I selected a sample of five (5) non-Black Colleges for the Black Colleges to compare their tech transfer programs to. I created a new database using these select non-Black Colleges' data collected from the NCES accredited colleges, Carnegie classification, NSF academic research expenditures, NRC faculty quality, and AUTM STATT licensing databases. Using a correlation analysis, I offer evidence to support my hypotheses regarding the relationships between tech transfer resources inputs at smaller research universities and their tech commercialization outputs.

Strengths and Limitations

Using this theoretical framework and correlations in this manner is a strong objective approach to model intellectual property (IP) policy development in higher education. Yet, this study is not without limitations. One over-arching limitation is that it does not provide an analytical comparison of the diversity of the 24 Doctoral HBCUs' and 5 non-HBCUs' financial portfolios. Besides federal and industry research funding, it would be interesting to compare these schools' private donations and tuition incomes. It would be interesting to discover to what extent these two income streams are used for R&D investments and tech transfer; and whether they positively correlate to licensing revenue generation.

Directions for Future Research

In addition, other HBCUs that do not currently offer doctoral research programs have expressed an interest in technology transfer. Those HBCUs participated in the 2013 HBCU Innovation Summit (Abate, 2013). The schools include Xavier University, Spelman College, Claflin University, Fisk University, Morehouse College, Tougaloo University, Dillard and NC Central. Thus, the proposed theoretical framework for researching HBCU tech transfer and toolkit development can be implemented at these emerging research universities also; and doing so will provide for additional future research opportunities. In fact, it would be insightful to conduct a more fine-grained study of all HBCUs that offer STEM related post

baccalaureate degree programs. Further, case studies of HBCUs that are willing to work on implementing the recommended model IP policies and implement this study's recommendations over a period of perhaps 5–10 years are future research opportunities. The proposed case studies should monitor the methods that the HBCUs use to fund their research and tech transfer resource investments.

Increased HBCU participation in tech transfer represents a paradigm shift. There are two (2) reasons that leaders do not solve problems right away. They either lack some technology or tool; or they do not know how and lack sophistication (Barker, 1992, p. 48–54). These proposed studies can reveal whether a paradigm shift into an increased research and tech commercialization arena makes a difference for the HBCUs financial situations and whether this initiative decreases their donation and tuition dependence.

In addition, a future research study of methods to increase HBCU engagement in trade organizations such as AUTM; and in surveys such as the AUTM annual licensing survey and the NRC faculty quality survey is needed. Future research should uncover reasons why HBCU representatives are reluctant to participate such as:

- Lack of awareness,
- Perceptions of not belonging to or identifying with these organizations,
- Perceptions of disrespect or unfairness,
- Perceived job insecurity due to under performance,
- Not believing in the rankings, or
- Not having effective data collection systems or data collection.

Three additional future research opportunities include conducting: (1) surveys to measure the level and extent to which HBCUs are currently marketing their research expertise, facilities, equipment, hardware, and software; (2) opinion surveys and interviews to measure the credibility gap and negative branding issues; and (3) opinion surveys and interviews to measure the HBCUs progress toward embracing academic entrepreneurship and developing more entrepreneurial cultures. Future case studies, interviews of

HBCU Presidents, and opinion surveys of HBCU research faculty should explore whether, at each HBCU, there is a(n):

- clear, adequate, and well-articulated vision including increasing research and technology commercialization;
- understanding of competitive threats;
- lack of competitiveness;
- leadership with a sophisticated understanding of university strategic positioning, research development and technology transfer;
- leadership that values university research development and technology transfer;
- appropriate teaching load for research faculty;
- adequate lab facilities, equipment, hardware and software;
- adequate R&D matching funds;
- adequate marketing of faculty expertise and the university's other research capabilities;
- any specific instances of the HBCUs' credibility being questioned or of negative branding related to research or the lack thereof; and what was done to cure the problem;
- perception that the HBCU has an entrepreneurial culture;
- high turnover in research faculty, TTO staff and/or research administrators;
- adequate TTO staffing with respect to their pay, education, technology transfer experience, number of deals they have closed, and the amount of licensing revenues they have generated; and
- adequacy of the willingness of the HBCU's faculty researchers to be fully engaged in the technology transfer process by giving their time and energy.

In addition, the method used in this study to create a model IP policy for HBCUs can be applied to other emerging research institutions at Minority serving institutions (MSIs). The other types include Hispanic serving institutions (HSIs), Native American serving institutions (NASNTIs), Asian American and Native American Pacific Islander serving Institutions (AANAPISI's).

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Bibliographical Note

Clovia Hamilton earned a PhD in Industrial & Systems Engineering with a concentration in Engineering Management from the University of Tennessee Knoxville. She also has a JD; a Master of Laws (LLM) in Intellectual Property Law from the University of Illinois at Urbana-Champaign; and MBA from Wesleyan College. Her published

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Appendix

Figure 1
University Technology Transfer Supply Chain Network
Concept Model

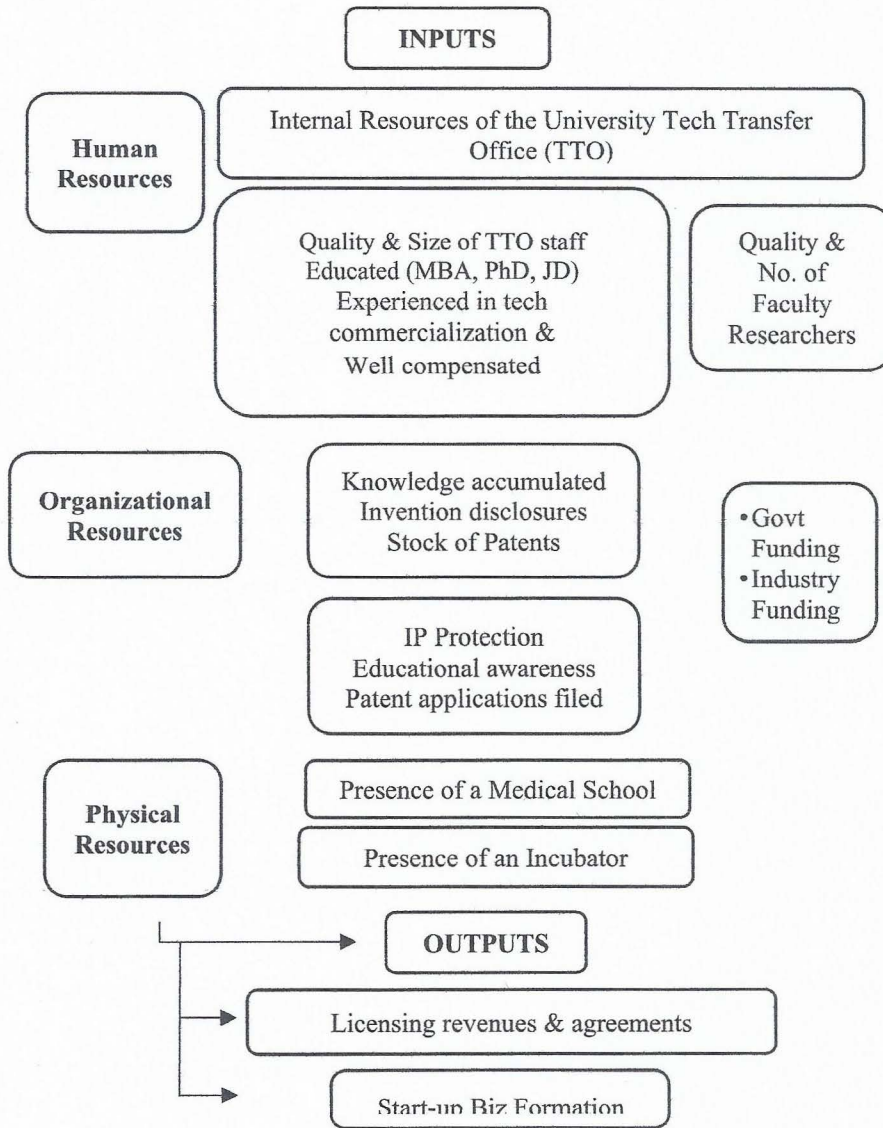


Table 1
Correlation Tables of Select Non-Black Colleges'
Licensing and Faculty Quality Measures

	Lic Staff FTEs	Oth Staff FTEs	Tot Res Exp	Fed Res Exp	Ind Res Exp	Tot Lic Opt Exec	Inv Dis
Number of citations per publication	.88	.71	.88	.88	.80	.95	.62
% Faculty with research grants	.52	.39	.63	.66	.54	.67	.09
% Faculty with honors and awards	.74	.55	.87	.81	.83	.87	.66
% Non-Asian minorities	.04	-.12	-.13	-.22	-.25	-.01	.32
% Women	.84	.72	.81	.83	.74	.87	.53
% Faculty engaged in inter-disciplinary research	.90	.96	.68	.73	.73	.69	.74
Faculty size per program	.78	.58	.98	.96	.92	.99	.48
% Assistant professors	.75	.68	.41	.42	.34	.55	.69
% Tenured professors	-.45	-.57	-.11	-.19	-.12	-.17	-.31

Table 1 (contd.)
Correlation Tables of Select Non-Black Colleges'
Licensing and Faculty Quality Measures

	Tot Pat App Filed	St Ups Formed	Gross Licensing Income	Legal Fees	No. of pubs per allocated faculty member
Tot Pat Apps Filed	1				
Start Ups Formed	.63	1			
Gross Lic Inc	.35	.81	1		
Legal Fees	.78	.73	.75	1	
No. of pubs per allocated faculty member	.57	.31	.12	.14	1
No. of cites per pub	.49	.73	.58	.36	.86
% Fac w/ res grants	.09	.57	.84	.38	.37
% Fac w/ hons & awards	.38	.33	.01	-.10	.90
% Non-Asian	.19	-.82	-.57	-.26	.53
% Women	.47	.85	.78	.52	.69
% Fac in inter- disc res	.79	.99	.80	.82	.51
Fac size per progr	.26	.58	.44	.08	.80
% Asst profs	.73	.92	.55	.68	.70
% enured profs	-.55	-.63	-.86	-.93	-.05

Table 1 (contd)
Correlation Tables of Select Non-Black Colleges'
Licensing and Faculty Quality Measures

	No. of cite per pub	% fac w/ res grant	% hon s and awd s	% non - Asi an	% wom	% fac in inter-disc res	fac size per progr	% asst prof s	% tenure profs
No. cites per pub	1								
% Fac with res grant	.77	1							
% Fac with hons & awds	.76	.26	1						
% Non-Asian	.12	-.29	.31	1					
% Wom	.96	.89	.56	.09	1				
% Fac inter-disc res	.72	.58	.42	.30	.80	1			
% Fac size per progr	.92	.69	.86	.02	.84	.59	1		
% Asst profs	.77	.58	.36	.35	.79	.69	.47	1	
% Tenure profs	-.38	-.60	.23	.30	-.60	-.72	-.09	-.70	1