

**Research Faculty, Entrepreneurship and Commercialization:
The Case of Kansas State University**

Vincent Amanor-Boadu and Chandra Mohan Reddy Metla

Department of Agricultural Economics

Kansas State University

Manhattan, KS 66506

Tel: 785-532-3520

Contact Email: vincent@ksu.edu

*Selected Paper prepared for presentation at the Southern Agricultural Economics Association
Annual Meeting, Dallas, TX, February 2-5, 2008*

Copyright 2008 by Vincent Amanor-Boadu and Chandra Mohan Reddy Metla. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

Abstract

In this study, we assess the relationships between the demographic characteristics of researchers and their perspectives on entrepreneurship and the commercialization of their inventions, and analyze the relationship between faculty perceptions of university commercialization policies and their entrepreneurial orientation. We conclude that there is a need for effective educational programs to address each of the issues and increase awareness among faculty and researchers.

Introduction

The Bayh-Dole Act was passed in 1980 to allow universities and institutions to retain the title to invention(s) even when federally funded. The expectation was that it would increase the commercialization of technologies. Prior to the Bayh-Dole Act, fewer than 250 U.S. patents were issued to universities each year. After the implementation of the Bayh-Dole Act in 1980, many research universities started giving priority to their technology commercialization efforts. Since 1993, U.S. universities averaged more than 1,600 U.S. patents annually, according to Association of University Technology Managers (AUTM). In the late 1990s, patents issued to U.S. universities have exceeded 2,000 patents. The interest in technology commercialization is reflected also by the growth in the membership of AUTM, which stands at more than 200 universities today, eight times more than in 1980. In addition, AUTM (2000) report shows that for the period 1991 to 1999, there were a 198% increase in new U.S. patent applications and a 133% increase in licenses from U.S. universities. The foregoing indicates that these institutes have responded to the Bayh-Dole Act.

Factors like declining share in federal funding, reduced industry funding for research and development activities in universities, and universities own development through internal

resources have firmed up universities commitment to look for possible means of commercializing their research for securing revenue to enhance their research capabilities. In the due process of commercialization, faculty involvement has promised them with more opportunities of embracing entrepreneurship and we attempt to understand this in the context of Kansas State University and also the influence of university intellectual property policies on faculty entrepreneurship and research commercialization. By allowing universities to commercialize their research outcomes, the Bayh-Dole Act stimulated technology commercialization and entrepreneurship judging by the number of licenses and start-ups (AUTM, 2000). A review of the literature shows that some universities do better at commercialization than others (Slaughter and Leslie, 1997; Etzkowitz, 2003) and this may be a function of their commercialization policies that encourage entrepreneurship (Etzkowitz et al. 2000; Goldfarb and Henrekson, 2003).

Such discussions have always been conducted with reference to single university or multi-university studies. But very few studies have focused on the university policies that govern academic entrepreneurship and research commercialization with emphasis on demographic characteristics. Kenny and Goe (2004) observed that entrepreneurship is influenced by social relationships and institutions, and faculty is embedded in a nested structure of institutional layers each of which may influence their involvement in entrepreneurial activity. In this study, we attempt to emphasize on the faculty characteristics that influence their perceptions and interpretation of the policies that are concerned with entrepreneurial and commercialization activities. We seek to understand through a survey of faculty and researchers for insights on effect of faculty entrepreneurship and intellectual property policies on commercialization process. The specific objectives are as follows:

(1) Assess the relationships between the demographic characteristics of researchers and their perspectives on entrepreneurship and the commercialization of their inventions, (2) Analyze the relationship between faculty perception of university intellectual property and commercialization policies and their entrepreneurial orientation, and (3) Develop recommendations for enhancing commercialization effort at Kansas State University based on the results of the study.

Research Commercialization in Universities

Technology commercialization can be defined as the “transformation of knowledge into products and services with practical application and/or valuable use” (Amanor-Boadu, 2006).

Technology commercialization may be viewed differently from a government or private sector perspective (Kremic, 2003). From the government perspective, technology commercialization is critical for enhancing economic development and ensuring the competitiveness of the domestic economy. Companies, on the other hand view technology commercialization as a necessity for keeping their own competitiveness and their ability to create value for their shareholders.

Slaughter and Leslie (1997) in their study of higher education and growing interest in entrepreneurial orientation found that research universities challenged with reductions in traditional sources of funding such as federal and state grants have sought to reduce dependencies on these sources by increasing their involvement in commercial activity and universities are able to obtain greater control over these resources.

Commercialization Paths

Technology commercialization is a detailed process involving several factors like time, number of parties, payment requirements, and information exchange, sale of intellectual property or services or equipment. Universities with technology commercialization interests have policies guiding research commercialization activities. Discussed here are various commercialization

paths typically followed by U.S. research institutions: (a) *Academic Entrepreneurship* lets the inventor take a more active part in the commercialization process by spinning off a company that uses the invention. (b) *Licensing* is a contract type option where the parties come together on mutually agreed clauses for the exchange of the product or process technology for a set monetary value. Licenses may be exclusive and non-exclusive. Exclusive licenses limit the use of license to only one party in the agreement or to a location. More than one party is a beneficiary in a non-exclusive license. (c) *Joint ventures* are partnerships formed by the university and another organization to commercialize the discovery or invention. A joint venture can involve university taking equity in the company where the IP would be used taking some other form of compensation. (d) The *Start-up* option involves a new company that is entirely based on the technology that is licensed or sold by the university and the company might be owned by the university and/or by the inventor(s). (e) The *Sale* option involves the university completely transferring ownership of the technology to the buyer for a selling price and relinquishing all rights to future benefits.

Kansas State University and Technology Commercialization

Kansas State University has been involved in technology commercialization for many years under the auspices of KSU Research Foundation (KSURF). Inventions at K-State are owned by the K-State Board of Regents. The Board's interest at K-State is overseen by KSURF, where the mandate is to protect, license, and commercialize research outcomes from K-State. While the protection of the intellectual property is done by Kansas State University Research Foundation, another organization National Institute for Strategic Technology Acquisition and Commercialization (NISTAC) takes care of the commercialization. NISTAC is a not-for-profit corporation contracted by KSURF to market and commercializes university technologies.

NISTAC (earlier known as Mid-America Commercialization Corporation, MACC) uses any of the commercialization paths discussed above to get technology to market. It would identify potential customers for the technology to be commercialized through any of various forms of commercialization means discussed above. NISTAC serves as the state's technology based economic development entity, and K-State. NISTAC's mission is to provide business incubation services, pre-seed capital and technology transfer support activities for entrepreneurs and to commercialize intellectual property emanating from K-State (Source: NISTAC, 2007). Not all disclosed inventions and discoveries are patentable or have any significant commercial potential. Under these circumstances, the university may waive its rights to the technology, at which point the technology or invention reverts to the inventor and the inventor is free to pursue the patenting and/or commercialization of the invention. In other words, Kansas Board of Regents intellectual property policy defines, "if the university decides that the invention does not warrant patenting, the inventor is free to patent it and in such case, the university does not relinquish any of the data obtained in the research project. However, if the university decides not to further the use of the invention, they shall assign all the rights to the inventor," this is again governed by the Conflict of Interest policy that requires proper disclosure of commercial interests if the inventor(s) desires to commercialize the invention.

AUTM conducts an annual survey of the licensing activity of its member institutions. AUTM annual survey report (2004) indicates that total number of licenses and options executions reported by respondents to the AUTM survey increased from about 1,230 to almost 4,800 between 1991 and 2004. The average number of executed licenses and options per respondent more than doubled from 11.3 to 24.2 over that period, growing at an average annual rate of about 5.3 percent over that period. The number of institutions responding to the survey

with income yielding licenses and options per institution increased from a little over 23 to about 58 between 1991 and 2004. But, comparatively the licenses and options yielding income have been stagnant over the period 1991-2004 for Kansas State University. This does not align with the average of other universities licensing, according to AUTM Survey, 2005. The AUTM 2002 Licensing Survey report tells that the total number of active licenses and options increased 13.7 percent when compared to 2001, while that of KSURF is below 10 percent.

Academic Entrepreneurship

Academic entrepreneurship is a form of commercializing technology from research universities. This model of entrepreneurship has become more prevalent in recent years as researchers or scientists are getting increasingly educated about the vast resources available to them to take the initiative in transforming their research in to a marketable product.

Entrepreneurship in the context of university commercialization process known as academic or faculty entrepreneurship is defined as an effort to generate revenue for themselves or for their universities through their involvement in commercial research activities. It has become one of the important features of the university academic culture (Fairweather, 1989 and Powers, 2003). Louis, et al. (1989) distinguished academic entrepreneurship into five types, mainly: engaging in large-scale science, earning supplemental income, gaining industry support for industry research, obtaining patents or generating trade secrets and commercialization by forming or holding equity in private companies based on researchers own invention. Toole and Czarnitzki (2005) showed that U.S. Small Business Innovation Research program as a policy is fostering academic entrepreneurship. They identified two characteristics that make the SBIR program attractive as an entrepreneurship policy: early-stage financing and researcher's participation in commercialization process. Louis, et al. (1989) examined academic entrepreneurship defining it

as an attempt to improve personal and professional profit and influence through the development and marketing of new research based product or process. They found that university policies and structures have little effect on academic entrepreneurship. Etzkowitz (1989) observed that among some faculty members, entrepreneurship and development of marketable research outcomes are a form of professional achievement as opposed to general perception among critics who say entrepreneurship is a way of renouncing the ethics of professorship.

Academic entrepreneurship results in faculty, researchers and students being more effective in the creation of research based ventures either individually or collectively. Doutriaux (1987) studied the growth and success of new business ventures created by university professors, technicians or students and contends that if a company is to be created then it should be independent from the university or if the venture capitalist or university seems to maximize their revenue out of the technology, then licensing is the best choice. Bird and Allen (1989) studied faculty entrepreneurship in the context of universities role in economic development, its support of entrepreneurial researchers and its role as an incubator and found that researchers chose consulting and contract R&D compared to investing their time in new venture creation.

Gender bias in entrepreneurship and patenting

Gender is an important issue because we have seen differences by gender in patenting, licensing and interest in entrepreneurship in universities. Whittington and Smith-Doerr (2005) examined gender disparities in patenting over a two decade period and argued that gender disparity in commercial activity varies by industry and that the difference between academic and industrial sectors is largely due to unequal opportunities to engage in such commercial activity rather than productivity differences between the sexes. Thursby and Thursby (2005) also assessed gender patterns on research and licensing activities of science and engineering faculty,

and discovered that women are less likely to disclose inventions even though there are no significant differences in their publication pattern.

There are several factors that encourage entrepreneurship. Some are institutional factors while the other being personal factors. A study conducted by Cromie (1987) found that non-economic motives tend to be more important to entrepreneur than economic motives. Three non-economic motives - autonomy, achievement and job dissatisfaction - dominated the economic motive of making money. Using a psychometric analysis, Cromie observed that there is a difference in motives between the sexes and contends that the reason for different motives might be due to social stratification rather than personal attributes.

Commercialization policies and motivations

Traditionally, universities are regarded as reliable sources of knowledge dissemination, rather than earning revenue from the sale and licensing of technologies (Vallance, 2001). Lately, this traditional understanding has changed to support wider objectives of achieving economic development through the use of university resources by promoting commercialization activities (Etzkowitz, 2003). Renault (2006) found that university incentive policies and ethical concerns had a negative effect on faculty productivity in technology commercialization efforts.

Owen-Smith and Powell (2001), using qualitative data on two university campuses found that faculty base their decisions to disclose on the personal and professional benefits of patenting, perceptions about benefits and cost of interacting with university administration and on the general university's policies guiding technology commercialization. Though motivations appear to be very important in encouraging faculty and researchers to involve in taking their inventions a step further in realizing the true benefits, but incentives that surround the research,

for example, rewards for publishing over patenting, benefits and costs associated with the involvement still remain unresolved.

Bird et al. (1993) surveyed science faculty at top R&D universities and entrepreneurship faculty at the Academy of Management to test how conflict of interest and values in faculty can delay, re-channel and deter commercial applications of research outcomes. They observed a change in faculty's status with the university with their involvement and development through commercial activities and only older faculty with less non-academic work are more inclined to a change against younger science faculty who have had less commercial experience.

Faculty Consulting

Faculty consulting in technology commercialization assumes significance as more and more faculty become involved in providing services to industry and individuals to advance various causes. They might be personal or professional, and these are constrained in a university system by conflict of interest and conflict of commitment policies. Also, consulting activities provide faculty with various resources to advance their research interests and help build a strong industry network to collaborate in research activities. Boyer and Lewis (1984) and Carter et al. (1986) found that consulting activities create an interface between academia and industry, arguing that such activities do not hinder academia in pursuing the primary objectives of the university: teaching, research and outreach.

Khamis and Mann (1994) viewed consulting as more beneficial and well aligned to the university policies. Marver and Patton (1976) used a large sample of college and university teachers from a national Survey of Higher Education. They argue that there is a negligible correlation between paid consulting and contact hours that might affect the quality of instruction or service to the university. They conclude that consulting is in the best interest of an institution,

stressing the fact that paid consulting may contribute to the professor's ability to teach more effectively in applied courses, regardless of discipline.

Our research focuses on the institutional policies that affect entrepreneurial and commercialization orientation of faculty, faculty expectation of services from university to advance commercialization efforts and develop recommendations in improving the effectiveness of commercialization efforts at K-State.

Data and methods

To achieve these objectives, we surveyed faculty and researchers at Kansas State University. With particular reference to the Kansas State University research, we used an electronic survey system, using the listserv of research faculty provided by the Office of the Provost. We simplify the process to facilitate participation, we structured the questionnaire so that individuals will self-classify and self-identify their research activities and their role in university commercialization initiatives. The number of respondents was only 198, suggesting a response rate of 16.2 percent based on the number of people invited to participate in the survey. The questionnaire employed in the survey comprised 41 questions divided into four segments: demographics, research, commercialization and entrepreneurship. The responses were analyzed using SAS statistical analysis software. We hypothesize that there are relationships between demographic characteristics and the entrepreneurial and commercialization orientation of respondents. We also study the institutional policies that affect the commercialization and entrepreneurial initiatives taken by researchers in the process of continuing their research and extension activities.

Survey and analysis

We formalize our discussion by developing a number of hypotheses about how the demographic characteristics can interact with each other. We tested the effect of demographic characteristics influence faculty entrepreneurship and university policies on entrepreneurship and research commercialization. Ginther (2001) in her research on gender discrimination in academia indicated that differences in income are attributable to unexplained gender disparities. There is a general belief that women are younger in academic field because they did not enter the academic profession early. This would imply that they would also have shorter lengths of service. But it is possible that women enter academia at an older age than their male counterparts. These perspectives warrant testing whether age and length of service are correlated by gender among faculty and researchers.

But, how are these variables related? For example, does the age and length of service determine the income distribution observed among the respondents? Similarly, do gender dynamics combine with income variables? We are particularly interested in gender effect on age and income, and also their understanding of entrepreneurial and commercialization issues. To answer these questions, we develop and test the following hypotheses:

Hypothesis 1: *Income, length of service and age: The income is a function of age and length of service. The older the respondent and the longer his or her length of service, the higher income will be.*

To test the hypothesis that respondent income (Y) is dependent on age (A) and length of service (T), we used the model presented in Equation 1:

$$Y_i = f(A_i, T_i) \quad \dots 1$$

The results support our hypothesis that income is positively influenced by both age and length of service. As expected the R² is 23% and F-value is 27.68. Thus, the model is itself significant, that the t-value on the intercept variable suggests that, indeed, there are other variables more

important in establishing the level of income than these two variables of interest. However, despite the parameter estimates of both age and length of service exhibiting a positive sign, the parameter estimate of age is not significant at the 5 percent level in the model. This implies that although we are unable to reject the hypothesis that age positively influence income, that influence is probably insignificant. In short, older faculty and researchers at Kansas State University do not necessarily make more money than younger faculty and researchers. On the other hand, length of service at Kansas State University definitely influences income.

Hypothesis 2: *Income and gender: The average income of female researchers is equal to the average income of male researchers.*

Our interest in gender-income relationship is primarily to provide us with information for later analysis as to the influence of gender and income on entrepreneurial orientation. Therefore, we adopt a simple approach, using a t-test of the difference between the mean incomes of the two groups (Equation 2):

$$\bar{Y}_F - \bar{Y}_M = 0 \quad \dots 2$$

The results indicated that the mean income for female faculty is \$66,778 and compared to \$78,636 for male faculty. The standard deviation (SD) of both variables is about \$20,200. The income difference between male and female is found to be significant at the 5 percent level of significance with a t-value of -3.42. This implies that the income of males in the sample was higher than that of females in the sample and the difference of about \$11,858 is statistically significant. Therefore, we are unable to accept our hypothesis that there is no difference between the genders when it comes to income.

Hypothesis 3: *Gender and length of service: The average income of female researchers is equal to the average length of service of male researchers.*

We used a t-test approach to test the difference between the mean service duration for its statistical significance.

$$\bar{T}_F - \bar{T}_M = 0 \quad \dots\dots 3$$

The mean length of service for females was 10.84 years compared to 13.8 years for males and their respective standard deviations were 10.7 and 11.63. The difference between the lengths of service for the two groups at the mean was almost three years and it was found to be statistically insignificant at the 5 percent level of significance.

Hypothesis 4: *Gender and age: There is no difference between the average age of female and male respondents in our sample. In other words, the average age of female researchers is equal to the average age of male researchers.*

Since males in the sample were determined to earn significantly more than females but their service duration was not statistically different, we were interested in determining if age could contribute to explaining the observations. This is what Hypothesis 4 sought to answer. We used a t-test approach to test the difference between the mean ages of respondents by gender for its statistical significance.

$$\Delta A = A_m - A_f = 0 \quad (\text{where, } A \text{ is the mean value of the variable}) \quad \dots\dots 4$$

The mean age for both male and female respondents was between 40 and 59 years. However, the females were slightly younger but the difference between the mean ages was not statistically significant at the 5 percent level.

Literature provided us with a general overview of the impact of institutional policies that affect entrepreneurial orientation and research commercialization interests among faculty. These policies are significant in the university context in that they influence faculty perceptions on entrepreneurship. Since, there are different perceptions among faculty and researchers in regards to research commercialization, it is interesting to see if gender and age have any influence in

understanding these policies. Rosa and Dawson (2006), discuss gender and commercialization in university science, highlighting that female researchers are underrepresented in the commercialization process. The female faculty respondents in their study have indicated that they lack commercial skills and knowledge of commercialization compared to male faculty.

Hypothesis 5: *Gender and understanding of commercialization policies: There is no difference between male and female faculty and researchers regarding their understanding of the institution's commercialization policies. This hypothesis is based on the assumption that there is no difference between male and female faculty and researchers in their entrepreneurial orientation.*

We used a t-test method to test if there were differences between male and female faculty and researchers regarding their understanding of the commercialization policies of the institution. The results indicated that while there was no statistical difference between male and female researchers and faculty in their understanding of the issues (the mean Likert-scale measure was below 3.0 in both cases), there were statistically significant differences between them with respect to their understanding of ownership rights and distribution of rewards at the 5 percent level. Males had a slightly better understanding of these policies than their female counterparts at the mean. The foregoing results were true in all cases under equal and unequal variance assumptions with the exception of intellectual property protection where there was significant difference under the unequal variance assumption.

Hypothesis 6: *Age and understanding of commercialization policies: Younger faculty and researchers have a better understanding of the commercialization policies of the institution. This is based on the assumption that younger faculty and researchers have a greater interest in securing non-traditional sources of funds to facilitate their research and creative activities.*

We used a Pearson correlation method to test the assumption that age has an effect on researcher's understanding of commercialization policies. This is equivalent to running a simple linear regression of the level of understanding on age. The results show that we cannot accept our hypothesis that age affects understanding of commercialization policies because the

correlation coefficient (r) was no significant in all cases at the 5 percent level. Therefore, efforts to enhance understanding of commercialization policies must be structured to be independent of the age of the researcher or faculty member.

Faculty and researchers have expectations from the institution in helping them advance their commercialization efforts (table 1). The mean rating of below 3.0 for financial help, management expertise and sale of invention are considered having low importance for researchers from their institution. While a mean rating of 3 and above for other roles shows their importance for respondents and the need for university administration to reach out to the faculty in addressing their needs. Faculty want more help in securing IPs (intellectual property), assess the commercial value of IP and finding a suitable partner in the industry to promote their invention. It also implies that faculty networking ability with the industry must be enhanced to better market the discoveries.

Table 1: Institutions role in commercialization efforts

Institution role in commercialization	Response %					Mean Rating
	5 Important Role	4 Somewhat Important	3 Neither/nor	2 Less Important	1 No Role	
<i>Find industry partners</i>	27.6	22.8	22.8	9.7	17.2	3.33
<i>Pay for Patents/IP</i>	32.9	26.7	15.8	8.2	16.4	3.51
<i>Spin-off companies</i>	22.9	16.0	26.4	11.1	23.6	3.03
<i>Negotiate contracts for researcher</i>	21.7	23.1	27.3	9.1	18.9	3.19
<i>Help develop a business plan</i>	23.9	23.9	21.0	10.9	20.3	3.27
<i>Help in Financing</i>	18.1	16.0	23.6	16.7	25.7	2.84
<i>Management Help for Researcher</i>	16.1	17.5	23.8	17.5	25.2	2.81
<i>License invention to researcher</i>	24.1	24.1	27.6	6.2	17.9	3.30
<i>Help determine commercial viability</i>	22.9	25.0	25.0	11.1	16.0	3.27
<i>Help with market development</i>	19.0	19.7	26.1	16.2	19.0	3.03
<i>Negotiate licensing agreements</i>	22.4	27.3	24.5	9.1	16.8	3.29
<i>Sell the invention</i>	17.5	21.0	24.5	10.5	26.6	2.92

In our survey, about 43 percent of respondents were unwilling to invest their personal finances and 63 percent are unwilling to resign from their current position to fully pursue the commercialization of their invention or discovery, but the percentage of respondents willing to take initiative in commercializing their current research is little above 23 percent and this we deem is low. This risk averse approach of respondents is obvious from those who are reluctant to give up their current academic positions and to invest their own personal resources.

Faculty are involved with organizations in different capacities that depends on the nature of service sought from them, our respondents were given a choice to select their capacity in the organization they have been involved with over the last two years. Of the total 192 responses who selected multiple options, 5 percent have said they were “Investor,” 8 percent said they were a “Manager,” 14 percent indicated they were a “Mentor,” 15 percent were in “Other capacity,” and about 17 percent have said they were “Director.”

There has been a long history of faculty involvement with different type of institutions for consulting services. Some of them have been in corporations where they work on industry-university research collaborations; with some being the government institutions sponsored research like National Science Foundation, National Institutes of Health, federal research laboratories and so on. Outreach activities of faculty are an important part of consulting services and faculty at K-State did express similar opinion. Of those who responded, about 9 percent of them said they are involved with “*large organization*,” 13 percent are involved with “*Out-of-State*” organizations, around 16 percent were with “*In-State*”, 18 percent were with “*For-Profit*,” about 20 percent have been involved with “*Small organizations*,” and whereas 25 percent were involved with “*Not-for-Profit*.”

Also, among the respondents who indicated they are likely to increase their involvement with organizations they have worked within the next two years, almost 32 percent have indicated that their involvement would see an “*increasing trend*”, while 18 percent have indicated of a “*decreasing trend*” and 50 percent have indicated of “*no change*” in their present involvement. Of the 32 percent respondents who see an increasing trend in involving with various organizations, about 78 percent are males and 22 percent are females.

Conclusion

The overall objective of this research was to assess faculty and researchers’ understanding of entrepreneurial and commercialization issues and the significance of their characteristics in explaining their orientation. There is a very low knowledge, awareness and understanding. To accelerate entrepreneurship among K-State researchers and faculty, there is an urgent need to address this barrier. We also found that faculty and researchers understanding of the commercialization policies were independent of their gender (though males had slightly better understand than their female counterparts) and age. Though there are less observable differences in the demographics, it is clear that perceptions about commercialization are independent of gender, age and length of service in the university. It is interesting to note that with the exception of income, gender was not a differentiating factor among our respondents. Even the length of service was found to be insignificant among the demographics. Therefore, any efforts to enhance understanding of commercialization policies must be structured to be independent of gender and age.

Also, about a quarter of the respondents implied that they would like help from the institution in finding business partners, licensing inventions to researchers, and launching spin-off companies. Faculty indicated they would like to increase consulting activities and university policies seem to

have constrained faculty expectations in the growth of consulting services. Also, a higher percentage of respondents indicated they would like to be associated with companies and would be willing to serve as directors, mentors, advisors or managers of a business.

Faculty and researchers identified several constraints that hinder their entrepreneurial and commercialization behavior and indicated removal of these constraints would help them achieve a greater success in research commercialization efforts. Lack of time, knowledge of entrepreneurship, and understanding of university intellectual property policies are also seen as constraints by faculty, but they also indicated institutional factors such as: lack of motivation and support from university; conflict of interest and burdening academic responsibilities; as major constraints. Our conclusion points to the fact that effective educational programs that address each of these issues would definitely help increase awareness among faculty and researchers about university academic entrepreneurship and commercialization intellectual property policies.

University policies on commercialization and entrepreneurship are important factors in faculty decisions to become entrepreneurs and pursue commercialization of their discoveries. As a result if K-State wants to increase its commercialization outcomes, it must pay attention to its policies and how they affect faculty and researchers. As noted in the K-State comparison with AUTM members, K-State performance in this regard is below average. Therefore, we recommend that if the university is going to address this below-average performance, understanding the relation between entrepreneurship policies and faculty behavior is important. Faculty is not interested in resigning academic positions to start their own companies. This would suggest that the university must encourage faculty to continue research efforts, while surrounding them with the necessary management and business know-how and talent to move

inventions and discoveries formed. We make the point on the fact that KSURF is under staffed in comparison to other institutions that are very successful in commercialization efforts.

This work focuses entirely on K-State and compares our results with the literature. It would be interesting to compare K-State to other research universities of like size and research efforts. A multi-university study including Kansas State University would help benchmark performance and also help in identifying the improvements needed in current university policies and provisions. Lack of comparison with similar universities in our analysis might restrict our results for comparison purposes and can be considered one of the limitations. Comparing individual policy issues among universities would lead to greater understanding of the root factors of success in research commercialization. Our research did not address this.

Our study does not attempt to quantify the success of entrepreneurial and commercialization opportunities available, but future studies focusing on this aspect would be of great interest.

The foregoing suggests the need for educational and professional training programs to alter the current, mostly negative perceptions about commercialization in the university community and provide faculty assistance in commercialization efforts. Until such a shift occurs in perception, it will be difficult for Kansas State University to attain the growth rate in commercialization that has been observed in other institutions around the country.

References

Amanor-Boadu, V. (2006) AMI BioScience Commercialization report.

Association of University Technology Managers (AUTM), Annual Survey Reports for US Universities, 1991-2005.

Bird, B. J., D. J. Hayward, and D.N. Allen. "Conflict in the commercialization of knowledge: perspectives from science and entrepreneurship." *Entrepreneurship Theory and Practice* 17(Summer 1993):57-77.

- Bird, B. J., and D. N. Allen. "Faculty entrepreneurship in Research University Environments." *Journal of Higher Education* 60(1989):583-596.
- Boyer, C.M., and D.R. Lewis. "Faculty Consulting: Responsibility or Promiscuity." *The Journal of Higher Education* 55(1984):637-659.
- Carter, R.L., R.L. Scheaffer, and R.G. Marks. "The Role of Consulting Units in Statistics Departments." *The American Statistician* 40(1986):260-264.
- Cromie, S. "Motivations of aspiring male and female entrepreneurs." *Journal of Occupational Behavior* 8(1987):251-261.
- DOUTRIAUX, JÉRÔME. "Growth Pattern of Academic Entrepreneurial Firms." *Journal of Business Venturing* 2(1987): 285-297.
- Etzkowitz, H. "Entrepreneurial Science in the Academy: A Case of the Transformation of Norms." *Social Problems* 36(1989):14-29.
- _____. "Research groups as 'quasi-firms': the invention of university entrepreneurship." *Research Policy* 32(2003):109-121.
- Etzkowitz, H., A. Wester, C. Gerbhard, and B. Terra. "The future of the university and university of the future: evolution of the Ivory Tower to Entrepreneurial Paradigm." *Research Policy* 29(2000):313-330.
- Fairweather, J. "Academic research and instruction: The industrial connection." *Journal of Higher Education* 60(1989): 388-407.
- Ginther, D. K. "Does Science Discriminate Against Women? Evidence from Academia, 1973-1997." Working Paper Series 2001-02, Federal Reserve Bank of Atlanta, Social Science Research Network.
- Goldfarb, B., and M. Henrekson. "Bottom-up versus top-down policies towards the commercialization of university intellectual property." *Research Policy* 33(2003):639-658.
- Kansas State University Research Foundation (KSURF), 2005. Internet site: <http://www.k-state.edu/tech.transfer/>
- Kenney, M. and W.R. Goe. "The role of social Embeddedness in professorial entrepreneurship: a comparison of electrical engineering and computer science at UC Berkeley and Stanford." *Research Policy* 33(2004):691-707.
- Khamis, H.J., and B.L. Mann. "Outreach at a University Statistical Consulting Center." *The American Statistician* 48(1994):204-207.

- Kremic, T. "Technology Transfer: A Contextual Approach." *Journal of Technology Transfer* 28(2003):149-158.
- Louis, S.K., D. Blumenthal, M.E. Gluck, and M.A. Stoto. "Entrepreneurs in Academe: A Exploration of Behaviors among Life Scientists." *Administrative Science Quarterly* 34(1989): 110-131.
- Marver, J.D., and C.V. Patton. "The Correlates of Consultation: American Academics in "The Real World"." *Higher Education* 5(1976):319-335.
- National Institute for Strategic Technology Acquisition and Commercialization (NISTAC) Report on Start-ups, 2007.
- Owen-Smith, J. and W. Powell. "To Patent or Not to Patent; Faculty Decisions and Institutional Success at Technology Transfer." *Journal of Technology Transfer* 26(2001):99– 114.
- Powers, J. B. Commercializing academic research: Resource effects on performance of university technology transfer. *The Journal of Higher Education* 74(2003):26–50.
- Renault, C. S. "Academic Capitalism and University Incentives for Faculty Entrepreneurship" *Journal of Technology Transfer* 31(2006):227-239.
- Rosa, P., and A. Dawson. "Gender and the commercialization of university science: academic founders of spinout companies." *Entrepreneurship and Regional Development* 18(July, 2006):341-366.
- Slaughter, S., and Leslie, L.L. *Academic Capitalism – Politics, policies, and the entrepreneurial university*. Baltimore: The John-Hopkins University Press, 1997.
- Thursby, J.G., and M.C. Thursby. "Gender Patterns of Research and Licensing Activity of Science and Engineering Faculty." *Journal of Technology Transfer* 30(2005):343-353.
- Toole, A.A., and D. Czarnitzki. Biomedical Academic Entrepreneurship through the SBIR Program. Working paper, National Bureau of Economic Research, June, 2005.
- Vallance, P. "Biotechnology and new companies arising from academia." *The Lancet* 358(2001):1804-1806.
- Whittington, K.B., and L. Smith-Doerr. "Gender and Commercial Science: Women's Patenting in Life Sciences." *Journal of Technology Transfer* 30(2005):355-370.