



RESEARCH NOTE

REVISED A Case Study of the Impediments to the Commercialization of Research at the University of Kentucky [version 2; peer review: 2 approved, 1 approved with reservations]

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Abstract

The commercialization of university-based research occurs to varying degrees between academic institutions. Previous studies have found that multiple barriers can impede the effectiveness and efficiency by which academic research is commercialized. This case study was designed to better understand the impediments to research commercialization at the University of Kentucky via a survey and interview with three successful academic entrepreneurs. The study also garnered insight from the individuals as to how the commercialization process could be improved. Issues with commercialization infrastructure; a lack of emphasis, at the university level, on the importance of research commercialization; a void in an entrepreneurial culture on campus; inhibitory commercialization policies; and a lack of business and commercialization knowledge among faculty were highlighted as the most significant barriers. The research subjects also suggested that commercialization activity may generally increase if a number of factors were mitigated. Such insight can be communicated to the administrative leadership of the commercialization process at the University of Kentucky. Long term, improving university-based research commercialization will allow academic researchers to be more active and successful entrepreneurs such that intellectual property will progress more freely to the marketplace for the benefit of inventors, universities and society.

Keywords

Research commercialization, entrepreneurship, intellectual property, technology transfer, disclosures, patents, license, start-ups

Open Peer Review

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	1	2	3
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(revision)	?	✓	✓
04 Aug 2015	report	report	report
	↑	↑	↑
version 1			
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	report	report	report

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Any reports and responses or comments on the article can be found at the end of the article.

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REVISED Amendments from Version 1

In response to the reviewers' comments, we have made several changes of which the most substantial are that we have clarified the overall intent of the study, increased the sample size and we have added a description of the study's limitations. We have also responded to each reviewers' report below.

See referee reports

Introduction

Research is a vital component of the mission of universities, and indeed academic institutions conduct a substantial volume of research that is funded by government, industry and philanthropic agencies. Development or the commercialization of research should also be a key component of the research mission such that novel ideas, techniques and products can enter the marketplace for the benefit of a variety of stakeholders including inventors, universities and society. In order to facilitate academic-based commercialization, legislation, such as the Bayh-Dole Act, provides universities the legal framework for commercializing the research that is developed within university settings^{1,2}.

In a commercialization survey conducted by the Association of University Technology Managers (AUTM), in 2013, United States-based institutions generated over 24,000 disclosures, obtained over 5,000 new patents, executed over 5,000 licensing agreements, formed over 800 start-up companies and generated \$2.75 billion in license income³. Despite this overall success, academic researchers experience many issues that obstruct the commercialization

of research within higher education settings. Previous studies at academic institutions have documented challenges to the commercialization process that include, but are not limited to: risk aversion; constraints on faculty time; lack of financial support; policy/regulation barriers; infrastructure insufficiencies; lack of a common understanding of the value of research commercialization; lack of entrepreneurial thinking among faculty; and lack of interaction and collaboration between universities and industry⁴⁻¹⁰. A previous study at the University of Kentucky found that expense, time constraints, insufficient infrastructure and lack of industry partnerships were the most common factors experienced by cancer researchers that impede research commercialization¹¹. Ultimately, challenges to the effective and efficient commercialization of research inhibits obtaining the maximum benefit of university research in that such barriers can prevent university-based innovation from progressing to the marketplace for the benefit of inventors, universities and society.

The University of Kentucky commercializes its research through the Intellectual Property Development and Technology Transfer Office, a unit of the Office of the Vice President for Research. Through this office, the university's research commercialization activities are historically modest compared to its benchmark institutions. The university currently ranks last among its benchmark institutions in regard to several commercialization metrics including in staffing, invention disclosures, patent applications and license/options executed (Table 1). And, growth in commercialization activity has been relatively flat from 2010–2013 with the exception of a recent increase in license income (Table 2). These data could suggest that the University of Kentucky may experience additional commercialization barriers as compared to its benchmark institutions and/or a higher magnitude of common barriers among institutions.

Table 1. University of Kentucky research commercialization metrics versus select benchmark institutions (2013)*.

Name of Institution	Research Expenditures	Licensing FTE	Invention Disclosures	Patent Applications	Patents Issued	Licenses and Options Executed	Start-ups	License Income Received
Michigan State University	\$515,707,000	5.50	122	49	46	33	1	\$3,302,322
Ohio State University	\$967,306,055	9.00	384	155	62	50	10	\$2,105,127
University of Arizona	\$629,466,000	8.50	144	76	27	48	3	\$926,023
University of Florida	\$544,936,847	13.50	335	152	107	140	16	\$28,067,988
University of Iowa	\$435,377,000	6.00	96	53	24	29	6	\$1,205,342
University of Kentucky	\$239,715,000	2.00	58	17	30	9	3	\$4,800,000
University of Michigan	\$1,328,721,165	9.00	412	148	128	108	9	\$14,464,565
University of Minnesota	\$882,022,000	18.00	331	148	64	91	14	\$38,030,470
University of North Carolina, Chapel Hill	\$777,976,677	6.00	138	72	25	56	14	\$3,783,545
University of Wisconsin-Madison	\$1,123,501,000	18.00	386	167	157	63	7	\$94,170,000

*Data obtained from the fiscal year 2013 AUTM report.

Table 2. University of Kentucky research commercialization activity, 2010–2013*.

Commercialization Activity	2010	2011	2012	2013
Disclosures	57	59	83	58
Patent Applications	28	22	12	17
Patents Issued	28	26	29	30
Licenses/Options Executed	9	8	9	9
Start-ups	6	7	6	3
License Income	\$2,161,743	\$1,544,664	\$1,628,264	\$4,800,000

*Data obtained from the fiscal year 2010–2013 AUTM reports.

The study herein was designed as a supplement to the previous study at the University of Kentucky¹¹ and focused on obtaining a more detailed understanding of the impediments to commercializing research at the university from the perspective of three faculty members that have been successful in the continuum of commercialization through successfully obtaining patents, licensing intellectual property and forming start-up companies. The rationale for conducting this supplemental study with only successful academic entrepreneurs was that we believed that more focused and individualized conversations with such entrepreneurs could provide more insight into the commercialization process versus conducting the study with individuals that have had more limited or no experience in commercializing research.

Methods

The study herein is a supplement to and modeled closely after a similar, larger scale study conducted at the University of Kentucky specifically among cancer researchers¹¹. The methodology and design of the study was qualitative in nature and was based on two modules: an online survey (included as [Supplementary materials S1](#)) followed by a face-to-face interview. It is important to note that the prior study¹¹ did not include a face-to-face interview and was conducted with faculty that had both successfully commercialized their research and those that had not. It is also noteworthy that the respondents for this supplemental work span different research categories as defined in [Table 4](#). The purpose of this supplemental research was to obtain more detailed information, primarily through the face-to-face interview, on the impediments to the commercialization of research at the University of Kentucky.

The selection criteria for inclusion in the study was that the selected participants must be faculty members, have active research programs and be successful academic entrepreneurs based on having obtained patents, licensed intellectual property and created start-up companies. The research subjects for this study were identified through searches of publically available databases containing information on the selection criteria. For module one, data were collected and managed using the [Research Electronic Data Capture \(REDCap\)](#) tool. REDCap is a secure, Internet-based study-support

application¹². Module two data were recorded in written format during the face-to-face interview.

There are several limitations associated with this study. As a limited case study designed as a supplement to prior research¹¹, the results may not be translatable to other situations or research questions beyond that addressed in the original study¹¹, and the opinions of the three respondents may not be representative of all the stakeholders involved in the commercialization landscape at the University of Kentucky or elsewhere. Thus, the findings may not be generalizable to all faculty either at the University of Kentucky or at other universities, and the findings may or may not be capable of being generalized to other research areas. Further, as a cross-sectional study, the barriers experienced by the participants outside of the data collection window may not have been captured. Subject selection bias, which could lead to data and outcome bias, may also exist. Lastly, the study was designed to identify general challenges, thus more specific challenges were likely not captured by this analysis. Despite these limitations, the data obtained from this study, especially from the face-to-face interviews, provide additional supplemental information that enhances the findings of the previous study¹¹. Thus, this supplemental work provides more detailed information that can be presented to the administrative leadership of the commercialization process at the University of Kentucky.

This study was determined to not require review by the University of Kentucky Institutional Review Board. The research subjects consented to participate in the study electronically via engagement with the online survey and chose to participate in both modules of the study. The participants chose to remain anonymous beyond interaction with the investigators involved in the study.

Results

Professional productivity and commercialization perspective

The first series of survey questions, summarized in [Table 3](#), aimed to assess the subjects' category of research, professional productivity and their perspective on research commercialization. Respondent 1 classified his research as "translational;" he feels satisfied with his

Table 3. Professional productivity and commercialization perspective.

Question	Respondent 1	Respondent 2	Respondent 3
Which category best describes your research?	Translational	Basic	Basic/Translational
Do you feel that your research results are sufficiently utilized through the generation of publications, grants, and other forms of professional productivity?	Yes	No	Yes
Do you intend to commercialize your research in the future?	Yes	Yes	No
Do you think research commercialization is important to promote within an academic setting?	Yes	Yes	Yes
Do you think the University of Kentucky places an emphasis on academic research commercialization to faculty?	No	No	No
Do you think your research field places an emphasis on academic research commercialization?	Yes	No	Yes

Table 4. Impediments to research commercialization.

Potential Barrier	Respondent 1	Respondent 2	Respondent 3
There are no barriers to commercializing research at the University of Kentucky	No	No	No
There is unwanted risk associated with commercialization	Yes	No	Yes
I lack the expendable time	No	No	Yes
There is excessive expense	No	No	Yes
There is a lack of investors	Yes	No	Yes
There is a lack of infrastructure including facilities and staff to help in the commercialization process	Yes	Yes	Yes
Unsupportive University policies, procedures and/or regulations	Yes	No	Yes
Unsupportive federal policies, procedures and/or regulations	Yes	No	No
There is a lack of industry partners	No	No	Yes
Limited or no commercial application of my research exists	No	No	No
There is a lack of importance to academia	No	Yes	No
There is a lack of importance to my field	No	No	No
There is a lack of benefit to society	No	No	No
I have no interest in commercialization	No	No	No
Other barriers not listed	Yes	Yes	No

level of professional productivity in terms of publishing research manuscripts, obtaining grant funding and other means of academic productivity; and he indicated that he intends to commercialize additional research in the future. Despite believing that research commercialization is important in the academic setting and that his research field values such work, he feels that the University of Kentucky places little emphasis on and thus does not greatly value research commercialization. Respondent 2 classified his research as “basic;” he feels that his research is underutilized; and he intends to continue commercializing his work. Further, respondent 2 believes commercialization is important in an academic setting, yet the University of Kentucky does not emphasize such activity and he believes that his research field does not place an emphasis on commercialization. Respondent 3 classified her research as

“basic/translational;” she is satisfied with her level of professional productivity; and, interestingly, despite having developed intellectual property and starting a company, she indicated that she may not pursue the commercialization of her research again in the future. Similar to respondent 1, respondent 3 also feels that research commercialization is important in the academic setting and that her research field values such activity, but that the University of Kentucky does not value research commercialization.

Impediments to research commercialization

The second set of survey questions, summarized in Table 4, addressed the research subjects’ perceived impediments to commercializing research. Respondent 1 believes that risk, lack of investors, commercialization infrastructure, unsupportive university and

federal policies, and “other barriers not listed” prohibit his efforts to effectively and efficiently commercialize research. Respondent 2 feels that commercialization infrastructure, lack of importance to academia (i.e., lack of emphasis placed on commercialization by academia), and “other barriers not listed” are the impediments that inhibit his commercialization efforts. The barriers identified by respondent 3 include the presence of risk, lack of time, expense, lack of investors, insufficient infrastructure, unsupportive university policies, and lack of industry partners.

In the face-to-face interview, respondent 1 indicated that the “other barriers” included major prohibiting factors such as the lack of university support/infrastructure in areas of market analysis, grant development, and navigating legal matters including conflict of interest and intellectual property ownership issues. Of these “other” items, we had anticipated that such factors could be captured under the commercialization infrastructure and/or policy categories of answer choices in the survey. Ultimately, respondent 1 indicated that infrastructure issues are the most significant factors that impede research commercialization at the University of Kentucky. The subject also discussed how some of these barriers are more challenging and more difficult to overcome and that he felt that the barriers he has encountered are different at other universities. Respondent 2 indicated three major factors that negatively impact commercialization at the university and those are: 1) a lack of an entrepreneurial culture at the university level which has eroded the interest faculty have in pursuing the commercialization of their work; 2) inhibitory commercialization policies and an unwillingness for those policies to be malleable to individual commercialization situations/circumstances; and 3) insufficient and inhibitory commercialization infrastructure. Respondent 3 described the biggest barriers to academic research commercialization as faculty’s lack of business knowledge and commercialization background. Interestingly, she considers it more the responsibility of each faculty member to drive any potential commercial aspect of their work rather than rely on resources and support that may or may not exist at the university level. Since the majority of faculty do not receive any training in business or

commercialization areas, she feels that this hampers the overall commercialization activity on university campuses.

Similar to the previous study among cancer researchers¹¹, these data suggest that faculty members experience multiple barriers in the commercialization process at the University of Kentucky. Additionally, in comparison with previous studies^{4–11}, the data may suggest that not all barriers are consistent or common between individual faculty members (for example, expense, time constraints, insufficient infrastructure, and lack of industry partnerships were the most common barriers experienced among University of Kentucky cancer researchers¹¹). And, some barriers appear to be more prohibitive than others.

Factors that could enhance research commercialization

The final set of questions, summarized in Table 5, were meant to determine which impediments would need to be overcome in order to increase faculty participation in research commercialization. Respondent 1 indicated that the barriers in the commercialization process do not deter him from attempting to commercialize his research, however, he believes that reducing/mitigating all the potential barriers surveyed, other than addressing royalty pay to inventors, would enhance research commercialization activity at the University of Kentucky. The subject also indicated that he would utilize outside (off campus) commercialization resources to lower the barriers he faces in order to improve his commercialization efforts. Respondent 2 would also use off campus resources to enhance his commercialization efforts and he believes that providing faculty protected time for commercialization efforts, providing additional and more helpful information to faculty about how to commercialize research, increasing the financial support available to entrepreneurial faculty, enhancing the commercialization infrastructure on campus, and increasing the emphasis placed on research commercialization would improve the commercialization activity at the university. Similar to respondents 1 and 2, respondent 3 would use off campus resources to commercialize her research, and she feels that providing information on how to commercialize,

Table 5. Factors that could enhance research commercialization.

Factor	Respondent 1	Respondent 2	Respondent 3
Offering protected time specifically for commercialization activities	Yes	Yes	No
Increasing information on how to commercialize	Yes	Yes	Yes
Increasing financial support	Yes	Yes	Yes
Better and/or more infrastructure including facilities and staff to help in the commercialization process	Yes	Yes	Yes
Revising university policies, procedures and/or regulations	Yes	No	Yes
Revising federal policies, procedures and/or regulations	Yes	No	No
Increasing links to industry	Yes	No	Yes
Increasing emphasis placed by academia and/or my research field on the importance of research commercialization	Yes	Yes	No
Greater personal benefits including more royalty pay	No	No	No
Greater societal benefits	Yes	No	No
Nothing would help	No	No	No

providing financial support, improving commercialization infrastructure, revising university policies, and increasing links to industry would improve commercialization activity at the University of Kentucky.

These data are similar to the feelings reported by cancer researchers¹¹ in which respondents believe that mitigating many factors would presumably increase commercialization activity. Not all respondents, however, completely agree on all the factors that are important to address.

Conclusion

This case study investigated the mindset of three successful academic entrepreneurs at the University of Kentucky in relation to the status of the research commercialization process and in context with the university's general commercialization activity. The general state of the institution's commercialization activity is modest relative to its benchmark institutions and stagnant in growth over time. The research subjects identified several factors that generally impede research commercialization and the subjects agreed that mitigating many factors may increase commercialization activity. Infrastructure insufficiencies, a lack of an emphasis by the university on the importance of research commercialization, a low to non-existent entrepreneurial culture on campus, inhibitory policies, and a lack of business and commercialization knowledge among faculty were highlighted as the most significant barriers. While generally fitting with the impediments found at other universities and among cancer researchers at the University of Kentucky⁴⁻¹¹, the results suggest that not all barriers are common or consistent between faculty and that some impediments may be more prohibitive than others. It is likely that the barriers vary between and among disciplines and the barriers may further vary based on an individual's general experience with the commercialization process.

These data can be shared with the University of Kentucky's Intellectual Property Development and Technology Transfer Office and the Office of the Vice President for Research and used as a guide to make changes that will improve the research commercialization process. The research subjects' comments regarding commercialization infrastructure, a stagnant entrepreneurial culture, inhibitory commercialization policies, and faculty's lack of business/commercialization knowledge may be particularly important to address in order to enhance commercialization activity at the university. Additionally, similar work could be conducted at and among other institutions. For example, a survey similar to the one herein and that used in the prior study¹¹ could be incorporated into the yearly AUTM licensing survey in order to gauge, on a much broader scale, the impediments to academic research commercialization as well as to understand how other institutions are mitigating such impediments. Understanding how institutions that are highly successful in commercializing research mitigate barriers in the process would be greatly beneficial to institutions that have low to modest commercialization activity.

Author contributions

NLV and EM conceived and designed the study; conducted the study; analyzed the data; and wrote the paper. This research project was completed, in part, to fulfill the requirements of EM's Bachelor of Science degree in Agricultural Biotechnology.

Competing interests

The authors have no competing interests.

Grant information

The author(s) declared that no grants were involved in supporting this work.

Supplementary materials

[Supplementary materials S1.](#)

Research Commercialization Survey

[Click here to access the data.](#)

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Current Peer Review Status: ? ✓ ✓

Version 2

Reviewer Report 17 August 2015

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Scott Crick

Licensing Associate, Office of Technology Management, Washington University, St Louis, MO, USA

Overall, this version is definitely an improvement over V1. The major weakness I see remaining is the lack of specific suggestions for improving the technology transfer process. The most ubiquitous complaints seemed to be regarding the infrastructure, and the lack of appreciation of the importance and support for commercialization. First, it would be nice to define what is meant by the infrastructure. This term is fairly vague and could reasonably be viewed as fairly all-encompassing. A narrowing definition would be useful. For example, is the infrastructure referring specifically to the Tech Transfer Office, which would suggest the office is perhaps understaffed? Without more clearly defining the complaint, positing possible mitigating improvements becomes more difficult. In short, I am going to recommend approval of the article, but I think it would be improved by including specific suggestions for overcoming perceived barriers to tech transfer.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 13 August 2015

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Evan Facher

Enterprise Development, University of Pittsburgh, Pittsburgh, PA, USA

I would like to thank the authors for their specific responses to my initial comments and for

clarifying many of these concerns with substantial changes to the text of the submission that both clarify the purpose of the study and add to the data collected.

My initial review focused on three main areas for consideration by the authors:

1. Conclusions based on the survey/interview of a single academic entrepreneur;
2. Expansion of perspectives on reasons for innovations not being commercialized and;
3. Increase engagement with academic entrepreneurs on campus that have been both successful and unsuccessful with bringing their ideas to market.

With the new submission, I believe the authors have addressed my three suggested areas of focus. It is now much clearer to me that this work was a supplement to an initial study performed to understand commercialization on campus. Through edits to the manuscript this rationale/purpose is now understood as a follow-up rather than a total brand new analysis. As such, there was a certain methodology that was being continued from the initial work that clarified the "customers" they were focused on as being faculty members that have successfully commercialized research. The study also increased the number of individuals that were interviewed from a single individual to multiple on campus allowing for a broader set of perspectives than initially obtained. Further, the authors did add focus on the limitations with the study based on design and purpose allowing the reader to more clearly understand the approach.

In conclusion, I would approve publication of this new version of the manuscript. The only additional recommendation I would provide from a practical perspective is that when presenting these findings to the university administrators, the authors should also offer some solutions to the issues they have uncovered. Problem solving will be viewed more favorably than purely problem identifying.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 13 August 2015

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Jessica Silvaggi

UWM Research Foundation, Milwaukee, WI, USA

The goal of the authors was to document any impediments to the commercialization process at the University of Kentucky. The study was spurred by the findings that UK significantly underperforms when compared to peer institutions of similar size. A previous study was published

in 2013 regarding this same topic at UK for the commercialization of cancer research. In this study, similar surveys were conducted with 3 entrepreneurial respondents as opposed to a larger cohort of cancer researchers in the previous UK study.

The updated information from 2 more respondents is appreciated, but ideally it would be nice to have a larger group than 3. Getting information from those that had a positive and a negative experience is helpful to make changes to the system. If the ultimate goal is to provide this feedback to the UK TTO in order to institute changes, more details would be helpful. Some aspects that I think would benefit from further detail are the following:

1. Interviews of the actual TTO employees? What is keeping the University from making any changes?
2. Some background information on what other universities have done to rebrand their TTO. There have been many stories regarding offices doing an overhaul and rebranding and trying new things. Table 5 is a good start in figuring out some areas that need more improvement. A section that details what other offices have tried would be useful to people in technology transfer. The suggestions listed in table 5 are fairly standard practices that TTOs must consider. Can you include suggestions of how other universities have for instance increased links to industry or how they have offered more information to researchers teaching them how to commercialize? What are the policies or regulations that are restrictive at UK? Would utilizing more interns/students/post docs as staff help in bringing in more disclosures or provide more hands to evaluate inventions?

Overall the authors claim that the goal is to present this data as a guide to the UK TTO to make changes. It would be helpful to provide suggestions rather than telling them these results which they likely already know and realize are a problem. It will be more useful to also provide some options that have been tried by other universities rather than just pointing out the failures. With these additions I think the article would be much stronger and more useful to other TTO offices.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Version 1

Reviewer Report 01 July 2015

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Evan Facher

Enterprise Development, University of Pittsburgh, Pittsburgh, PA, USA

The study by Vanderford and Marcinkowski attempts to identify challenges to the commercialization of innovations discovered at their institute of higher learning, the University of Kentucky. The goal of this work is to improve the sluggish local climate for translation of discoveries by communicating the findings resulting from this effort back to administrative leadership with the hope that the identification of these impediments leads to real change. By deploying a survey and subsequent interviews the authors plan to generate learnings sufficient to form the basis of their recommendations.

Movement of research discoveries from academic institutes to the marketplace is important not only for these discoveries to have their societal impact but also to drive economic growth of a region. The juxtaposition of most new jobs created over the last two decades coming from startup companies and much innovation from academia serving as the impetus for these new entities hints at the regional criticality of a university being able to successfully translate its discoveries into products reaching the market.

While the Vanderford and Marcinkowski article has a solid thesis and very good intent, it is however limited (in this reviewers mind) by a handful of items. First, the conclusions the authors generate are based on the survey and interview of a single academic entrepreneur. The data achieved from this individual is certainly very valuable but it might not be reflective of the other individuals on campus that have had experiences with commercialization of university-based research. The challenges described by this individual on campus ring true of the commercialization issues found throughout other academic organizations; however due to the small sample size it is hard to draw solid conclusions for the University of Kentucky as a whole. As one of the aims of the study is to report findings back to the administration with the goal of impacting change, I would suggest that the senior leadership, while sympathetic to the challenges expressed by the authors, will not institute changes based on such a small set of data that may not accurately reflect the general experiences of its academic entrepreneurs in totality.

I would recommend that the authors attempt to increase the number of study subjects to enhance the power of their research. In addition to surveys/interviews with academics that have successfully commercialized their innovations on campus, I would strongly urge the authors to include a set of individuals that have had unsuccessful experiences as well. Learnings from this cohort might provide an additional set of data to further drive the goals of enhancing translation at their institute.

The second item I would suggest the authors to contemplate in their assessments is expanding their perspectives on reasons for an innovation not being commercialized. It seems as if the main focus of the surveys/interviews is on structural elements involved in the workflow for moving a university idea to commercialization. It is often that the main reason for the lack of translation has nothing to do with the internal processes for moving the opportunity forward but rather that the innovation never really addressed a true market need despite the solid academic research. As such, regardless of the view of commercialization risk, the number of investors, the supportiveness of university policies or facilities/staff to advance the process, the idea itself is not commercialized because it does not contain a value proposition for any outside entity to take hold of. It is imperative to identify a product-market fit for an innovation as not all concepts should

become companies and not all ideas impact the market. A strong technology translation capability cannot make up for an opportunity without a direct connection to an existing customer pain-point, which is only identified through a process of customer discovery outside of the university's walls.

Lastly, from a practical perspective, I would recommend that as part of the engagement with a larger set of academic entrepreneurs on campus (both successful and unsuccessful), the survey/interview deployed by the authors engage these individuals in soliciting programs, opportunities, efforts, and ideas to improve the existing stagnant innovation culture on campus. I believe by engaging these "customers" on campus in dialogue focused on solving the challenge, administrative support will be more easily achieved.

In conclusion, I believe the authors are on the right track and that their efforts have significant merit. I would urge them to continue their work, expand the sample size, examine a bit broader set of reasons why the problems exist and work with their respondents to improve the situation.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 04 Aug 2015

Nathan Vanderford, University of Kentucky, Lexington, USA

Dear Dr. Facher,

Thank you for your time and comments. Your critique has helped guide us through revising the article. We would like to directly respond to some of your comments. We would first like to clarify that this case study was designed and conducted as a supplement to the **prior study** looking at the barriers associated with cancer research commercialization at the University of Kentucky (we have made this clarification in the new version of the article). The prior study's conclusions were based solely on the responses to the survey as individual interviews were not conducted. Thus, the intent of the current study was to collect more specific, supplemental information through interviews with "successful" entrepreneurs. Given this intent and the study's supplemental nature, we have purposefully not incorporated new research questions into the current case study. We have, however, at your suggestion, expanded the sample size by two respondents and this generated a number of additional significant comments that are important to understand regarding the university's low commercialization rate. We agree with your assertions that additional reasons for low commercialization activity likely exist and that expanding our research questions and sample size to include a mix of stakeholders involved in the research commercialization process (including faculty that have been unsuccessful at commercializing their research and staff/administrators of the commercialization process, etc.) would aid in uncovering other issues. We would like to note, however, that expansion of this current work would change the intent (described above) and design of our study. Therefore, we have maintained the overall intent and design of the study other than adding the additional respondents. We believe that this design will allow us to bring some

additional closure to the **prior study**. Lastly, to offset additional concerns, we have included a description of the limitations of this case study in the methods sections.

In closing, we hope that you will review this revised version of the article in light of our changes based on your comments as well as those of the other two reviewers (we hope that you will read the other reviewers' comments as well as our response to those reviews) and in relation to its intended purpose of being a supplemental component to the **prior study** at the University of Kentucky.

Sincerely,
Nathan L. Vanderford and Elizabeth Marcinkowski

Competing Interests: No competing interests were disclosed.

Reviewer Report 17 June 2015

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Scott Crick

Licensing Associate, Office of Technology Management, Washington University, St Louis, MO, USA

This study attempted to identify potential impediments to commercialization of research at the University of Kentucky. The authors point out that, according to data from AUTM, the University of Kentucky ranks near the bottom in a number of key metrics of commercialization when compared to its benchmark institutions. The goal of the study was to identify barriers to commercialization. These findings will then be brought to administration in hopes of rectifying the problem.

I think there are several issues with this work that, if addressed properly, will greatly strengthen its impact and utility not only at UK but also at other university technology transfer organizations.

The first issue I have with the work is the inclusion of only a single faculty member with entrepreneurial experience. The rationale given was that that person could provide more insight into the process as a whole. Looking at the data referenced in Table 1, the most striking discrepancy between UK and benchmark institutions is the number of invention disclosures. When the data are normalized to the number of invention disclosures per institution, UK appears to be making good use of the inventions that are disclosed to them. It seems to me that one of the major issues at UK is simply getting inventors. While I agree that the entrepreneurial faculty member could have a lot of insight into issues after the first step, I wonder how much insight this person provided with regards to why people are not disclosing inventions. I am certain it would be possible to identify faculty that publicly disclosed potentially valuable assets without ever filing an invention disclosure, and I would suggest understanding those issues are 1) extremely important

for improving commercialization at UK, and 2) more easily addressable at an institutional level than some other potential barriers.

The second issue with relying on input from a single faculty member is that barriers are variable (as even mentioned in the article) not only between individuals, but between disciplines and sub-disciplines as well. Although the individual faculty member can identify barriers he/she has experienced, it would be disingenuous to suggest these barriers and the relative weight given to each of them is an accurate reflection of the system as a whole. A minor point....It would also be very helpful to know general field of research of the faculty member interviewed. "Translational" is very broad. Is he/she in pharma, biotech, medical devices, engineering...?

I have two recommendations to strengthen this article.

My first recommendation is that the authors include in the case study at least two other faculty members with technology commercialization experience (not necessarily on par with the initial interviewee). I would also suggest that these faculty be from distinct research areas and departments. Although still qualitative, it would be insightful to see if these people with different types of technology, different department makeup, and very likely different experiences and backgrounds still identify the same barriers.

My second recommendation is to limit the scope to barriers that are perceived after invention disclosure. It appears as though there is an issue at UK (which I should say is certainly not unique) that I suspect has to do with education of potential inventors such that a number of these people are not even considering that their technology might have commercialization potential. A follow-up study trying to tease apart this issue would be interesting and may have broader appeal.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 04 Aug 2015

Nathan Vanderford, University of Kentucky, Lexington, USA

Dear Dr. Crick,

We thank you for taking the time to review our case study. Your critique has helped shape our current version of the article. We would like to respond to some of your comments. First, per your suggestion, we have expanded our sample size by two respondents. This expansion lead to the collection of a significant amount of additional crucial comments that are important to understand about the issues related to the low commercialization activity at the University of Kentucky. Second, in regard to your question about the respondents' field of research, we understand your desire to have more information regarding the respondents' research areas, but we feel that for confidentiality purposes, we cannot be any more specific; given the small sample size of "successful" academic entrepreneurs at the University of Kentucky, reporting a respondent's specific research field could potentially

allow for the identification of the subject. Next, you made very insightful comments regarding the desire to better understand the issues involved in the university's low invention disclosure rate. We agree with your points and we would also like to address this issue. With that said, however, we would like to clarify that this case study was designed and conducted as a supplement to the **prior study** looking at the barriers associated with cancer research commercialization at the University of Kentucky; the sole intent of the current study was to collect more specific, supplemental information through interviews with the respondents (we have now explicitly stated this intent in the new version of the article). Given this intent and the study's supplemental nature, we have purposefully not incorporated new research questions into the current case study. We feel that expanding the current study would likely change its primary intent. We do hope to address additional research questions, including understanding issues related to the low disclosure rate, in future work. Lastly, to offset additional concerns, we have included a description of the limitations of this case study in the methods sections.

In closing, we hope that you will review this revised version of the article in light of our changes based on your comments as well as those of the other two reviewers (we hope that you will read the other reviewers' comments as well as our response to those reviews) and in relation to its intended purpose of being a supplemental component to the **prior study** at the University of Kentucky.

Sincerely,
Nathan L. Vanderford and Elizabeth Marcinkowski

Competing Interests: No competing interests were disclosed.

Reviewer Report 05 June 2015

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Jessica Silvaggi

UWM Research Foundation, Milwaukee, WI, USA

The goal of the authors was to document any impediments to the commercialization process at the University of Kentucky. The study was spurred by the findings that UK significantly underperforms when compared to peer institutions of similar size. A previous study was published in 2013 regarding this same topic at UK for the commercialization of cancer research. In this study, similar surveys were conducted with one single entrepreneurial respondent as opposed to a larger cohort of cancer researchers in the previous UK study.

They report that the major issue impeding commercialization, according to the respondent, is the

lack of appropriate infrastructure at the university. The results were apparently similar to those found in this 2013 paper. I found this topic to be of great interest in comparing the performance to schools of similar benchmarks. The results could be helpful to many institutions that are underperforming and looking to boost commercialization. The survey questions used could be useful for any institution to keep track of the satisfaction of the researchers in regard to commercialization of their technologies, and to assess the adequacy of the performance of the technology transfer office.

Major concerns/Revisions

1. While I think the survey questions used were reasonable, I have doubts about the validity of asking a single entrepreneur the survey questions. It comes across as if the same 2013 study was repeated, but with only one person. I don't feel that one person is a significant number for this type of paper to make conclusions with. N=1 doesn't seem to be a true scientific sampling. Unfortunately, if more respondents were utilized, then this paper would appear to be a repeat of the earlier study. Perhaps another angle would be to survey the staff at UK as to why they are underperforming. Asking the tech transfer professionals and other research administrators would also be informative and provide a different angle to the original survey of cancer researchers. Or perhaps a broader survey of other departments would be helpful, rather than only focusing on the cancer department.
2. I feel that several other angles could have also been explored in this paper to contrast or follow up on the work in the 2013 paper about UK. After the first study were any changes made based on the conclusions? Did the number of staff change? Did any of the infrastructure change at UK? Did UK do anything to increase the level of commercialization? There are many other interesting questions that could be explored rather than repeating the study over again with one participant.
3. If the university has not responded to the previous study in any fashion, I find that of great interest. Why hasn't the technology transfer office been expanded and further supported? Why is there no incentive by those in charge of this area to revamp the office? There has been a large push at many universities to further promote entrepreneurship in faculty and students and support commercialization. In some online information it states that in the past UK was pushing to be a top 20 university by 2020. I am curious to know why there has been no change in the recent years.

Minor Revisions

1. When comparing benchmarks, another important factor missing in the table is the amount of research dollars. There is a ratio of expected disclosures per millions of dollars of research which varies, but is quoted in several locations at 1 disclosure per \$1.5M-\$3M and 1 start-up company per ~\$100M. Knowing the amount of research dollars going into UK would help to show a lack of productivity with inventions at the university. This information should be available through AUTM if not through the technology transfer office directly. Based on some online information the research expenditures at UK appear to be in the hundreds of millions of dollars. Assuming ~\$400M in expenditures, one would expect about 130 disclosures. The UK website cites 84 disclosures in 2014.

Summary:

I feel that major revisions are necessary for this paper to add some new information and expand

the scope of the study. The results here do not seem to add onto those previously found but simply confirm the previous findings with the survey of one entrepreneurial researcher. A different sample of respondents would greatly enhance this paper such as asking researchers from all departments, or focusing on the staff involved in technology transfer, commercialization and entrepreneurship. Or perhaps if changes were made by the tech transfer office and these did not have an effect, this would be good to know for other offices. There appears to be something missing from this story. This paper would be of interest if revamped to add a new twist distinct from the 2013 paper.

I have read this submission. I believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 04 Aug 2015

Nathan Vanderford, University of Kentucky, Lexington, USA

Dear Dr. Silvaggi,

We greatly appreciate the time you dedicated to review our article. We found your comments very helpful as we revised the article. We are happy that you found this topic of interest and applicable to other institutions. Before reading the new version, we would like to address some of your comments and concerns. First, we appreciate your concerns regarding the "n-of-1" design of the study. As suggested by each reviewer, we have added two additional respondents to the study and this did indeed generate several additional important points regarding the issues related to the low commercialization activity at the University of Kentucky. Second, we appreciate your comments regarding how this work could be construed as a repeat of the **prior study**. We agree with your assertions that other issues are likely involved in the low commercialization activity at the university and we agree that surveying a mix of stakeholders involved in the research commercialization process could aid in uncovering other issues. However, we would like to clarify that this case study was, in fact, specifically designed and conducted as a supplement to the **prior work** looking at the barriers associated with cancer research commercialization at the University of Kentucky (we have made this clarification in the new version of the article). The prior study's conclusions were based solely on the responses to the survey and individual interviews were not conducted. The intent of the current study was to collect more specific, supplemental information through interviews. Given this intent and the study's supplemental nature, we have purposefully not incorporated new research questions into the current case study. We believe that future work would best address many of your comments which add additional research questions that would help understand other issues that may be connected to the low research commercialization activity. You have also made several important comments regarding whether the university has made any changes in the research commercialization process since the **2013 study**. In fact, few changes have

been made and that is one reason why it was important to conduct this case study; it was important to obtain specific comments from “successful” entrepreneurs so that these individuals could identify specific issues in the system. Finally, to offset additional concerns, we have included a description of the limitations of this case study in the methods sections. Per your minor point, we have now also added research expenditures to Table 1.

In closing, we hope that you will review this revised version of the article in light of our changes based on your comments as well as those of the other two reviewers (we hope that you will read the other reviewers’ comments as well as our response to those reviews) and in relation to its intended purpose of being a supplemental component to the **prior study** at the University of Kentucky.

Sincerely,
Nathan L. Vanderford and Elizabeth Marcinkowski

Competing Interests: No competing interests were disclosed.

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