ARC NETWORK
A STEM EQUITY BRAIN TRUST

The academic entrepreneurship of women faculty in STEM: A meta-synthesis
By Teresa Nelson

About the ARC Network

Funded by the National Science Foundation ADVANCE Program, Award HRD-1740860, the ADVANCE Resource and Coordination (ARC) Network seeks to achieve gender equity for faculty in higher education science, technology, engineering, and mathematics (STEM) disciplines. As the STEM equity brain trust, the ARC Network recognizes the achievements made so far while producing new perspectives, methods and interventions with an intersectional, intentional and inclusive lens. The leading advocate for women in STEM the Association for Women in Science (AWIS) serves as the backbone organization of the ARC Network.

About the Virtual Visiting Scholars

The Virtual Visiting Scholars (VVS) program provides a unique opportunity for select scholars across disciplines to pursue research meta-analysis, synthesis, and big data curation on topics crucial to STEM faculty equity. VVS analyze existing research and data, synthesizing different, sometimes competing, perspectives, frameworks, metrics, and outcomes to offer new insights and applications to the broader community.

About the Author

Dr. Teresa Nelson holds a PhD in strategic management and is currently a full professor of strategic management and entrepreneurship at Simmons University in Boston, USA. Her teaching and research center in the areas of creativity, innovation and entrepreneurship; strategic management; diversity and inclusion; governance and innovative organizational forms. Teresa is the Senior Director of Policy and Research for Astia, an investment fund and angel investor group for women high-growth entrepreneurs. She is also a Founder and Director of Research for The Impact Seat, a consultancy to business and nonprofits on the strategic aspects of diversity, inclusion, and equity. She served as a member of the National Women's Business Council during the Obama administration taking a particular interest in the federal SBIR program and its inclusion of women as grant PIs and IP owners. Nelson completed a year- long project in 2020 as a Research Director at the MIT Innovation Initiative to assess the activity of STEM faculty members as founders and directors of private high-growth businesses.

Executive Summary

A sequence of institution-building acts in the United States 1930-1980 set an infrastructure in place to facilitate the partnership of university faculty with government and private industry for the purpose of science invention and subsequent commercialization. Today *academic entrepreneurship* is increasingly a center of science invention with entire industries like the internet and biotechnology rooted in faculty ingenuity and accomplishment. Rising demand since the 1960s for STEM gender equity intersects and complicates this institutional success story. This meta-synthesis compiles research from multiple fields to present the state of knowledge on female faculty and gender, with an intersectionality concern, as regards participation in academic entrepreneurship in STEM in the United State 2000-mid-2020.

ARC NETWORK
A STEM EQUITY BRAIN TRUST

Research Summary

Research Question: What is the state of knowledge on women and gender, with an intersectionality lens, as regards faculty participation in academic entrepreneurship in STEM?

Statement of Research Problem: Academic entrepreneurship is the commercialization of the knowledge and research of college and university faculty members into products and services offered for sale through firms and markets in the private, nonprofit, and government sectors. Faculty commercialization of science and technology proceeds through activities such as the service of faculty members as founders, employees, advisors, and board members of private companies; product and/or prototype sales; and by the sale outright, or of rights to use, of patents and licenses for commercial development, for example.

Research generally across fields over the last 50 years has explored the under-representation of women in professional fields and activities in the U.S. and globally. For academia, despite significant gains in female attainment of PhDs in STEM, the sex of faculty members skews male; more in some fields than others (NAS 2019, AWIS 2019). Further, even for women in place in tenured and tenure-stream positions, their likelihood of being entrepreneurs has been shown to be lower, as compared to men, even at the U.S.'s most elite innovation universities (Nelson 2020, Hanes, Ku, Primiano, Arvin, 2018).

Research on gender – a normative social perception tied to expectations of what men can and should do, and what women can and should do (e.g., Nelson & Constantinidis 2017) has identified behavioral and systemic biases that disadvantage women in attaining recognition, resources, support, and advancement in their careers. These biases extend to female faculty participation in academic entrepreneurship (Abreu & Grinevich 2017, Grimaldi, et al. 2011), an emerging concern and expectation of faculty professional attention at research intensive universities (Audretsch, et al. 2016, National Research Council 2010). Efforts to challenge and restructure such relationships from within academe are noteworthy (e.g., Chesler, et al. 2010, MIT 1999) and they extend to identifying and challenging gendered patterns of resource allocation for research (e.g., students and post-docs, space, equipment, course releases, release from administrative duties) and access to knowledge and networks (e.g, social capital building, training on the patenting process, options for dissertation design) – all elements that when gendered to disadvantage female faculty, can be associated with a "chilly climate" (Britton 2016).

Collecting and understanding the literature across intellectual domains that intersects the role of gender and the participation of female faculty in academic entrepreneurship is the purpose of this project. My goal is to contribute to the creation of unbiased and enlivening higher education work environments for faculty and for the students and junior faculty members who look to more senior faculty as role models and mentors. Further, in practice, academic entrepreneurship holds increasing influence in the economy, and on the direction and reach of vital industries including life and

computer sciences. Everyone should have access to, and be welcomed in contributing to the U.S.'s innovation future.

This project will include an intersectionality lens to better understand the female experience (NAS 2013, Ginther & Kahn 2012).

Definitions:

- **ACADEMIC ENTREPRENEURSHIP (AE):** The engagement of college and university faculty members in research and other knowledge building activities that lead to private sector development of products and services intended for commercial sale.
- **GENDER**: Social assumptions assigned to individuals and groups of people about what they can and can't do, and what they should and shouldn't do, in relation to their assignment to assumed biological sex. The research work surveyed for this project has assumed a man-woman gender binary.
- **INTERSECTIONALITY:** A conceptual recognition that personal, group and social identity is a multi-faceted phenomenon that integrates single and integrating identity dimensions such as sex, ethnicity, nationality, skin color, country of origin, etc. at the person and group level. Such recognition is contextual. These identity dimensions, prima facie or otherwise, can socially locate individuals voluntarily and involuntarily leading to biased attitudes and outcomes, either for or against.
- **FACULTY:** Tenure stream, full-time faculty employed by an accredited college or university.

STAGE 1: SEATING THE META-ANALYSIS IN CONTEXT

Review of Reviews description

The first step in this project was to identify reviews of the literature on academic entrepreneurship 2000-2020. The goal was to create the ground on which to place the meta-analysis in the context of this body of work.

Table 1 presents an overview of the 22 literature reviews identified with a categorization of their purposes and the range of their coverage both in terms of time and number of studies. Full citations appear in Appendix 1. The reviews were published between 2006 and 2019 with more reviews appearing in later years. The number of articles referenced per review varied from 26 low to 534 high. The publication dates of the articles included in the reviews scanned 1959-2018. There was a density pattern to the publication of the review articles with 8 appearing in the Journal of

Technology Transfer, 3 each in the journals Research Policy and Scientometrics, and 8 one-off in various other journal outlets, including one book chapter.

More recent reviews identified that research on academic entrepreneurship has intensified in the last decade and several reviews noted that AE research has been largely atheoretical and concerned with describing the phenomena. This was reinforced by 3 reviews that focused on the description and application of specific organizational mechanisms to link university and industrial innovation activities. After study, I concur with this assessment. Most of the reviews are descriptive or largely descriptive. Exceptions were Hmieleski and Powell, 2018; Bozeman, Fay and & Slade, 2012; Skute, 2019; Sandstrom, Wennberg, Wallin and Zherlygina, 2018; and Gerbin and Drnovsek, 2016.

Gender was *mentioned* as a feature of AE in 4 reviews but only in a cursory way. No other demographic characteristics of academic entrepreneurs were mentioned (e.g., ethnicity, immigrant status, etc.).

Reviews categorization

I categorized the 22 review articles into 5 areas:

- Public policy implications of academic entrepreneurship (N=4)
- Academic entrepreneurship under the umbrella of academic engagement (N=3)
- Aspects of spinoffs and their systems (N=9)
- Specific mechanisms of tech transfer (N=3)
- The faculty entrepreneur person (N=3)

Overall, there were two contrasting views on the value of academic entrepreneurship represented across the reviews: one tying AE to positive social outcomes of economic growth and innovation (the strong majority) and another concerned about AE's drain on traditional university values and roles such as leadership in the achievement of fundamental versus applied research.

For the latter, represented by the category, *public policy implications of academic entrepreneurship*, four articles considered AE critically from the lens of AE as a higher education endeavor. There was acknowledgement of the traditional role of the goals of higher education and a discussion of science and invention in consideration of a government-university-private sector invention collaboration. The influence of growing levels of AE was considered from the point of view of social welfare, public science, and higher education purpose.

In the second category, *academic entrepreneurship under the umbrella of academic engagement*, a distinction was made between university-industrial relations generally, and the more specific activities related to science commercialization. For example, knowledge-related collaboration of academic researchers

and business could include research of a fundamental nature, contract research, consulting, advice giving, and professional networking. Commercialization activities in contrast would include activities such as patent assignment and licensing and private firm start-up. The difference between the two categories relies on the intensity of focus on immediate knowledge application to create products and processes for private sale.

The third and largest set of reviews, *aspects of spinoffs and their systems,* concerned the identification and categorization of research regarding the activities of commercialization, specifically the creation of new firms based on science created within he university. These articles include assessment of how the literature has changed over time with growth in attention overall, and some change in focus of topics over time. Here, different levels of analysis were considered: ecosystem, university, firm, entrepreneur.

The next category, s*pecific mechanisms of tech transfer,* grows even more specific with a targeted focus on incubators and technology transfer offices as mechanisms of AE. In the final category, *the faculty entrepreneur person,* the individual is the focus and psychological dimensions and collaboration patterns are of concern.

These reviews demonstrate together that there are a great number of lens from which to consider academic entrepreneurship, its ecosystem, participant elements, and participants.

Review Citation	Publication Year	Gender or other diversity included	# reference articles/ Publication years	Short description
PUBLIC POLICY IMPLICATIONS OF ACADEMIC ENTREPRENEURSHIP				
Sandstrom, C., Wennberg, K., Wallin, M., Zherlygina, Y., Public policy for academic entrepreneurship initiatives: A review and critical discussion, JOURNAL OF TECHNOLOGY TRANSFER, 43:1232	2018	none	166 - 2000–2014	Assessing the likelihood of academic entrepreneurship generating public value through innovation and economic growth
Larson, M., The implications of academic enterprise for public science: An overview of the empirical evidence, RESEARCH POLICY 40:6	2011	mention	220 - 1959-2008	Potential negative and unintended consequences of AE on the production and dissemination of fundamental and applied scientific knowledge
Gerbin, A., Drnovsek, M., Determinants and public policy Implications of academic industry knowledge transfer in life sciences: A review and a conceptual framework, JOURNAL OF TECHNOLOGY TRANSFER, 41:979	2016	mention	135 - 1980 - 2014	Academic-industry knowledge and technology transfer in life sciences and its relevance to policy and public science
Mars, M. & Rios-Aguilar, C. Academic entrepreneurship (re) defined: Significance and implications for the scholarship of higher education, HIGHER EDUCATION, 59(4).	2009	none	44 - 1999-2008	How higher education literature views AE
ACADEMIC ENTREPRENEURSHIP UNDER THE UMBRELLA OF ACADEMIC ENGAGEMENT				
Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Brostrom, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, A., Lissoni, F.,	2013	Male academics more likely to engage in	36 - 1980 -2011	Commercialization in contrast to wider academic engagement umbrella of faculty activities

Salter, A., Sobero, M., Academic engagement and commercialisation: A review of the literature on university–industry relations, RESEARCH POLICY, 42: 423		academic engagement and commercialisation		
Teixeira, A., Mota, L., A bibliometric portrait of the evolution, scientific roots and influence of the literature on university–industry links, SCIENTOMETRICS, 93:719	2012	none	534 - 1986 -2011	A categorization of AE literature including growth and decline of research areas
Geuna, A., Muscio, A., The governance of university knowledge transfer: A critical review of the literature, MINERVA, 47:93.	2009	none	100 - 1992-2008	Broad lens on university-industry knowledge transfer including AE
ASPECTS OF SPINOFFS AND THEIR SYSTEMS				
O'Shea, R., Chugh, H., Allen, T., Determinants and consequences of university spinoff activity: A conceptual framework, JOURNAL OF TECHNOLOGY TRANSFER, 33:653	2008	none	71 - 1979-2007	Categorization of AE spinoff determinants and consequences
Skute, I., Opening the black box of academic entrepreneurship: A bibliometric analysis, SCIENTOMETRICS, 120:237	2019	none	615 - 2008 -2017	Categorization of broad, multi-level knowledge transfer including AE with ecosystem, entrepreneurs, spinoffs
Miranda, F., Chamorro, A., Rubio, S., Re-thinking university spin-off: A critical literature review and a research agenda, JOURNAL OF TECHNOLOGY TRANSFER, 43: 1007.	2018	Gender as an individual level characteristic of the entrepreneur	268 - 1987–2016	Identifying and evaluating the literature on university spin-offs
Djordje, D., Souitaris, V., Spinouts from academic institutions: A literature review with suggestions for	2008	none	102 - 1982-2005	Synthesis of findings on university spin-outs companies

further research, JOURNAL OF TECHNOLOGY TRANSFER, 33:225				
Hayter Conceptualizing academic entrepreneurship ecosystems: A review, analysis and extension of the literature, JOURNAL OF TECHNOLOGY TRANSFER, 43:1039	2018	none	209 - 2000-2017	Strategic and systemic conceptualizations of entrepreneurship ecosystems
Rothaermel, F., Agung, S., Jiang, L., University entrepreneurship: A taxonomy of the literature, INDUSTRIAL AND CORPORATE CHANGE, 16(4): 691.	2007	none	137 - 1981 - 2005	Broad lens to categorize AE and its mechanisms and ecosystem engagement and effects
Mustar, P., Renault, M., Colombo, M., Piva, E., Fontes, M., Lockett, A., Wright, M., Clarysse, B., & Moray, N. Conceptualising the heterogeneity of research-based spin-offs: A multi-dimensional taxonomy. RESEARCH POLICY, 35(2006).	2006	none	26 - 1990-2005	Categorization of AE spin-offs as compared to new high technology venture not university based
Mathisen, M. & Rasmussen, E. The development, growth, and performance of university spin-offs: A critical review. JOURNAL OF TECHNOLOGY TRANSFER.	2019	none	105 - 2000-2018	Review on development, growth, and performance of spin-offs with critique of the literature on methods robustness
Yusof, M., & Jain, K. Categories of university-level entrepreneurship: A literature survey. INTERNATIONAL MANAGEMENT AND ENTREPRENEURSHIP JOURNAL. 6:81-96.	2008	none	72 - 1989-2006	Categorization related to how AE manifests at the organizational, individual, and ecosystem levels
SPECIFIC MECHANISMS OF TECH TRANSFER				
Siegel, D., Veugelers, R., Wright, M., Technology transfer offices and commercialization of university intellectual property:Performance and policy	2007	none	36 - 1998-2007	Whether and how technology transfer offices are successful in generating additional revenue on university intellectual property

implications, OXFORD REVIEW OF ECONOMIC POLICY, 23(4): 460				
Mian, S., Lamine, W., Fayolle, A., Technology business incubation: An overview of the state of knowledge, TECHNOVATION, 50-51:1	2016	none	149 - 1985 -2014	Concept, mechanisms, and policies of technology business incubation through science parks, incubators and accelerators to support innovation and tech development
Meyer, M., Grant, K., Morlacchi, P., Weckowska, D., Triple Helix indicators as an emergent area of enquiry: A bibliometric perspective, SCIENTOMETRICS, 99:151.	2014	none	109 - 1996-2013	Identify research indicators related to the Triple Helix literature pertaining to university–industry–government relations and their associated functions, including AE
THE FACULTY ENTREPRENEUR PERSON				
Lawton-Smith, H., Henry, C., Etzkowitz, H., Meschetti, V., Poulovassilis, A., Female academic entrepreneurship: Reviewing the evidence and identifying the challenges, The Routledge Companion to Global Female Entrepreneurship, (eds.) Henry, C., Nelson, T., Lewis, K., pg. 78	2015	none	59 – 2000-2015	Factors of success and failure for women as academic entrepreneurs commercializing their research

Hmieleski, K., Powell, E., The psychological foundations of university science commercialization, ACADEMY OF MANAGEMENT PERSPECTIVE, 321): 43	2018	Males more likely to engage in AE due to entrepreneurial self-efficacy, risk propensity, networks, and access to financial capital	56 - 2006–2015	Psychological aspects of academic scientists' involvement in AE
Bozeman, B., Fay, D., Slade, C., Research collaboration in universities and academic entrepreneurship: The-state-of-the-art, JOURNAL OF TECHNOLOGY TRANSFER, 38(1):1	2012	none	159 - 1968-2011	Primary focus on individual-level research collaboration of university researchers to expand knowledge and economic value through AE

TABLE 1: Literature review articles on the subject of academic entrepreneurship, 2000-2020

STAGE 2: IDENTIFICATION OF THE BODY OF WORK

Research Methods

Sources

The Web of Science was the primary mechanism used to identify and collect articles for the study. The Web of Science database includes 21.000 journals worldwide covering 250 science and social science disciplines[1]. Given the research question, the first goal was to identify any article that included coverage of both topics of academic entrepreneurship and sex (male/female). The time period 2000-2020 was chosen to delineate article publication dates. Only publications in English were acquired. These primarily concerned U.S. settings, though there were European, and scattered other global geographic areas of study as well.

Meta-synthesis Techniques

My meta-synthesis techniques follow Cooper (2016). I use systematic processes to locate, evaluate, summarize, and interpret (integrate) research to generate inductively derived claims about the body of knowledge across a range of disciplines that discuss female/gender and faculty academic entrepreneurship, beginning with a meta-scoping of source areas.

Search Strategy

After extensive testing, a final search string strategy was selected.

Search query phrase string 1: female or woman or women or gender AND
Search query phrase string 2: ("academic entrepreneurship" OR spin OR commerciali* OR "tech*-transfer" OR "entrepren* universit*") AND*
Search query phrase string 3: faculty

Once an initial article set was selected and cleaned, the references of each of those articles was searched by title for additional papers which were then read and included in the study database, as appropriate.

Two additional searches were undertaken. The first involved NGO and Government reports: 15 were identified. Four were reports on research projects undertaken through government grant programs. They were integrated into the study database. The remainder, 11 reports, provided mainly reasoning for gender equity in STEM entrepreneurship, statistics on participation rates, and some select recommendations for further inclusion of women academics in entrepreneurship. I decided not to integrate this latter group with the scholarship research database to keep the focus to the research question.

[1] https://clarivate.libguides.com/webofscienceplatform/coverage

The second additional search involved reviewing the last 8 years of ADVANCE grant awardees and searching by awardee name in Web of Science for articles that reported out findings of ADVANCE grant projects. Two articles were so identified and included in the database.

Note: The closure of libraries due to COVID-19 in spring 2020 restricted search of books and book chapters. Personal knowledge suggests that while there is a substantial set of work on the status of women in STEM, and the status of women as university faculty, specific books on the subject of women academics and STEM commercialization are rare or nonexistent. A search of library databases and amazon.com support this conclusion. Book chapters were included in the Web of Science article search.

Figure 1 outlines the process of arriving at the final sets of N=123 articles for the meta-synthesis.

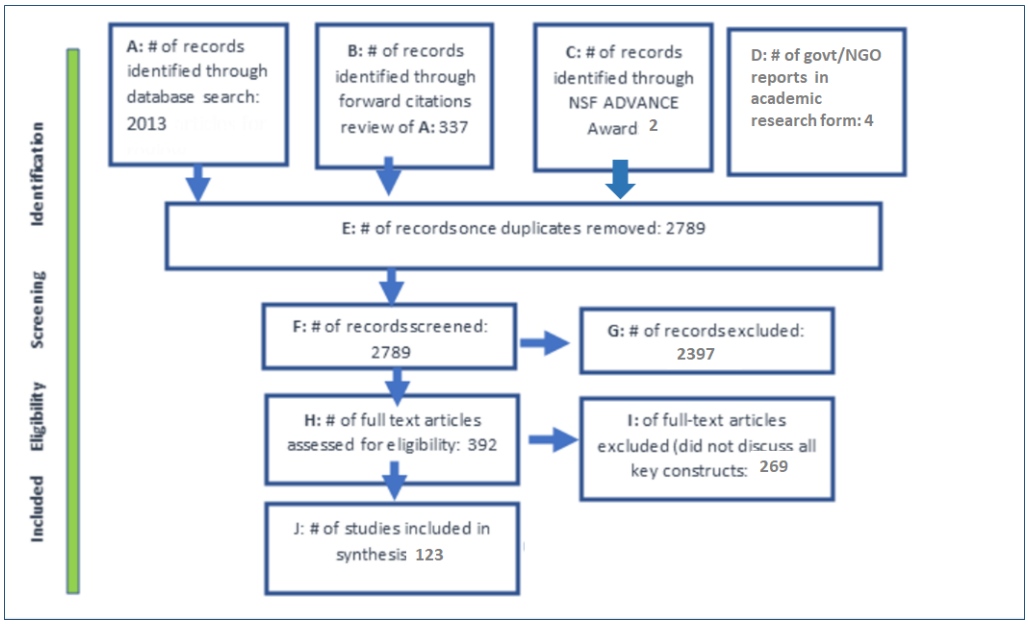

Figure 1: Database search strategy with # of articles produced for the final database

Research Inquiry

In addition to the main research question, the following open- ended research questions were developed to guide the evaluation and categorization of the articles.

1. In what domains do we find this literature concerning women faculty members as commercializers, either directly or in comparison to men?

2. What are the variables of concern in this literature including type of commercialization, type of faculty member, domain of activity, intersectional acknowledgment?
3. What is the configuration of the literature in terms of volume, content and conclusions about women faculty members as commercializers, either directly or in comparison to men?
4. To what degree is this literature empirical? quantitative? qualitative?
5. What "best practices" for gender equity in access to commercialization have been made available, and what empirical evidence exists for their impact?

Description of the database

A full bibliography of the N=123 articles is presented in Appendix 2. Ninety-eight of the articles were empirical and 25 were non-empirical.

Figure 2 demonstrates the time range of the study articles 2000-mid-2020. Comparing decades 2000-2009 and 2010-2020, there is a substantial increase in scholarship on the topic.

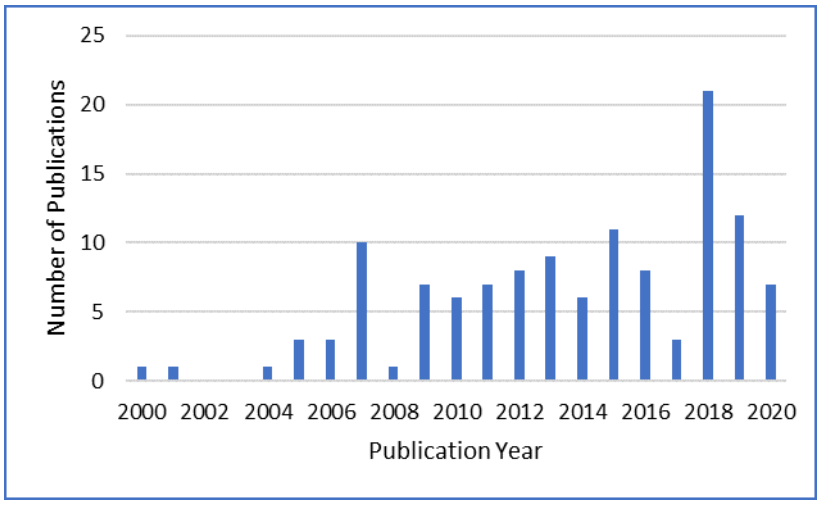

Figure 2: Year of publication of study articles N=123

Mostly, the articles concerned the USA, and then Europe. Of course, restricting search to publications in English had a strong influence on this set.

Country	# of articles	Country	# of articles
USA	70	China	2
Germany	10	Portugal	2

multi-Europe	7	India	1
Spain	7	Malaysia	1
UK	5	Saudi Arabia	1
multi-global	4	Sweden	1
Italy	3	No. American	1
Taiwan	3	unidentified	3
Canada	2		

Table 2: Country of inquiry of study articles N=123

While all the articles were screened to include the concepts of academic entrepreneurship and sex/gender, I also then looked more closely to determine the most central concerns. In 110 articles, academic entrepreneurship was of central interest while gender/sex was included. In 13 articles, sex/gender was central and academic entrepreneurship was included as a topic area. In other words, in most cases, the activities of women faculty were not the organizing focus.

		Gender central	
		YES	NO
Academic entrepreneurship central	YES	51	59
	NO	0	13

Table 3: Central concern of the study articles vis-à-vis study core concepts N=123

Key authors with multiple articles (>3) are given in Table 4. From 2000-2020, David Audretsch (2020: Indiana University, Barry Bozeman (2020: Arizona State University), and Kjersten Bunker Whittington (2020: Reed College) are the most prolific authors in the area. Audretsch's research employs sex/gender as an additional explanatory variable in the study of scientist entrepreneurs. For Bozeman, sex/gender is somewhat more central to the body of work, and for Whittington it is front and center. Each additionally has extensive portfolios of work beyond AE, more rather than less focused on science invention.

Authors	Year	Title	Publication
Audretsch, DB N=7			
Audretsch, DB; Aldridge, TT	2009	Scientist commercialization as conduit of knowledge spillovers	ANNALS OF REGIONAL SCIENCE
Aldridge, TT; Audretsch, DB	2010	Does policy influence the commercialization route? Evidence from National Institutes of Health funded scientists	RESEARCH POLICY
Aldridge, TT; Audretsch, DB	2011	The Bayh-Dole act and scientist entrepreneurship	RESEARCH POLICY
Alshumaimri, A., Aldridge, TT, Audretsch, DB.	2012	Scientist entrepreneurship in Saudi Arabia	JOURNAL OF TECHNOLOGY TRANSFER
Aldridge, TT; Audretsch, DB; Desai, S; Nadella, V	2014	Scientist entrepreneurship across scientific fields	JOURNAL OF TECHNOLOGY TRANSFER
Guerzoni, M; Aldridge, TT; Audretsch, DB; Desai, S	2014	A new industry creation and originality: Insight from the funding sources of university patents	RESEARCH POLICY
Audretsch, DB; Cunningham, JA; Kuratko, DF; Lehmann, EE; Menter, M	2019	Entrepreneurial ecosystems: economic, technological, and societal impacts	JOURNAL OF TECHNOLOGY TRANSFER
Barry Bozeman, PhD N=6			
Bozeman, B; Corley, E	2004	Scientists' collaboration strategies: implications for scientific and technical human capital	RESEARCH POLICY
Bozeman, B; Gaughan, M	2007	Impacts of grants and contracts on academic researchers' interactions with industry	RESEARCH POLICY
Link, A; Siegel, D; Bozeman, B	2007	An empirical analysis of the propensity of academics to engage in informal university technology transfer	INDUSTRIAL AND CORPORATE CHANGE
Bozeman, B; Gaughan, M	2011	How do men and women differ in research collaborations? An analysis of the collaborative motives and strategies of academic researchers	RESEARCH POLICY

Bozeman, B; Fay, D; Slade, C	2013	Research collaboration in universities and academic entrepreneurship: the-state-of-the-art	JOURNAL OF TECHNOLOGY TRANSFER
Bozeman, B; Boardman, C	2013	Academic Faculty in University Research Centers: Neither Capitalism's Slaves nor Teaching Fugitives	JOURNAL OF HIGHER EDUCATION
Whittington, KB N=5			
Whittington, KB, Smith-Doerr, L	2005	Gender and commercial science: Women's patenting in the life sciences	THE JOURNAL OF TECHNOLOGY TRANSFER
Whittington, KB; Smith-Doerr, L	2008	Women inventors in context - Disparities in patenting across academia and industry	GENDER & SOCIETY
Whittington, KB	2011	Mothers of Invention? Gender, Motherhood, and New Dimensions of Productivity in the Science Profession	WORK AND OCCUPATIONS
Plank-Bazinet, JL; Whittington, KB; Cassidy, SKB; Filart, R; Cornelison, TL; Begg, L; Clayton, JA	2016	Programmatic Efforts at the National Institutes of Health to Promote and Support the Careers of Women in Biomedical Science	ACADEMIC MEDICINE
Whittington, KB	2018	A tie is a tie? Gender and network positioning in life science inventor collaboration	RESEARCH POLICY

Table 4: Most prolific authors in the database

Beyond sex/gender, 8 articles in the set of 123 engaged additional identity dimensions. In only one case (Fechner & Shapanka, 2018) did a study directly discuss African-American and Black women. The 7 remaining articles included references to intersectionality by the identification and recognition of the relevance of multiple identity dimensions.

# of articles	Year of publication	Identity dimension considered (beyond sex/gender):
1	2005	"age and color"
1	2010	“age”
1	2013	"age and family characteristics"
1	2014	"minority and foreign-born scientists"
1	2016	“nationality”
1	2018	"people of color and lower income individuals (at birth)"
1	2019	"race and parents' socioeconomic class"
1	2018	“ethnic populations”

Table 5: Study articles referencing identity dimensions beyond sex/gender N=123

In terms of level of analysis, there was a strong emphasis on the social macro level, with 59% of articles carrying a focus on the social macro level, 49% at the individual level, and 46% at the organizational level. Considering the three categories together we find that 54% were uni-level and 46% were multi-level. The distribution of these categories in given in Table 6.

Level of analysis concepts covered	social macro level (=1)	Organizational Level (=2)	individual people level (=3)	# of articles
1-1-1	1	1	1	9
1-1-0	1	1	0	16
1-0-1	1	0	1	13
1-0-0	1	1	0	35
0-1-1	0	1	1	18
0-1-0	0	1	0	12
0-0-1	0	0	1	20

Table 6: Emphasis of the study articles in terms of levels of analysis N=123

In terms of the types of commercialization activity considered, N=72 of the articles focus on particular practices as indicated in Table 7, most notably patenting activity at 67%.

patenting	38
Patenting with other	11
start-up/spin-out	13
varied	5
consulting	2
board membership	1
licensing	1
industry network	1
subtotal	**72**
No specific focus	51

Table 7: Emphasis of the study articles in terms of specific types of academic entrepreneurship N=123

An overview of the journals for the N=123 show an array of publication sources. There is a concentration in applied practice and policy journals at N=62 or 50% (Journal of Technology Transfer, Research Policy, and Technology and Innovation). Thirty-six journals had only 1 publication on the topic with a smattering of small numbers between the single digit and concentration distribution.

Journal	#	Note
JOURNAL OF TECHNOLOGY TRANSFER	33	3 special issues
RESEARCH POLICY	19	
TECHNOLOGY AND INNOVATION - National Academy of Inventors	10	1 special issue
CONFERENCE PAPERS	4	
SCIENTOMETRICS	4	
TECHNOVATION	4	
SMALL BUSINESS ECONOMICS	3	
ASIA PACIFIC EDUCATION REVIEW	2	
INDUSTRIAL AND CORPORATE CHANGE	2	
INTERNATIONAL JOURNAL OF ORGANIZATIONAL ANALYSIS	2	
PLOS ONE	2	

SCIENCE	2	
ACADEMIC MEDICINE	1	
ACADEMY OF MANAGEMENT JOURNAL	1	
ANNALS OF REGIONAL SCIENCE	1	
APPLIED ECONOMIC LETTERS	1	
CANADIAN PUBLIC POLICY-ANALYSE DE POLITIQUES	1	
CRITICAL STUDIES IN EDUCATION	1	
ECONOMICS & SOCIOLOGY	1	
ECONOMICS OF INNOVATION AND NEW TECHNOLOGY	1	
ENTREPRENEURSHIP AND REGIONAL DEVELOPMENT	1	
ENTREPRENEURSHIP THEORY AND PRACTICE	1	
GENDER & SOCIETY	1	
GENDER IN MANAGEMENT	1	
GENDER WORK AND ORGANIZATION	1	
GLOBAL BUSINESS AND ECONOMICS REVIEW	1	
HARVARD JOURNAL OF LAW AND GENDER	1	
IIMB MANAGEMENT REVIEW	1	
JOURNAL OF DIVERSITY IN HIGHER EDUCATION	1	
JOURNAL OF ECONOMIC BEHAVIOR & ORGANIZATION	1	
JOURNAL OF ECONOMIC PSYCHOLOGY	1	
JOURNAL OF HIGHER EDUCATION	1	
JOURNAL OF INDUSTRIAL ECONOMICS	1	
JOURNAL OF INFORMETRICS	1	
JOURNAL OF TECHNOLOGY MANAGEMENT AND INNOVATION	1	
JOURNAL OF PRODUCT INNOVATION MANAGEMENT	1	
JOURNAL OF THE AMERICAN COLLEGE OF RADIOLOGY	1	
JOURNAL OF VOCATIONAL BEHAVIOR	1	

KNOWLEDGE MANAGEMENT RESEARCH & PRACTICE	1	
LES NOUVELLES - JOURNAL OF THE LICENSING EXECUTIVES SOCIETY	1	
MANAGERIAL DECISION ECONOMICS	1	
NEW ENGLAND JOURNAL OF MEDICINE	1	
PEER REVIEW	1	
QUARTERLY JOURNAL OF ECONOMICS	1	
RESEARCH EVALUATION	1	
SCIENCE AND ENGINEERING ETHICS	1	
TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT	1	
TOPIA-CANADIAN JOURNAL OF CULTURAL STUDIES	1	

Table 8: Source publications of the study articles N=123

Web of Science categorized the journals in the following way, Table 9.

Journals by domain	%, allows multiple category assignments
Management and business	65
Engineering/industrial	19
Multi-disciplinary science	12
Economics	12
Information & Library Science	10
Computer science	8
Education	7
Sociology	4
Operations research	3
Women's studies	3
Regional & urban planning	1

Table 9: study article publications by domain area N=123

Comments

The literature on academic entrepreneurship as it relates to gender is rather widely dispersed and shallow. In general, sex and/or gender is a feature in the database articles. Most articles use "female" as a descriptor and consider the topic from a "presence of bias" perspective. In other words: an unequal outcome of AE as regards women and men is reported or documented and/or barriers to equality for women to fully participate in academic entrepreneurship are acknowledged and/or discussed. In only one case is intersectionality directly addressed, though it was mentioned in 6 of the N=123 articles. Only 4 use gender theory as a base.

Regarding domains, most study articles appear in publications that circle the busines/economics and commercial innovation/science/technology research areas. A few are in other domains such as education, culture studies, and political science. A few are in professional domains where AE takes place including academic medicine and radiology. Four articles are in gender focused journals that deal with law and organizational activity.

The majority of articles are empirical (80%).

STAGE 3: ANALYSIS OF THE CORE COLLECTION

Selection

From the N=123 database, 32 articles were chosen for more in-depth analysis. The goal was to focus in on articles that attended to AE *and* gender in the most central way. Because the view of this author is that gender is socially constructed and embedded culturally, the core collection was restricted to articles studying the United States or attending to the topic of AE in a global, non-geographical way. Articles that are highly descriptive, without analysis, were excluded. Articles that focused on gender/sex for which academic entrepreneurship was not a central focus were excluded. Conference papers were excluded.

Description

Of the 32 articles in the core collection, published between 2004 and 2018, 21 are empirical and 11 are non-empirical. The articles were published in 21 different journals. Fifteen articles come from the journals that published most articles in the full N=123 database (Journal of Technology Transfer, Research Policy, Technology and Innovation). Table 10 displays the distribution of the core collection by journal.

Journal Title	#
TECHNOLOGY AND INNOVATION - National Academy of Inventors	6
JOURNAL OF TECHNOLOGY TRANSFER	5
RESEARCH POLICY	4
SCIENCE	2
ACADEMY OF MANAGEMENT JOURNAL	1
APPLIED ECONOMIC LETTERS	1
GENDER & SOCIETY	1
HARVARD JOURNAL OF LAW AND GENDER	1
INDUSTRIAL AND CORPORATE CHANGE	1
JOURNAL OF TECHNOLOGY MANAGEMENT AND INNOVATION	1
JOURNAL OF THE AMERICAN COLLEGE OF RADIOLOGY	1
LES NOUVELLES - JOURNAL OF THE LICENSING EXECUTIVES SOCIETY	1
PEER REVIEW	1
PLOS ONE	1
SCIENCE AND ENGINEERING ETHICS	1
SCIENTOMETRICS	1
TECHNOVATION	1
TOPIA-CANADIAN JOURNAL OF CULTURAL STUDIES	1
WORK AND OCCUPATIONS	1

Table 10: Core collection articles distributed by journal

In comparison to the full N=123 set, the core collection puts more emphasis on the social macro level and the individual people level .

Level of analysis concepts covered	social macro level (=1)	organizational Level (=2)	individual people level (=3)	# of articles N=123	% N=123	# of articles N=34	% N=32
1-1-1	1	1	1	9	0.07	0	0.00
1-1-0	1	1	0	16	0.13	2	0.06
1-0-1	1	0	1	13	0.11	1	0.03
1-0-0	1	1	0	35	0.28	15	0.47
0-1-1	0	1	1	18	0.15	3	0.09
0-1-0	0	1	0	12	0.10	6	0.19
0-0-1	0	0	1	20	0.16	5	0.16

Table 11: Emphasis of the study articles in terms of levels of analysis N=32, and in comparison to N=123

Table 12 provides an overview of the 34 articles of the core collection including citation, brief description, and identification of intersectionality coverage. Empirical and non-empirical articles are presented by section.

Author	Publication Year	Journal	Title	Description	Intersectional focus?
EMPIRICAL ARTICLES					
Sugimoto, CR, Ni, CQ, West, JD, Lariviere, V	2015	PLOS ONE	The Academic advantage: Gender disparities in patenting	Gender disparities in patenting; country, technological area, and type of assignee using the 4.6 million utility patents issued in U.S. between 1976 and 2013. Our analyses of fractionalized inventorships demonstrate that women's rate of patenting has increased from 2.7% of total patenting activity to 10.8% over the nearly 40-year period. Our results show that, in every technological area, female patenting is proportionally more likely to occur in academic institutions than in corporate or government environments."	N
Hanes, S, Ku, K, Primiano, L, Arvin, A	2018	LES NOUVELLES - JOURNAL OF THE LICENSING EXECUTIVES SOCIETY	Gender analysis of invention disclosures and companies founded by Stanford University faculty from 2000-2014	Male/female faculty comparison of academic entrepreneurship rates at Stanford University, 2000-2014. "Women faculty increasingly engaged in offering their discoveries for possible commercial development...however, they remain much less likely than their men counterparts to be involved with start-up companies and in leadership roles among companies licensing university-generated intellectual property."	N

Ding, Choi, E	2011	RESEARCH POLICY	Divergent paths to commercial science: A comparison of scientists' founding and advising activities	The profiles of scientists who become academic entrepreneurs are different from those who become companies' scientific advisors. "Factors such as gender, research productivity, social networks and employer characteristics... differ in their effects on the propensity for founding and advising...in addition...being a company's scientific advisor decreases the probability of becoming an academic founder."	N
Murray, F, Graham, L	2007	INDUSTRIAL AND CORPORATE CHANGE	Buying science and selling science: Gender differences in the market for commercial science	At one high-status university we examine the mechanisms that instituted, reinforced, and reduced the gender gap in commercial science between 1975 and 2005."Explicit early exclusion of women left them with fewer opportunities in the marketplace, weakening their socialization and skills in commercial science. This uneven opportunity structure left senior/mid-career women with fewer chances to confront the ambiguities of this new practice, resulting in their greater ambivalence. Gender differences remain significant among junior faculty but we find their decline prompted by greater gender-equality in advisor mentoring and the presence of institutional support which together have started to reshape the supply-side of commercial science."	N

Meng, Y	2018	SCIENTOMETRICS	Gender distinctions in patenting: Does nanotechnology make a difference?	For 1990 to 2005, this study benchmarks the collaboration patterns and gender-specific performance in patenting nanotechnology. "The empirical evidence reported here suggests that the gap to women's disadvantage was smaller in nanotechnology than in the overall tech area...while more than 90% of patents across fields were from industry where patenting is least likely to be collaborative, nano-patents have more diverse origins (79% from industry and 21 from universities, government, public institutions, and cross-sectoral collaboration) and are more likely to be collaborative outcomes (including those from industry)...nanotechnology presents an environment where women are more able to catch collaborative opportunities and engage in patenting."	N
Stephan, PE, El-Ganainy, A	2007	JOURNAL OF TECHNOLOGY TRANSFER	The entrepreneurial puzzle: Explaining the gender gap	Documents the substantial gender gap that exists among university scientists with regard to entrepreneurial activity, particularly in biomedical sciences. "Factors affecting supply.. .include gender differences in attitudes towards risk, competition, 'selling' of 'science', type of research and geographic location...factors affecting demand include the role of networks, preferences of venture capitalists and 'gender discounting'.	N

Ebersberger, B, Pirhofer, C	2011	APPLIED ECONOMIC LETTERS	Gender, management education and the willingness for academic entrepreneurship	Documents the effects of gender and supplementary management education on academics' willingness to start up a company. "Controlling for academic achievement, field of science, and perceived hampering factors, we find that female academics show a significantly lower propensity to have a high willingness to start up. Our results indicate that supplementary management education does not *in general* have a significant effect on the willingness to start up,..yet, for female academics, supplementary management education *exerts a significantly positive effect* almost off-setting the gender effect."	N
Ding, WW, Murray, F, Stuart, TE	2013	ACADEMY OF MANAGEMENT JOURNAL	From bench to board: Gender differences in university scientists' participation in corporate scientific advisory boards	Examines the gender difference in the likelihood that male and female academic scientists will join corporate scientific advisory boards. "Holding constant professional achievement, network ties, employer characteristics, and research foci, male scientists are almost twice as likely as females to serve on the SABs of biotechnology companies. We do not find evidence in our data supporting a choice-based explanation for the gender gap. Instead, demand-side theoretical perspectives focusing on gender-stereotyped perceptions and the unequal opportunities embedded in social networks appear to explain some of the gap."	N
Corley, E, Gaughan, M	2005	JOURNAL OF TECHNOLOGY TRANSFER	Scientists' participation in university research	University-affiliated multidisciplinary research centers...affect the development of academic careers."....we use a new, nationally representative	Y

			centers: What are the gender differences?	dataset of scientists and engineers working in Carnegie Research Extensive universities to develop an understanding of how center-affiliated scientists differ from exclusively department-based academic scientists and engineers, and investigate the extent to which gender moderates the effects of centers. ...(overall) women are younger, whiter, less likely to be tenured, and at a lower rank than their male colleagues (and still) women are as likely to join centers as men, and do so at a similar stage in their career…women appear to have greater research equality in (centers)(compared to the departmental setting). In particular, men and women in centers spend the same amount of time writing grant proposals, conducting both grant-supported and unfunded research, and administering grants. This suggests that centers may constitute an institutional context in which some aspects of gender equity in science may be achieved."	
Whittington, KB	2011	WORK AND OCCUPATIONS	Mothers of invention? Gender, motherhood, and new dimensions of productivity in the science profession	"Contrary to findings regarding publishing, academic mothers suffer a motherhood penalty (in patenting) not experienced by childless women or mothers in industry. Controls for past involvement remove the disparity, and a sex gap in industry. Work/family balance, sector-level incentives, and status expectations may explain these results, providing implications for future research on gender, motherhood, and work."	N

Ding, WW, Murray, F, Stuart, TE	2006	SCIENCE	Gender differences in patenting in the academic life sciences	"We analyzed longitudinal data on academic careers and conducted interviews with faculty members to determine the scope and causes of the gender gap in patenting among life scientists. Our regressions on a random sample of 4227 life scientists over a 30-year period show that women faculty members patent at about 40% of the rate of men. We found that the gender gap has improved over time but remains large."	N
Bozeman, B, Corley, E	2004	RESEARCH POLICY	Scientists' collaboration strategies: Implications for scientific and technical human capital	"We examine data from 451 scientists and engineers at academic research centers in the U.S. (with a focus on) scientists' collaboration choices and strategies[particularly) strategies that involve mentoring graduate students and junior faculty and to collaborating with women. Our findings indicate that those who pursue a 'mentor' collaboration strategy are likely to be tenured; to collaborate with women; and to have a favorable view about industry and research on industrial applications...Female scientists have a somewhat higher percentage (36%) of female collaborators, than males have (24%). However, non-tenure track females having 84% of their collaborations with females. Most researchers are not particularly cosmopolitan in their selection of collaborators (hey tend to work with the people in their own work group). More cosmopolitan collaborators tend have large grants. A major policy implication is that there is great variance in the extent to which collaborations seem to	N

				enhance or generate S&T human capital. Not all collaborations are equal with respect to their 'public goods' implications."	
Meng, Y	2016	RESEARCH POLICY	Collaboration patterns and patenting: Exploring gender distinctions	"Drawing upon the theory of gender frame, the research on gender in science, and social network studies,(we study) the social mechanism of collaboration, specifically the boundary-spanning collaboration, to understand the gender gap in academic patenting in the U.S.. (All) else being equal, only collaboration with industry would significantly increase the probability of patenting for female academic scientists, but this helps explain considerable difference in patenting between female and male academics."	N
Whittington, KB, Smith-Doerr, L	2008	GENDER & SOCIETY	Women inventors in context: Disparities in patenting across academia and industry	"How variation in organizational logic affects sex differences in scientists' commercial productivity, as measured by patenting. Using detailed data from a sample of academic and industrial life scientists working in the U.S... (we present results) on scientific patenting. The data show that controlling for education- and career-history variables, women are less likely to patent than men. However, in biotechnology firms-industrial settings characterized by flatter more flexible, network-based organizational structures-women scientists are more likely to become patent-holding inventors than in more hierarchically arranged organizational settings in industry or academia. (The)organization of scientists'	N

				work settings may influence enduring disparities between men and women in science."	
Mercier, NR, Ranjit, V, Reardon, RJ	2018	TECHNOLOGY AND INNOVATION - National Academy of Inventors	Engaging women innovators: Analytical support for women innovator programming in university technology transfer	This article summarizes the results of technology transfer activities by women innovators both prior to and following 3 years of participation in the Women in Innovation and Technology program at Washington University St. Louis (presented by the Office of Technology Management), 2014-17...constructive support for female innovators was made available and structural changes to engaging women in technology transfer were enacted...(Post program) data with respect to invention disclosures, patent applications, and individual participants showed an increase in activity (for female faculty).	N
Whittington, KB,, Smith-Doerr, L	2005	THE JOURNAL OF TECHNOLOGY TRANSFER	Gender and commercial science: Women's patenting in the life sciences	"We investigate gender disparities in commercial outcomes, for scientists in both the academic and industrial sectors. Using a unique combination of career history data and patenting information across a period of two decades, we present descriptive statistics and graphical trends of male and female commercialization.....female scientists engage in and produce less commercial work than their male counterparts, and that the degree of disparity remains constant across time. (However), the quality and impact of women's commercial work remains the same or better than that of men scientists."	N

Gaughan, M, Corley, EA	2010	TECHNOVATION	Science faculty at US research universities: The impacts of university research center-affiliation and gender on industrial activities	"We use scientific and technical human capital theory to test the hypothesis that university research center-affiliation helps to facilitate valuable industrial involvement by university professors. We are particularly interested in how gender may moderate the effects of university research center-affiliation on industrial activities. We study tenure-track academic scientists and engineers in US research universities to find that affiliation with a university research center increases the industrial involvement of both men and women. We conclude that the development of university research centers has resulted in a new basis of institutional stratification among professors, with affiliates engaging in more industrial activities than their exclusively department-based peers. Although university research center-affiliation advantages both men and women, male university research center-affiliates enjoy a slightly greater advantage than female center-affiliates in their industrial involvement."	N

Colyvas, J, Snellman, K, Bercovitz, J, Feldman, M	2012	JOURNAL OF TECHNOLOGY TRANSFER	Disentangling effort and performance: A renewed look at gender differences in commercializing medical school research	"We pooled faculty invention data from ten departments in three Academic Health Centers (medical school faculty) from 1991 to 1998 —a period when patenting had become prevalent and other researchers note that a gender gap was pronounced. Rather than focusing on patenting, we capture the first step in the commercialization process, as well as the subsequent successful licensing of faculty inventions to a company. We find no significant gender differences in the likelihood of reporting inventions or successfully commercializing them. We do find differences in the number of inventions reported, however, with women disclosing fewer inventions than their male counterparts. Our results demonstrate that gender effects are highly conditioned by employment context and resources. We(recommend) the use of outcome measures that capture both behavior and performance, and the inclusion of a more extensive set of control variables"	N
McCook, A	2013	SCIENCE	Barred from the Boardroom	Anecdotal statistics from MIT and other elite innovation universities show that women faculty represent <5% of members of scientific advisory boards of STEM companies.	N

Fox, MF, Xiao, WB	2013	JOURNAL OF TECHNOLOGY TRANSFER	Perceived chances for promotion among women associate professors in computing: Individual, departmental, and entrepreneurial factors	"Focusing on women associate professors in computing, (this article) assesses the relationship between perceived chances for promotion to full professor and indicators of entrepreneurship...Data from a national survey of women in academic computing indicate that time spent in entrepreneurial activity does not predict excellent/good (compared to fair/poor) chances for promotion perceived by these women faculty, nor does the quantity/quality of entrepreneurial activity that they report for their home units. Departmental reward structures reported as favoring entrepreneurial activity negatively predict perceived chances for promotion. Other key individual and departmental characteristics also predict chances for promotion: faculty members' age, collaboration, family characteristics, departmental climate, and US (compared to Canadian) location."	Y
Whittington, KB	2018	RESEARCH POLICY	A tie is a tie? Gender and network positioning in life science inventor collaboration	"This research addresses differences in men's and women's collaborative positioning and collaborator characteristics in science, and whether network influences on scientists' future productivity may be contingent on gender. Utilizing co-inventor network relations that span thirty years of global life science patenting across sectors, geographic locations, and technological background, I present trends of men's and women's involvement in patenting and their collaborative characteristics across time. Amidst some network similarities, women are less likely to connect	N

				otherwise unconnected inventors (brokerage) and have greater status-asymmetries between themselves and their co-inventors. In multivariate models that include past and future activity, I find that some network benefits are contingent on gender. Men receive greater returns from network positioning for brokerage ties, and when collaborating with men. Women benefit from collaborating with women, and are more likely to collaborate with women, but both men and women collaborate with mostly men."	
NON-EMPIRICAL ARTICLES					
de Melo-Martin, I	2013	SCIENCE AND ENGINEERING ETHICS	Patenting and the gender gap: Should women be encouraged to patent more?	Calls to encourage women to patent on grounds that such activity is likely to play a significant role in the betterment of both women's careers and society seem to be based on two problematic assumptions: (1) that the methods to determine women's productivity in patenting activities are an appropriate way to measure their research efforts and the impact of their work, and (2) that patenting, particularly in academia, benefits society. The purpose of this paper is to call into question these two assumptions.	N

Demiralp, B, Morrison, LTR; Zayed, S	2018	TECHNOLOGY AND INNOVATION	On the commercialization path: Entrepreneurship and intellectual property outputs among women in STEM	Presents an examination of innovation among women in STEM fields by identifying gaps in their entrepreneurial outcomes and highlighting future opportunities for policy improvements.	N
Newson, J	2012	TOPIA-CANADIAN JOURNAL OF CULTURAL STUDIES	Academic feminism's entanglements with university corporatization	"(Academic feminism) has taken place at the same time as another process, corporatization, has been reconfiguring the academy in significant ways...Their concurrence...raises important theoretical and political questions. Has the success of the feminist intervention intermingled with and been shaped by corporatization? Have academic women's advancements actually aided corporatization? "	N
Anzai, Y, Meltzer, CC, DeStigter, KK, Destounis, S, Pawley, BK, Oates, ME	2016	JOURNAL OF THE AMERICAN COLLEGE OF RADIOLOGY	Entrepreneurial women in Radiology: Role models of success	"Alongside surgery and orthopedic surgery, academic radiology ranks near the bottom in having the lowest proportion of full-time female faculty members. Despite many efforts to recruit talented women, the pipeline entering the radiologic disciplines continues to flow at a trickle. One factor is the relative lack of role models for female medical students". This article highlights two entrepreneurial female radiologists.	N
Polkowska, D	2013	JOURNAL OF TECHNOLOGY MANAGEMENT	Women scientists in the leaking pipeline: Barriers to the commercialisation of	Discusses barriers to the commercialization of scientific knowledge by women. "...most of 'experienced' obstacles (can be attributed to the 'leaking pipeline' context...barriers originate in at least two sources:	N

		AND INNOVATION	scientific knowledge by women	women themselves and external factors beyond women's control."	
Hazelwood, V, Carpenter-Smith, E, Continisio, M, DeAngelo, V, Mugurusa, R; Gray, M, Hassler, C, Wos, J	2019	TECHNOLOGY AND INNOVATION	What might we do to encourage more women to write patents	Recommendations discussed on how to improve the probability of more women becoming patent authors. "What else might we do to land more women in patent-intensive job tasks?"	N
Howe, SA, Juhas, MC, Herbers, JM	2014	PEER REVIEW	Academic women: Overlooked entrepreneurs	Description of an effort at The Ohio State University for the purpose of boosting female faculty engagement in invention disclosures and patents, launch of startup companies, and the attraction of venture capital and angel funds.	N

Marcowitz-Bitton, M, Kaplan, Y, Morris, EM	2019	HARVARD JOURNAL OF LAW AND GENDER	Unregistered patents & gender equality	"This article therefore proposes an unconventional new regime of unregistered patent rights to relieve women and other disadvantaged inventors of the costs of applying for registered patent rights and to help them gain greater access to patent protections. Patents are a glaring exception to the unregistered protections provided in other areas of intellectual property, which are more egalitarian in design. By providing automatic patent rights, our proposed regime would allow for greater protection for disadvantaged innovators, in much the same way that copyright, trademark, and other forms of intellectual property currently do. To explain our proposal, we detail the challenges facing women and other disadvantaged inventors in applying for patents as well as the fact that other intellectual property regimes do not require such applications."	N
Fechner, H, Shapanka, M	2018	TECHNOLOGY AND INNOVATION - National Academy of Inventors	Closing diversity gaps in innovation: Gender, race, and income disparities in patenting and commercialization of innovations	Thought piece and policy recommendations for closing diversity gaps in innovation existing on the basis of gender, race, and income disparities in patenting and around other commercialization of innovation practices.	Y

Sohar, K, Mercier, N, Goble, L, Ghahramani, F, Loftin, B	2018	TECHNOLOGY AND INNOVATION - National Academy of Inventors	Gender data gap baseline of US academic institutions	"This investigation sought to both establish a baseline for measuring U.S. academic institutions' tracking of inventors by gender and gain insight about the barriers keeping technology transfer offices (TTOs) from tracking gender in commercialization-related areas. The researchers also conducted an initial analysis on the leading software tools currently being utilized to track gender in academic TTOs. Raising awareness of this issue on a national level will help institutional leaders create strategies and mechanisms to help address the issue of gender disparity and increase the inclusion of women in the innovation lifecycle, particularly at the university disclosure and patenting level."	N
Sexton, K, Ligler, F	2018	TECHNOLOGY AND INNOVATION - National Academy of Inventors	Strategies to close the gender gap in invention and technology commercialization	Current data indicate that female faculty are less engaged in every area of technology commercialization than male faculty. This paper proposes practical approaches that university TTOs can implement to address the gender gap in invention and technology commercialization.	N

Table 12: Core collection articles N=32

Analyzing the N=21 empirical articles in the core collection, 17 of them are based on a comparison of male to female commercialization activity. A further 4 are concerned with in-group female comparisons: mothers versus non-mothers, women AE trained and untrained (over time), female faculty seated in research centers versus departments, perceived promotion chances when AE engaged, versus not AE engaged.

For the male/female comparison, there is confirmation across the studies that women commercialize at a lower absolute rate. Further, that for those studies taking a longitudinal focus, women's commercialization activity has been rising, not dramatically, but meaningfully, over time: "Women's rate of patenting has increased from 2.7% of total patenting activity to 10.8% over the nearly 40-year period" (Sugimoto, Ni, West, Lariviere, 2015). Two studies, applying controls, push further to find that while the absolute rate of AE was less for women, the quality and application value of women's work was equal to men's (Colyvas, Snellman, Bercovitz, Feldman, 2012; Whittington, Smith-Doerr, 2005).

Three of the articles in the core collection include some narrative on intersectionality, as displayed in Table 13. Only Fechner and Shapanka (2018) attend to the topic as their central concern.

	Year of publication	Identity dimension beyond sex/gender considered:	Data source and description
Corley, Gaughan, 2005	2005	"age and color"	*Data source: 2004 Survey of Academic Researchers completed by the Research Value Mapping Program (Barry Bozeman, PI)* Presents some descriptive statistics on percentages of "nonwhite" faculty
Fox, Xiao, 2013	2013	"age and family characteristics"	*Data source: Author produced - 170 web -based surveys collected in 2006-07 with follow-up phone interviews of 6* Age, marriage or partnered status, presence of children, and work-family interference with work demands are integrated as control variables into an assessment of promotion potential. Age and the presence of children under 6 years carries a positive relationship with promotion

			potential, while children 6-18 years carries a negative assessment of promotion potential.
Fechner, Shapanka, 2018	2018	"people of color and lower income individuals (at birth)"	*Data source: Milli J, Williams-Baron E, Berlan M, Xia J, Gault B. Equity in innovation: women inventors and patents. Washington (DC): Institute for Women's Policy Research; 2016* "Women, especially African American and Hispanic women, obtain patents at significantly lower rates than men; people of color obtain patents at significantly lower rates than whites; and individuals from lower-income families are significantly less likely to obtain a patent than individuals who grew up in wealthier families."

Table 13: Core collection articles referencing identity dimensions beyond sex/gender N=32

In terms of recommendations for women, the gathered studies suggest directly or imply that, to increase their commercial activity, women should:

- look actively internally for institutional support
- look for university or other management education training opportunities on AE
- look for tenured male faculty members who are interested in mentoring
- look actively internally for mentoring
- see what your university's tech transfer office has to offer
- get into a research center as early as you can in your career (as opposed to, or in addition to, a department appointment)
- recognize that certain industry networks tend to be more collaborative, with industry inventors more able to expand or form new relationships on their own without "permission" or explicit support from their institutions: find them

- go into industry versus academia
- intentionally choose your field; look for domains where collaboration opportunities are more the norm
- intentionally choose the type of research you pursue, and your geographic location
- gravitate toward a start-up role versus an advising role with companies; career paths usually involve a choice
- get NIH funding

- get your first patents early, before you have children
- consider a short stint in industry before or after your PhD

- actively identify and manage your stock of scientific and pecuniary resources to mobilize material and social capital for commercial gain
- assess all your inventions for commercial potential
- be vigilant in identifying the possibility of, and obtaining property rights over, your research output

- research shows that women benefit from working with women in terms of patenting success
- understand and manage for the fact that for structural and career factors, many levers are largely in the hands of universities, specific funders, and regulators of science
- choose your work settings: look for more flexible, network-based organizational structures rather than more hierarchically arranged organizational settings
- look beyond your capability to produce in volume, but rather for quality and impact of work
- be cautious about assumptions related to how AE behavior will be evaluated internally vis-à-vis tenure and promotion
- identify and follow role models who have gone through the process that you aspire to

Comment

An analysis of the core collection articles shows that the study of gender, faculty, and AE is complicated. There are:

- Differences in types of commercialization activity – e.g., patenting/licensing, start-ups, governance players
- Different faculty roles involved including teaching and research (direct and with students)
- Kinds of women and kinds of men: women mothers and non-mothers, senior faculty men, associate faculty women, tenured/untenured faculty
- Different faculty locations of AE – e.g., departments, research centers, embedded with industry, in associated organizations such as hospitals
- Differences in intentions to commercialize and in outcomes of commercializing
- Types of relevant intersectionality – race, family, geography, ethnicity, immigrant status, nativity, etc.
- Domains of engagement – e.g., science, engineering or biotech, computing, biology, chemistry, medicine
- Elite organizations and other organizations

1. Different biases in practice – time demands relative to work/life; unreflexive organizational structures; closed networks and structures; entire fields that were more or less biased

Study areas include:

- Different levels of analysis: macro, organizational (university and start-up), group, and individual
- Different concerns about gender/women and bias – e.g., equity, equality, representation, the exercise and access to decision making and resource power
- Focus on a specific domain of STEM, e.g., nanotechnology, look within an area, e.g., bioscience, or take a more expansive view of science or technology, or both

In practice, research in the core collection clustered around:

- Male/female comparisons on rates of AE, though there were some comparison with-in group for women
- An emphasis on patenting, and secondarily start-ups as particular AE expressions
- Rates of AE over time, across domains, or across geography

STAGE 5: DISCUSSION

In summary, the data of this meta-synthesis show that research on female faculty and academic entrepreneurship gathers primarily in the business/economics/technology publication domain though there are sprinklings of articles across other areas. Attention on the topic is relatively light with N=123 articles identified for the period 2000-mid-2020. In most cases, academic entrepreneurship is the primary focus and gender/sex is a secondary focus.

An interest in women faculty arises primarily as one feature of a research project that is attending to academic entrepreneurship. There are a limited number of articles that put their primary focus on women faculty, and then an even more limited set that expand the "woman" category with elements of intersectionality. Most of the articles with a stronger attention on gender/sex are looking at male-female comparisons in behavior and output. There are few articles that integrate gender theory. For the most part, "women" or "female" is taken as a descriptor, not as a socially constructed category (or another theoretically based idea).

When comparing this set of articles to the AE review articles described in Stage 1 of this report, we see some overlap, but it is not uniform. Considering the 5 categories discussed there, reflection suggests:

- ***Public policy implications of academic entrepreneurship***: some coverage in the non-empirical articles but little gender theory. Wide messaging that women's engagement in AE is important because it adds to innovation output overall (i.e., underutilized resource).
- ***Academic entrepreneurship under the umbrella of academic engagement:*** little consideration of female faculty's careers writ large, and how AE might contribute, stall, or influence them.
- ***Aspects of spinoffs and their systems:*** Spin-offs much less in focus as an AE expression, as compared to patenting. Perhaps because sex and patent rate data are more easily available, also perhaps because women are more engaged in this AE practice.
- ***Specific mechanisms of tech transfer:*** research centers are the stand-in for tech transfer mechanisms discussed in the reviews (incubators, science parts, tech transfer offices) as alternate, structural solutions for engagement.
- ***The faculty entrepreneur person:*** most in focus as recommendations are made concerning women's options for integrating work so that they better fit the AE system. Also, how women faculty collaborate and network over their careers, and to what effect.

When considering the study database in contrast, the following categories would be added:

- ***Gender disparities: how, and to what degree, women faculty in various settings face barriers to their participation in AE***
- ***Mechanisms to reduce gender disparities***
- ***How women perform in AE compared to men***

The exceptions include one article that celebrates female success in AE (Anzai, Meltzer, DeStigter; Destounis, Pawley, Oates, 2016). One that studies the perceptions of women faculty in terms of AE (Fox, Xiao, 2016). One that proposed a new ecosystem mechanism to combat gender inequity in AE (Marcowitz-Bitton, Kaplan, Morris, 2019).

The literature identified is more empirical than not, and more quantitative than qualitative. Patent records are the most frequently used quantitative data source. Different forms of commercialization are considered from the specific – e.g., start-up or patenting, to the general – e.g., industry engagement. Academic entrepreneurship is centered on the the ecosystem and on the person; the faculty member, and their role enactment in the university (departments and research centers), in professional networks, as a mentor, colleague, or junior.

Best practices for women to succeed as academic entrepreneurs cover 3 topic areas: career planning, research planning, university resources. Of critical importance, the majority have to do with *what women can do* to be more successful, rather than what organizations or ecosystems can do. This "fix

the women" approach has been roundly criticized by gender scholars who see responsibility for the destruction of barriers lying with the systems and power-holders in place.

Recommendations for women include:

1. **Career planning**
    - If your goal is STEM entrepreneurship through patents, consider industry over academia or a short stint in industry before faculty life
    - Think about your research domain: align with women's historical success, look for fields with collaborative natures; look for mentors
    - Think about geography: choose your geography in terms of entrepreneurship ecosystem
    - Think about timing: get your first patents early, before you have children
    - Be intentional about how you want to work in AE: career paths diverge with start-ups down one path and company advising down another
    - understand and manage for the fact that for structural and career factors, many levers are largely in the hands of universities, specific funders, and regulators of science
    - Choose your work settings: look for more flexible, network-based organizational structures rather than more hierarchically arranged organizational settings
    - Be cautious about assumptions related to how AE behavior will be evaluated internally vis-à-vis tenure and promotion

2. **Research planning**
    - get NIH funding
    - actively identify and manage your stock of scientific and pecuniary resources to mobilize material and social capital for commercial gain; be vigilant in identifying the possibility of, and obtaining property rights over, your research output
    - assess *all* your inventions for commercial potential
    - Research shows that women benefit from working with women in terms of patenting success
    - Be open to looking beyond productivity volume in terms of AE success; rather for quality and impact of work

3. **University resources**
    - Make yourself aware of the resources that are available to you institutionally Look for business training opportunities, mentors, including male senior mentors, tech transfer office programs, affiliation with a research center, welcoming industry networks

I also want to acknowledge the handful of articles that are addressing fundamental issues regarding AE generally, and female faculty: whether AE is "good" for society, and good for universities as historically constituted. In my experience, the narrative of "build U.S. competitiveness through innovation by 'activating' the previously under-represented" deserves more scrutiny. I recommend 2 articles that give this topic its due as regards sex/gender.

- deMelo-Martin, I. (2013): Patenting and the gender gap: Should women be encouraged to patent more? (Science and Engineering Ethics)

- Newson, J. (2012): Academic feminism's entanglements with university corporatization (Topia-Canadian Journal of Cultural Studies)

deMelo-Martin calls into question whether the drive for patenting, particularly in academia is good for society and whether it is a good measure of success of success for women building an academic career through research. Newson identifies academic feminism and the corporatization of the university as two rising forces of the late 20th century. She discusses how both have influenced the academy in significant ways. Answers to the question, "what is success?" are brought into question.

Finally, one is left with the realization that the literature on female faculty and academic entrepreneurship is single minded in its attention to barriers and biases against women. More theorizing is needed – and more creativity – to see the ways AE is enacted and could be enacted. Much more attention is due on the responsibility of the university, the business sector, and their joint ecosystems to develop best practices for inclusion. Diversity, inclusion, and equity need to be measured with results shared transparently, until equitable standards and participation are achieved. A vision beyond bias is called for.

STAGE 6: RESEARCH RECOMMENDATIONS

I have 6 recommendations for future research.

1. **Research on female faculty entrepreneurship can be envisioned theoretically from bases of theory in gender, high growth STEM entrepreneurship, academia/higher education, and innovation.** The study and core articles show a limitation in being highly descriptive and atheoretical. While describing things as they are is important to define the baseline, putting AE in institutional and economic contexts (among others) would boost value.

2. **More research is needed on why the university and the wider ecosystem of AE has been so ineffectual in addressing gender inequities in AE.** Furthermore, how this lack

of progress is related to gender inequity for females in academia in general, and in AE practice in particular.

3. **A good, research-based assessment review on best practices for gender equity in AE in colleges and universities is needed.** Mostly, discussion of corrections takes the form of rather ungrounded suggestions or reports on efforts undertaken. What works? should be a question to be answered.

4. **A comprehensive, careers-based focus on post-PhD life for women in STEM could aid women in making the right choices for themselves.** An options-based approach could illuminate how career paths are built inside, outside, and back and forth for women, including breaks for family life. AE could receive a critical review as a component part of career trajectories.

5. **As in many fields, the study of female academics, for the most part is a single focus activity: intersectional views are needed (Crenshaw 1991).** The theory of intersectionality, now blossoming in feminist research, allows for a much more realistic, much more robust consideration for studying people. Gender is not the only identity dimension of concern. This study shows that projects with an intersectional lens are needed both in descriptive and theoretical forms.

6. **The study of women faculty and AE should be more than a field concerned with bias and challenges.** A meta-level investigation of research topics of interest should be generated by funders interested in gender and its application in STEM.

Limitations

The realities of working in the time of COVID-19 presented challenges. Library access was limited for some services through the second half of this study. People were harder to reach. Research assistants were unreliable. As a result, due to time constraints, I was not able to integrate government and NGO reports into the study.

Relying on Web of Science to identify the initial database was a benefit and cost. Some articles may be missed, but the reach to more obscure journals in science, technology, and academia was increased.

I did not use a software package for thematic analysis. This too has its pros and cons. I may have missed some points, though I believe with my self-designed approach delivered more nuance and I now have a better grounding in the literature to design future studies.

Funding

This study was funded by the ARC-Network, an NSF funded program administered by the Association for Women in Science. The study represents my primary deliverable as an ARC Network Virtual Visiting Scholar (2019-20).

References

AWIS (Association for Women in Science). (2019). Available 5/15/19 at: https://www.awis.org/about-the-arc-network/.

Britton, D. (2016). Beyond the chilly climate: The salience of gender in women's academic careers, Gender and Society, 31(1): 5-27.

Chesler, N., Barabino, G., Bhatia, S., Richards-Kortum.R. (2010.) The pipeline still leaks and more than you think: A status report on gender diversity in biomedical engineering, Annals of Biomedical Engineering 38 (5):1928–35.

Cooper, H. M. (1998). Synthesizing research: A guide for literature reviews: Vol. 2. Applied social research methods (3rd ed.). Thousand Oaks, CA: Sage.

Ginther, D. & Kahn, S. (2012). Education and career outcomes for women of color in science and engineering, unpublished manuscript. Available 5/15/19 at: http://www.people.ku.edu/~dginther/Ginther_Kahn_WomenofColor.pdf.

Hanes, S., Ku, K., Primiano, L., & Arvin, A. (2018). Gender Analysis of Invention Disclosures and Companies Founded by Stanford University Faculty from 2000-2014. *les Nouvelles-Journal of the Licensing Executives Society*, *53*(1).

Krenshaw, K. (1991). Mapping the margins: Intersectionality, identity politics, and violence against women of color, Stanford Law Review, 43(6): 1241-1299.

MIT. (1999). A study on the status of women faculty in science at MIT. Cambridge, MA: Massachusetts Institute of Technology, First and Second Committees on Women Faculty in the School of Science, accessed 5/15/19 at: http://web.mit.edu/fnl/women/women.html

NAS (National Academies of Sciences), Committee on Women in Science, Engineering, and Medicine, available 5/15/19 at: https://sites.nationalacademies.org/PGA/cwsem/index.htm

NAS (National Academies of Science), Women in Science and Engineering Statistics. (2013). 30 Years after Bayh–Dole: Reassessing Academic Entrepreneurship, available May 6, 2019 at: http://sites.nationalacademies.org/pga/cwsem/PGA_049131

National Research Council. (2010). Gender differences at critical transitions in the careers of science, engineering, and mathematics faculty. Washington, DC: The National Academies Press.

Nelson, T., Nelson, D. (2020). Commercialization activity of MIT faculty across Science and Engineering: Comparing the engagement of women and men, unpublished manuscript.

Nelson, T., Constantindis, C. (2017). Sex and gender in family business research: A review and forward agenda from a social construction perspective, Family Business Review.

Appendix 1: N=22 Study review articles

Bozeman, B., Fay, D., & Slade, C. P. (2012). Research collaboration in universities and academic entrepreneurship: the-state-of-the-art. *The Journal of Technology Transfer*, *38*(1), 1-67.

Djokovic, D., & Souitaris, V. (2008). Spinouts from academic institutions: a literature review with suggestions for further research. *The Journal of Technology Transfer*, *33*(3), 225-247.

Gerbin, A., & Drnovsek, M. (2016). Determinants and public policy implications of academic-industry knowledge transfer in life sciences: A review and a conceptual framework. *The Journal of Technology Transfer*, *41*(5), 979-1076.

Geuna, A., & Muscio, A. (2009). The governance of university knowledge transfer: A critical review of the literature. *Minerva*, *47*(1), 93-114.

Hayter, C. S., Nelson, A. J., Zayed, S., & O'Connor, A. C. (2018). Conceptualizing academic entrepreneurship ecosystems: A review, analysis and extension of the literature. *The Journal of Technology Transfer*, *43*(4), 1039-1082.

Hmieleski, K. M., & Powell, E. E. (2018). The psychological foundations of university science commercialization: A review of the literature and directions for future research. *Academy of Management Perspectives*, *32*(1), 43-77.

Larsen, M. T. (2011). The implications of academic enterprise for public science: An overview of the empirical evidence. *Research Policy*, *40*(1), 6-19.

Lawton-Smith, H., Etzkowitz, H., Meschitti, V., & Poulovassilis, A. (2015). Female academic entrepreneurship: Reviewing the evidence and identifying the challenges. In: Henry, C. and Nelson, T. and Lewis, K. (eds.) *The Routledge Companion to Global Female Entrepreneurship*. London, Routledge.

Mars, M. M., & Rios-Aguilar, C. (2009). Academic entrepreneurship (re) defined: significance and implications for the scholarship of higher education. *Higher Education*, *59*(4), 441-460.

Mathisen, M. T., & Rasmussen, E. (2019). The development, growth, and performance of university spin-offs: a critical review. *The Journal of Technology Transfer*, *44*(6), 1891-1938.

Meyer, M., Grant, K., Morlacchi, P., & Weckowska, D. (2014). Triple Helix indicators as an emergent area of enquiry: a bibliometric perspective. *Scientometrics*, *99*(1), 151-174.

Mian, S., Lamine, W., & Fayolle, A. (2016). Technology Business Incubation: An overview of the state of knowledge. *Technovation*, *50*, 1-12.

Miranda, F. J., Chamorro, A., & Rubio, S. (2018). Re-thinking university spin-off: A critical literature review and a research agenda. *The Journal of Technology Transfer*, *43*(4), 1007-1038.

Mustar, P., Renault, M., Colombo, M., Piva, E., Fontes, M., Lockett, A., Wright, M., Clarysse, B., & Moray, N. (2006). Conceptualising the heterogeneity of research-based spin-offs: A multi-dimensional taxonomy. *Research Policy*, *35*(2), 289-308.

O'Shea, R. P., Chugh, H., & Allen, T. J. (2008). Determinants and consequences of university spinoff activity: a conceptual framework. *The Journal of Technology Transfer*, *33*(6), 653-666.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Brostrom, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, A., Lissoni, F., Salter, A., Sobero, M. (2013). Academic engagement and commercialisation: A review of the literature on university–industry relations. *Research Policy*, *42*(2), 423-442.

Rothaermel, F. T., Agung, S. D., & Jiang, L. (2007). University entrepreneurship: a taxonomy of the literature. *Industrial and Corporate Change*, *16*(4), 691-791.

Sandström, C., Wennberg, K., Wallin, M. W., & Zherlygina, Y. (2018). Public policy for academic entrepreneurship initiatives: a review and critical discussion. *The Journal of Technology Transfer*, *43*(5), 1232-1256.

Siegel, D. S., Veugelers, R., & Wright, M. (2007). Technology transfer offices and commercialization of university intellectual property: performance and policy implications. *Oxford Review of Economic Policy*, *23*(4), 640-660.

Skute, I. (2019). Opening the black box of academic entrepreneurship: a bibliometric analysis. *Scientometrics*, *120*(1), 237-265.

Teixeira, A., & Mota, L. (2012). A bibliometric portrait of the evolution, scientific roots and influence of the literature on University-Industry links. *Scientometrics*, *93,* 719-743.

Yusof, M., & Jain, K. K. (2008). Categories of university-level entrepreneurship: a literature survey. *International Entrepreneurship and Management Journal*, *6*(1), 81-96.

Appendix 2: N=123 study database

Abreu, M., & Grinevich, V. (2017). Gender patterns in academic entrepreneurship. *The Journal of Technology Transfer*, *42*(4), 763-794.

Abreu, M., Demirel, P., Grinevich, V., & Karataş-Özkan, M. (2016). Entrepreneurial practices in research-intensive and teaching-led universities. *Small Business Economics*, *47*(3), 695-717.

Aldridge, T. T., & Audretsch, D. (2011). The Bayh-Dole Act and Scientist Entrepreneurship. *Research Policy*, *40*(8), 1058-67.

Aldridge, T. T., Audretsch, D., Desai, S., & Nadella, V. (2014). Scientist entrepreneurship across scientific fields. *The Journal of Technology Transfer, 39(6),* 819-835

Aldridge, T., & Audretsch, D. B. (2010). Does policy influence the commercialization route? Evidence from National Institutes of Health funded scientists. *Research Policy*, *39*(5), 583-588.

Allen, S. D., Link, A. N., & Rosenbaum, D. T. (2007). Entrepreneurship and human capital: Evidence of patenting activity from the academic sector. *Entrepreneurship Theory and Practice*, *31*(6), 937-951.

Alshumaimri, A., Aldridge, T. T., & Audretsch, D. B. (2012). Scientist entrepreneurship in Saudi Arabia. *The Journal of Technology Transfer*, *37*(5), 648-657.

Anzai, Y., Meltzer, C. C., DeStigter, K. K., Destounis, S., Pawley, B. K., & Oates, M. E. (2016). Entrepreneurial women in radiology: role models of success. *Journal of the American College of Radiology*, *13*(11), 1378-1382.

Audretsch, D. B., & Aldridge, T. T. (2009). Scientist commercialization as conduit of knowledge spillovers. *The Annals of Regional Science*, *43*(4), 897-905.

Audretsch, D. B., Cunningham, J. A., Kuratko, D. F., Lehmann, E. E., & Menter, M. (2019). Entrepreneurial ecosystems: economic, technological, and societal impacts. *The Journal of Technology Transfer*, *44*(2), 313-325.

Azagra-Caro, J. M. (2007). What type of faculty member interacts with what type of firm? Some reasons for the delocalisation of university–industry interaction. *Technovation*, *27*(11), 704-715.

Azagra-Caro, J. M., Archontakis, F., Gutiérrez-Gracia, A., & Fernández-de-Lucio, I. (2006). Faculty support for the objectives of university–industry relations versus degree of R&D cooperation: The importance of regional absorptive capacity. *Research Policy*, *35*(1), 37-55.

Azoulay, P., Ding, W., & Stuart, T. (2007). The determinants of faculty patenting behavior: Demographics or opportunities? *Journal of Economic Behavior & Organization*, *63*(4), 599-623.

Azoulay, P., Ding, W., & Stuart, T. (2009). The impact of academic patenting on the rate, quality and direction of (public) research output. *The Journal of Industrial Economics*, *57*(4), 637-676.

Azoulay, P., Michigan, R., & Sampat, B. N. (2007). The anatomy of medical school patenting. *New England Journal of Medicine*, *357*(20), 2049-2056.

Baldini, N. (2009). Implementing Bayh–Dole-like laws: Faculty problems and their impact on university patenting activity. *Research Policy*, *38*(8), 1217-1224.

Beaudry, C., & Larivière, V. (2016). Which gender gap? Factors affecting researchers' scientific impact in science and medicine. *Research Policy*, *45*(9), 1790-1817.

Bell, A., Chetty, R., Jaravel, X., Petkova, N., & Van Reenen, J. (2019). Who becomes an inventor in America? The importance of exposure to innovation. *The Quarterly Journal of Economics*, *134*(2), 647-713.

Berger, L., Benschop, Y., & van den Brink, M. (2015). Practising gender when networking: The case of university–industry innovation projects. *Gender, Work & Organization*, *22*(6), 556-578.

Blackwell, L. V., Snyder, L. A., & Mavriplis, C. (2009). Diverse faculty in STEM fields: Attitudes, performance, and fair treatment. *Journal of Diversity in Higher Education*, *2*(4), 195.

Blit, J., Skuterud, M., & Zhang, J. (2018). an analysis of the patenting rates of Canada's ethnic populations. *Canadian Public Policy*, *44*(S1), S125-S145.

Boardman, P. C., & Ponomariov, B. L. (2009). University researchers working with private companies. *Technovation*, *29*(2), 142-153.

Bozeman, B., & Boardman, C. (2013). Academic faculty in university research centers: neither capitalism's slaves nor teaching fugitives. *The Journal of Higher Education*, *84*(1), 88-120.

Bozeman, B., & Corley, E. (2004). Scientists' collaboration strategies: implications for scientific and technical human capital. *Research Policy*, *33*(4), 599-616.

Bozeman, B., & Gaughan, M. (2007). Impacts of grants and contracts on academic researchers' interactions with industry. *Research Policy*, *36*(5), 694-707.

Bozeman, B., & Gaughan, M. (2011). How do men and women differ in research collaborations? An analysis of the collaborative motives and strategies of academic researchers. *Research Policy*, *40*(10), 1393-1402.

Bozeman, B., Fay, D., & Slade, C. P. (2013). Research collaboration in universities and academic entrepreneurship: the-state-of-the-art. *The Journal of Technology Transfer*, *38*(1), 1-67.

Calvo, N., Fernández-López, S., & Rodeiro-Pazos, D. (2019). Is university-industry collaboration biased by sex criteria? *Knowledge Management Research & Practice*, *17*(4), 408-420.

Chatterjee, C., & Ramu, S. (2018). Gender and its rising role in modern Indian innovation and entrepreneurship. *IIMB Management Review*, *30*(1), 62-72.

Cimenler, O., Reeves, K. A., & Skvoretz, J. (2015). An evaluation of collaborative research in a college of engineering. *Journal of Informetrics*, *9*(3), 577-590.

Clarysse, B., Tartari, V., & Salter, A. (2011). The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship. *Research Policy*, *40*(8), 1084-1093.

Colyvas, J. A., Snellman, K., Bercovitz, J., & Feldman, M. (2012). Disentangling effort and performance: a renewed look at gender differences in commercializing medical school research. *The Journal of Technology Transfer*, *37*(4), 478-489.

Comedy, Y. L., & Dougherty, E. L. (2018). Breaking Barriers: Female Inventors Blazing a Path Forward. *Technology & Innovation*, *19*(4), 751-758.

Corley, E., & Gaughan, M. (2005). Scientists' participation in university research centers: What are the gender differences? *The Journal of Technology Transfer*, *30*(4), 371-381.

Costa, J., & Rodrigues, C. (2020). Why innovative firms do not rely on universities as innovation sources? *Global Business and Economics Review*, *22*(4), 351-374.

Couch, S., Estabrooks, L. B., & Skukauskaite, A. (2018). Addressing the gender gap among patent holders through invention education policies. *Technology & Innovation*, *19*(4), 735-749.

Davey, T., Rossano, S., & Van der Sijde, P. (2015). Does context matter in academic entrepreneurship? The role of barriers and drivers in the regional and national context. *The Journal of Technology Transfer*, *41*(6), 1457-1482.

de Melo-Martín, I. (2013). Patenting and the gender gap: Should women be encouraged to patent more? *Science and Engineering Ethics*, *19*(2), 491-504.

Demiralp, B., Morrison, L. T., & Zayed, S. (2018). On the commercialization path: Entrepreneurship and intellectual property outputs among women in STEM. *Technology & Innovation*, *19*(4), 707-726.

Ding, W. W., Murray, F., & Stuart, T. E. (2006). Gender differences in patenting in the academic life sciences. *Science*, *313*(5787), 665-667.

Ding, W. W., Murray, F., & Stuart, T. E. (2013). From bench to board: Gender differences in university scientists' participation in corporate scientific advisory boards. *Academy of Management Journal*, *56*(5), 1443-1464.

Ding, W., & Choi, E. (2011). Divergent paths to commercial science: A comparison of scientists' founding and advising activities. *Research Policy*, *40*(1), 69-80.

Ebersberger, B., & Pirhofer, C. (2011). Gender, management education and the willingness for academic entrepreneurship. *Applied Economics Letters*, *18*(9), 841-844.

Fältholm, Y., Abrahamsson, L., & Källhammer, E. (2010). Academic entrepreneurship: gendered discourses and ghettos. *Journal of Technology Management & Innovation*, *5*(1), 51-63.

Fechner, H., & Shapanka, M. S. (2018). Closing diversity gaps in innovation: Gender, race, and income disparities in patenting and commercialization of inventions. *Technology & Innovation*, *19*(4), 727-734.

Fini, R., Fu, K., Mathisen, M. T., Rasmussen, E., & Wright, M. (2017). Institutional determinants of university spin-off quantity and quality: a longitudinal, multilevel, cross-country study. *Small Business Economics*, *48*(2), 361-391.

Fox, M. F., & Xiao, W. (2013). Perceived chances for promotion among women associate professors in computing: individual, departmental, and entrepreneurial factors. *The Journal of Technology Transfer*, *38*(2), 135-152.

Fritsch, M., & Krabel, S. (2012). Ready to leave the ivory tower? Academic scientists' appeal to work in the private sector. *The Journal of Technology Transfer*, *37*(3), 271-296.

Gallagher, P. M., Alestalo, S. W., Bhatia, S. K., Athanasopoulos-Zekkos, A., & Soundarajan, S. (2018). Geotechnical Women Faculty from 1989–2017: A US Case Study. In *IFCEE 2018*: *Recent Developments in Geotechnical Engineering Practice*, 434-447.

Gaughan, M., & Corley, E. A. (2010). Science faculty at US research universities: The impacts of university research center-affiliation and gender on industrial activities. *Technovation*, *30*(3), 215-222.

Ghiasi, G., Larivière, V. (2018). *On the Gendered Examination of Patents* [Paper presentation]. SIGMET Workshop 2018, Vancouver, Canada.

Ghiasi, G., Larivière, V., & Sugimoto, C. R. (2015). On the compliance of women engineers with a gendered scientific system. *PloS One*, *10*(12).

Giuliani, E., Morrison, A., Pietrobelli, C., & Rabellotti, R. (2010). Who are the researchers that are collaborating with industry? An analysis of the wine sectors in Chile, South Africa and Italy. *Research Policy*, *39*(6), 748-761.

Giuri, P., Grimaldi, R., Kochenkova, A., Munari, F., & Toschi, L. (2020). The effects of university-level policies on women's participation in academic patenting in Italy. *The Journal of Technology Transfer*, *45*(1), 122-150.

Goel, R. K., & Göktepe-Hultén, D. (2013). Nascent entrepreneurship and inventive activity: a somewhat new perspective. *The Journal of Technology Transfer*, *38*(4), 471-485.

Goel, R. K., & Göktepe-Hultén, D. (2018). What drives academic patentees to bypass TTOs? Evidence from a large public research organisation. *The Journal of Technology Transfer*, *43*(1), 240-258.

Goel, R. K., & Göktepe-Hultén, D. (2019). Innovation by foreign researchers: relative influences of internal versus external human capital. *The Journal of Technology Transfer*, 1-19.

Goel, R. K., & Göktepe-Hultén, D. (2019). Risk attitudes, patenting and invention disclosures by academic researchers. *The Journal of Technology Transfer*, *44*(1), 155-166.

Goel, R. K., & Göktepe-Hultén, D. (2020). Drivers of innovation productivity of academic researchers through career advancement. *The Journal of Technology Transfer*, *45*(2), 414-429.

Goel, R. K., & Göktepe-Hultén, D. (2018). Academic leadership and commercial activities at research institutes: German evidence. *Managerial and Decision Economics*, *39*(5), 601-609.

Goethner, M., Obschonka, M., Silbereisen, R. K., & Cantner, U. (2012). Scientists' transition to academic entrepreneurship: Economic and psychological determinants. *Journal of Economic Psychology*, *33*(3), 628-641.

Göktepe-Hulten, D., & Mahagaonkar, P. (2010). Inventing and patenting activities of scientists: in the expectation of money or reputation? *The Journal of Technology Transfer*, *35*(4), 401-423.

Grimpe, C., & Fier, H. (2010). Informal university technology transfer: a comparison between the United States and Germany. *The Journal of Technology Transfer*, *35*(6), 637-650.

Guerzoni, M., Aldridge, T. T., Audretsch, D. B., & Desai, S. (2014). A new industry creation and originality: Insight from the funding sources of university patents. *Research Policy, 43*(10), 1697-1706.

Guo, F., Restubog, S. L. D., Cui, L., Zou, B., & Choi, Y. (2019). What determines the entrepreneurial success of academics? Navigating multiple social identities in the hybrid career of academic entrepreneurs. *Journal of Vocational Behavior*, *112*, 241-254.

Haase, H., Franco, M., & Fernandes, A. (2012, September). University-industry collaboration: do the characteristics of academic staff matter? In *Proceedings of the 7th European Conference on Innovation and Entrepreneurship: ECIE* (p. 289).

Haeussler, C., & Colyvas, J. A. (2011). Breaking the ivory tower: Academic entrepreneurship in the life sciences in UK and Germany. *Research Policy*, *40*(1), 41-54.

Hanes, S., Ku, K., Primiano, L., & Arvin, A. (2018). Gender Analysis of Invention Disclosures and Companies Founded by Stanford University Faculty from 2000-2014. *les Nouvelles-Journal of the Licensing Executives Society*, *53*(1).

Hazelwood, V., Carpenter-Smith, E., Continisio, M., DeAngelo, V., Mugurusa, R., Gray, M., Hassler, C., & Wos, J. (2019). What Might We Do to Encourage More Women to Write Patents? *Technology & Innovation*, *21*(1), 43-48.

Hernández-Martín, E., Calle, F., Dueñas, J. C., Holgado, M., & Gómez-Pérez, A. (2019). Participation of women in doctorate, research, innovation, and management activities at

Universidad Politécnica de Madrid: analysis of the decade 2006–2016. *Scientometrics*, *120*(3), 1059-1089.

Hosler, L. (2018). Mind the gap: the USPTO's efforts to narrow the gender gap in patenting and innovation. *Technology and Innovation*, *19*(4), 759-762.

Howe, S. A., Juhas, M. C., & Herbers, J. M. (2014). Academic women: Overlooked entrepreneurs. *Peer Review*, *16*(2), 17.

Huang, C. Y. (2018). How background, motivation, and the cooperation tie of faculty members affect their university–industry collaboration outputs: an empirical study based on Taiwan higher education environment. *Asia Pacific Education Review*, *19*(3), 413-431.

Huang, C. Y., Yang, C. W., & Fang, S. C. (2019). The contrasting interaction effects of university-industry collaboration motivation with demographic characteristics on university-industry collaboration performance in Taiwan. *Technology Analysis & Strategic Management*, *31*(9), 1048-1062.

Huyghe, A., & Knockaert, M. (2015). The influence of organizational culture and climate on entrepreneurial intentions among research scientists. *The Journal of Technology Transfer*, *40*(1), 138-160.

Karlsson, T., & Wigren, C. (2012). Start-ups among university employees: the influence of legitimacy, human capital and social capital. *The Journal of Technology Transfer*, *37*(3), 297-312.

Klofsten, M., & Jones-Evans, D. (2000). Comparing academic entrepreneurship in Europe–the case of Sweden and Ireland. *Small Business Economics*, *14*(4), 299-309.

Knockaert, M., Der Foo, M., Erikson, T., & Cools, E. (2015). Growth intentions among research scientists: A cognitive style perspective. *Technovation*, *38*, 64-74.

Kou, M., Zhang, Y., Zhang, Y., Chen, K., Guan, J., & Xia, S. (2020). Does gender structure influence R&D efficiency? A regional perspective. *Scientometrics*, *122*(1), 477-501.

Krabel, S., & Mueller, P. (2009). What drives scientists to start their own company? An empirical investigation of Max Planck Society scientists. *Research Policy*, *38*(6), 947-956.

Landry, R., Amara, N., & Saïhi, M. (2007). Patenting and spin-off creation by Canadian researchers in engineering and life sciences. *The Journal of Technology Transfer*, *32*(3), 217-249.

Libaers, D. (2014). Foreign-Born Academic Scientists and Their Interactions with Industry: Implications for University Technology Commercialization and Corporate Innovation Management. *Journal of Product Innovation Management*, *31*(2), 346-360.

Link, A. N., Siegel, D. S., & Bozeman, B. (July 11, 2007). An empirical analysis of the propensity of academics to engage in informal university technology transfer. *Industrial and Corporate Change, 16,* 4, 641-655.

Lowe, R. A., & Gonzalez-Brambila, C. (2007). Faculty entrepreneurs and research productivity. *The Journal of Technology Transfer*, *32*(3), 173-194.

Marcowitz-Bitton, M., Kaplan, Y., & Morris, E. M. (2019). Unregistered Patents & Gender Equality. *Harvard Journal of Law & Gender*, *43*, 47.

Mauleón, E., Daraio, C., & Bordons, M. (2014). Exploring gender differences in patenting in Spain. *Research Evaluation*, *23*(1), 62-78.

McCook, A. (2013). Barred from the boardroom. *Nature*, *495*(7439), 25.

Melkers, J., & Xiao, F. (2012). Boundary-spanning in emerging technology research: Determinants of funding success for academic scientists. *The Journal of Technology Transfer*, *37*(3), 251-270.

Meng, Y. (2016). Collaboration patterns and patenting: Exploring gender distinctions. *Research Policy*, *45*(1), 56-67.

Meng, Y. (2018). Gender distinctions in patenting: Does nanotechnology make a difference? *Scientometrics*, *114*(3), 971-992.

Mercier, N. R., Ranjit, V., & Reardon, R. J. (2018). Engaging women innovators: Analytical support for women innovator programming in university technology transfer. *Technology & Innovation*, *19*(4), 685-699.

Miranda, F. J., Chamorro-Mera, A., Rubio, S., & Pérez-Mayo, J. (2017). Academic entrepreneurial intention: the role of gender. *International Journal of Gender and Entrepreneurship*.

Moog, P., Werner, A., Houweling, S., & Backes-Gellner, U. (2015). The impact of skills, working time allocation and peer effects on the entrepreneurial intentions of scientists. *The Journal of Technology Transfer*, *40*(3), 493-511.

Morgan, R. P., Kruytbosch, C., & Kannankutty, N. (2001). Patenting and invention activity of US scientists and engineers in the academic sector: comparisons with industry. *The Journal of Technology Transfer*, *26*(1-2), 173-183.

Muñoz, R. T., & Graña, C. P. (2016). The effects of gender on the quality of university patents and public research centres in Andalusia: is it better with a female presence? *Economics & Sociology*, *9*(1), 220.

Murray, F., & Graham, L. (2007). Buying science and selling science: gender differences in the market for commercial science. *Industrial and Corporate Change*, *16*(4), 657-689.

Newson, J. (2012). Academic feminism's entanglements with university corporatization. *TOPIA: Canadian Journal of Cultural Studies*, *28*, 41-63.

O'Hagan, C., O'Connor, P., Myers, E. S., Baisner, L., Apostolov, G., Topuzova, I., Saglamer, G., Tan, M. G., & Çağlayan, H. (2019). Perpetuating academic capitalism and maintaining gender

orders through career practices in STEM in universities. *Critical Studies in Education*, *60*(2), 205-225.

Plank-Bazinet, J. L., Whittington, K. B., Cassidy, S. K., Filart, R., Cornelison, T. L., Begg, L., & Clayton, J. A. (2016). Programmatic efforts at the National Institutes of Health to promote and support the careers of women in biomedical science. *Academic Medicine*, *91*(8), 1057.

Polkowska, D. (2013). Women scientists in the leaking pipeline: barriers to the commercialisation of scientific knowledge by women. *Journal of Technology Management & Innovation*, *8*(2), 156-165.

Roberto, F., Rey, A., Maglio, R., & Agliata, F. (2020). The academic "glass-ceiling": investigating the increase of female academicians in Italy. *International Journal of Organizational Analysis*.

Rodríguez-Gulías, M. J., Fernández-López, S., & Rodeiro-Pazos, D. (2018). Gender differences in growth of Spanish university spin-offs. *Gender in Management: An International Journal*.

Rosa, P., & Dawson, A. (2006). Gender and the commercialization of university science: academic founders of spinout companies. *Entrepreneurship and Regional Development*, *18*(4), 341-366.

Sanberg, P. R., & Schreiber, C. (2020). The State of the Academy: Commentary on the Growth Of the National Academy of Inventors. *Technology & Innovation*, *21*(2), 179-185.

Schuelke-Leech, B. A. (2013). Resources and research: An empirical study of the influence of departmental research resources on individual STEM researchers involvement with industry. *Research Policy*, *42*(9), 1667-1678.

Sexton, K. B., & Ligler, F. S. (2018). Strategies to close the gender gap in invention and technology commercialization. *Technology & Innovation*, *19*(4), 701-706.

Shane, S., Dolmans, S. A., Jankowski, J., Reymen, I. M., & Romme, A. G. L. (2015). Academic entrepreneurship: Which inventors do technology licensing officers prefer for spinoffs? *The Journal of Technology Transfer*, *40*(2), 273-292.

Slavtchev, V., & Göktepe-Hultén, D. (2016). Support for public research spin-offs by the parent organizations and the speed of commercialization. *The Journal of Technology Transfer*, *41*(6), 1507-1525.

Sohar, K., Mercier, N., Goble, L., Ghahramani, F., & Loftin, B. (2018). Gender data gap: Baseline of US academic institutions. *Technology & Innovation*, *19*(4), 671-683.

Stephan, P. E., & El-Ganainy, A. (2007). The entrepreneurial puzzle: explaining the gender gap. *The Journal of Technology Transfer*, *32*(5), 475-487.

Strong, D. R., Chandran, V. G. R., & Hayter, C. S. (2018). Great expectations: assessing the impact of commercialization-focused policies among Malaysia's public research institutes. *Economics of Innovation and New Technology*, *27*(5-6), 438-453.

Su, X. (2014). Academic scientists' affiliation with university research centers: Selection dynamics. *Research Policy*, *43*(2), 382-390.

Sugimoto, C. R., Ni, C., West, J. D., & Larivière, V. (2015). The academic advantage: Gender disparities in patenting. *PloS One*, *10*(5).

Tartari, V., & Salter, A. (2015). The engagement gap: Exploring gender differences in university–industry collaboration activities. *Research Policy*, *44*(6), 1176-1191.

Thursby, J. G., & Thursby, M. C. (2005). Gender patterns of research and licensing activity of science and engineering faculty. *The Journal of Technology Transfer*, *30*(4), 343-353.

Turrentine, A., & Well, V. (2015). Career advancement through academic commercialization: acknowledging and reducing barriers for women engineering faculty. In *122nd ASEE Annual Conference & Exposition*, 14-17.

van Holm, E. J., Jung, H., & Welch, E. W. (2020). The impacts of foreignness and cultural distance on commercialization of patents. *The Journal of Technology Transfer*, 1-33.

Weng, H. J., & Chang, D. F. (2016). Determining the influence of heterogeneity in graduate institutions on university–industry collaboration policy in Taiwan. *Asia Pacific Education Review*, *17*(3), 489-499.

Whittington, K. B. (2011). Mothers of invention? Gender, motherhood, and new dimensions of productivity in the science profession. *Work and Occupations*, *38*(3), 417-456.

Whittington, K. B. (2018). A tie is a tie? Gender and network positioning in life science inventor collaboration. *Research Policy*, *47*(2), 511-526.

Whittington, K. B., & Smith-Doerr, L. (2005). Gender and commercial science: Women's patenting in the life sciences. *The Journal of Technology Transfer*, *30*(4), 355-370.

Whittington, K. B., & Smith-Doerr, L. (2008). Women inventors in context: Disparities in patenting across academia and industry. *Gender & Society*, *22*(2), 194-218.

Zhang, F., Yan, E., Niu, X., & Zhu, Y. (2018). Joint modeling of the association between NIH funding and its three primary outcomes: patents, publications, and citation impact. *Scientometrics*, *117*(1), 591-602.