



# Identifying the emergence of academic entrepreneurship within the technology transfer literature

Christopher S. Hayter<sup>1</sup> · Albert N. Link<sup>2</sup> · Matthew Schaffer<sup>3</sup>

Accepted: 19 July 2023 / Published online: 7 August 2023

© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2023

## Abstract

Though academic entrepreneurship has long been associated with technology transfer and more broadly with the passage of the Bayh–Dole Act in 1980, we have little understanding of its emergence as a research field. This paper therefore investigates development of the concept of academic entrepreneurship by studying the use of related keywords in the titles of papers published in the *Journal of Technology Transfer (JTT)* beginning with volume 1 in 1977. We conclude from our empirical findings that the role of universities in technology transfer has been consistently emphasized in the titles of papers published in the *JTT* over time, with entrepreneurship emerging more recently as a crucial area of scholarly focus.

**Keywords** Academic entrepreneurship · Entrepreneurial university · Technology transfer · Project evaluation · Research portfolio choices

**JEL Classification** O33 · L26 · H4 · G11

## 1 Introduction

Academic entrepreneurship—the establishment of new ventures to commercialize technology derived from university research—has long been recognized as a critical activity at research universities and as a fundamental contributor to regional economic development and dynamism. Though scholars have focused on academic entrepreneurship for nearly

---

✉ Albert N. Link  
anlink@uncg.edu

Christopher S. Hayter  
chayter3@gatech.edu

Matthew Schaffer  
mschaff5@emich.edu

<sup>1</sup> Georgia Institute of Technology, Atlanta, GA, USA

<sup>2</sup> University of North Carolina at Greensboro, Greensboro, NC, USA

<sup>3</sup> Eastern Michigan University, Ypsilanti, MI, USA

four decades (e.g., Doutriaux, 1987), we have little understanding about when and how this category of scholarship emerged over time.

The origins of technology transfer research can arguably be traced back at least to Gilmore (1969, p.2) who defined the concept as “a purposive, conscious effort to move technical devices, materials, methods, and/or information from the point of discovery or development to new users.” Table 1 includes several early definitions of technology transfer by academic researchers and policy organizations.<sup>1</sup>

Given our interest in the origins of academic entrepreneurship,<sup>2</sup> we note that except for WIPO, the listed definitions in Table 1 do not describe technology transfer as an activity of focus for universities or other research institutions. Yet, one might also surmise from the definitions in the table that technology transfer does include elements—such as knowledge development (e.g., inventions or innovations), intellectual property (e.g., patents), and scientific outcomes (e.g., scientific publications)—that are constituent considerations within the academic entrepreneurship literature.<sup>3</sup>

This paper therefore investigates the emergence of academic entrepreneurship within the context of the technology transfer literature. We began our study with the maintained assumption that researchers themselves are an important source, if not the most appropriate source, of information to rely on to characterize the scope of research related to technology transfer. The *Journal of Technology Transfer (JTT)* is arguably the premier academic journal primarily devoted to the study of technology transfer.

The *JTT* was established in 1977.<sup>4</sup> Its purpose was to publish conference proceedings from periodic meetings of the Technology Transfer Society; members of the Society primarily represented technology transfer personnel from federal laboratories located within the United States. Editorial responsibility for the *JTT* rotated among non-academic members until 1996,<sup>5</sup>

---

<sup>1</sup> As discussed below, noteworthy is the fact that the Jolly and Creighton (1977) definition of technology transfer in Table 1 appeared in the first issue of the *Journal of Technology Transfer (JTT)*.

<sup>2</sup> Arguably, the contemporary defining study on academic entrepreneurship is by Siegel and Wright (2015). Relatedly, see Urbano and Guerrero (2013), Guerrero and Urbano (2014), Schmitz et al. (2017), and Roncancio-Marin (2022).

<sup>3</sup> See literature reviews by Hayter et al. (2018) and Mathisen and Rasmussen (2019). See also Hayter and Link (2018) for the strategic role of publications in nascent ventures.

<sup>4</sup> In the first issue of the *JTT*, in 1977, the scope of the journal was described in the following way (Editorial, 1977, p. 5): “It is the desire of the editors and the editorial advisory board to have articles in the *Journal of Technology Transfer* that cover a specific range of interest. There should be some theoretical articles dealing with technology transfer, technology assessment, and technology forecasting. Some articles should concentrate on the pragmatic techniques used to accomplish technology transfer, technology assessment or technology forecasting. A third category, that is believed to be of importance to the *Journal of Technology Transfer* readers, is case studies of technology assessment or technology forecasting. Both successful and unsuccessful cases need to be documented and reported. Both are important for education and reference. Yet another, a fourth category, that appears to have reader interest, is a narrative description of an organization whose principle product is the main stream of technology transfer, technology assessment or technology forecasting.”

<sup>5</sup> The aims and scope of the *Journal of Technology Transfer* under the new editorial regime has not changed over time. It remains as: “*The Journal of Technology Transfer* provides an international forum for research on the economic, managerial and policy implication of technology transfer, entrepreneurship, and innovation. The *Journal* is especially interested in articles that focus on the relationship between the external environment and organizations (governments, public agencies, firms, universities) and their innovation process. The *Journal* welcomes alternative modes of presentation ranging from broad empirical analyses, to theoretical models, to case studies based on theoretical foundations.” See <https://www.springer.com/journal/10961/aims-and-scope>.

**Table 1** Selected definitions of *technology transfer* (listed chronically)

Author(s)	Definition
Doctors (1969, p. 12)	“Federal agencies have tended to interpret their technology transfer mission in terms of documentation and formal information dissemination”
Gilmore (1969, p. 2)	“[Technology transfer is] a purposive, conscious effort to move technical devices, materials, methods, and/or information from the point of discovery or development to new users”
Bar-Zakay (1971, p. 214)	“When scientific or technological information generated and/or used in one context is reevaluated and/or implemented in a different context, the process is called technology transfer”
Comptroller General of the United States (1979, p. 5)	“[Technology transfer is] the secondary application of technology developed for a particular mission or purpose to fill different needs in another environment”
National Academy of Engineering (1974, p. 4)	“The process of collection, documentation, and successful dissemination of scientific and technological information to a receiver through a number of mechanisms, both formal and informal, passive and active”
Federal Coordinating Council for Science, Engineering, and Technology (1977, p. v)	“In its broadest sense, technology transfer encompasses the collection, documentation, of scientific and technical information, including data on the performance and costs of using technology; the transformation of research and technology into processes, products, and services that can be applied to public or private needs; and the secondary application of research or technology developed for a particular mission that fills a need in another environment”
Jolly and Creighton (1977, p. 78)	“[Technology transfer is] the acceptance by a user of a practice common elsewhere, or may be a different application of a given technique designed originally for another use”
Teich (1979, p. 5)	“There is single, unambiguous meaning to the term “technology transfer.” In practice, the notion encompasses a variety of activities all of which aim to transform R&D into products, processes or services that can serve needs in the public or private sectors”
Tuma (1987, p. 404)	“Technology transfer means acquisition and adaptation of a technique from one country or industry to another and its application in the production process. The transfer becomes complete when the technique has been domesticated and utilized as an integral part of the domestic production economy”
Seely (2003, p. 8)	“Technology transfer [is] the processes and consequences of moving technological ideas, skills, processes, hardware, and systems across a variety of boundaries—national, geographic, social and cultural, or organizational and institutional...”

**Table 1** (continued)

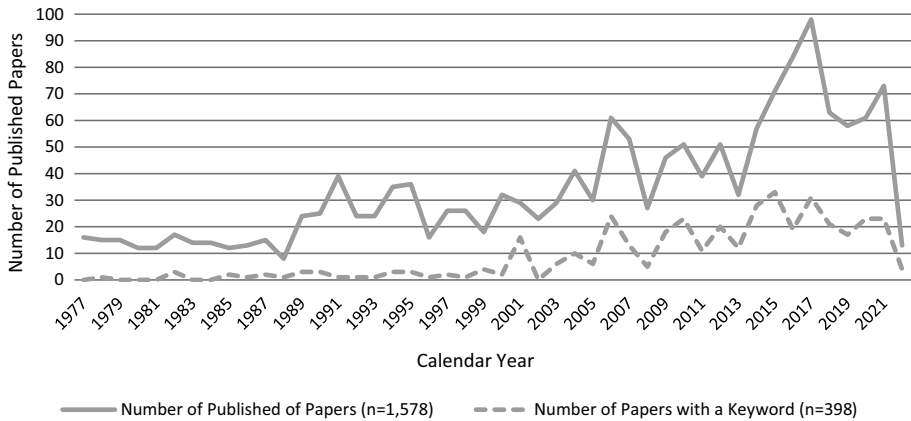
Author(s)	Definition
Association for University Technology Managers–AUTM (undated)	“[Technology transfer is] about evaluating, protecting and transferring intellectual property from the lab to the marketplace, corporate engagement, start-up and entrepreneurial support, and economic development”
Federal Laboratory Consortium for Technology Transfer (undated)	“Technology transfer is the process by which existing knowledge, facilities, or capabilities developed under federal R&D funding are utilized to fulfill public and private needs”
World Intellectual Property Organization (WIPO) (undated)	“Technology transfer (TT) is a collaborative process that allows scientific findings, knowledge and intellectual property to flow from creators, such as <i>universities and research institutions</i> [emphasis added], to public and private users. Its goal is to transform inventions and scientific outcomes into new products and services that benefit society. Technology transfer is closely related to knowledge transfer”

when A. Link was invited to be an editor of the journal.<sup>6</sup> In 1998/1999 Link invited D. Siegel and M. Wright to join as co-editors, and Link became Editor-in-Chief. Also during this transition, the publication of the journal changed from a self-published society publication to an academic journal managed and published by Kluwer Academic Publishers. Kluwer Academic Publishers later merged with Springer-Verlag (now Springer). After 1998/1999, others were invited to join the editorial structure as co-editors and co-associate editors. The broadly defined focus of the *JIT* did not change with the new editorial structure, but the preferred methodology and methods of research did change to reflect less of a practitioner perspective and more of an academic perspective.

Given the journal’s history and evolution, we view the *JIT* as an appropriate source from which to obtain relevant information to address the research questions considered in this paper.

The remainder of this paper is organized as follows. In Sect. 2, we describe the data used to characterize the scope of published research related to technology transfer, and we identify keywords from the titles of published papers used by authors to define the activities of emphasis in their study. In Sect. 3, we posit an econometric model from which to investigate changes over time in the use of researchers’ keywords in the titles of their published papers that describe their published technology transfer research, and we discuss our findings. In Sect. 4, we offer a summary statement, and we conclude that if past is prologue, our analysis might represent a roadmap for future research.

<sup>6</sup> Maria Papadakis of James Madison University was also invited to be an editor.



**Fig. 1** Number of published papers and number of published papers with a Keyword of *University*, *Universities*, or *Academic* in the Title, by Calendar Year

## 2 The data

Springer, the publisher of the *JTT*, graciously provided a database from which we could extract the title of all published papers in the *JTT*, by calendar year.<sup>7</sup> The database begins with the first issue of the journal in 1977 and goes through mid-2022. Over these decades there were 1649 titled entries in the *JTT*. Given the purpose of our research, we deleted a number of these entries. Those deleted were book reviews, editorials, errata statements, and introductions to special or symposium issues. The resulting sampling population contains 1578 published papers. Based on a word search of published paper titles, the most commonly used terms by authors focus on dimensions of university activity. Using the designated keywords of *university*, *universities*, and *academic*, we arrived at 398 uniquely titled papers over the calendar years 1977 through mid-2022.<sup>8</sup> These 398 titled papers represent 25.2% of the sampling population of published papers.

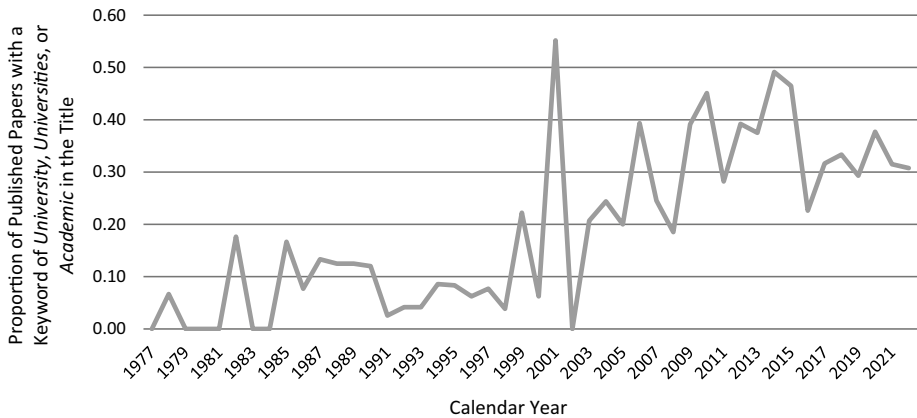
Figure 1 shows, by calendar year, the total number of published papers and the number of published papers using at least one of the three designated keywords. The precipitous drop in both metrics in 2022 is due to data being available for only a part of that calendar year.<sup>9</sup> The trend in both metrics is visually positive, and the two lines of trend appear to move together.

Figure 2 shows the proportion of published papers using at least one of the keywords of *university*, *universities*, or *academic*, by calendar year. The trend in this metric is also positive. Noticeable in the figure is that in 2001 over one-half of the titled papers were related to university activity. In that year, the majority of these papers were part of a special double issue that focused on organizational issues in university-industry technology transfer.

<sup>7</sup> In this paper, we define the year of publication to be the calendar year of the online publication of a paper. This dating method most closely identifies in time the year relevant to the author's choice of keywords. At the *JTT*, an author's online published paper occurs within weeks of the paper's final acceptance.

<sup>8</sup> 304 of the 1578 published papers used either the term *technology transfer(s)* or *technology-transfer(s)*, and a number of those paper titles focused on the university. The term *Bayh-Dole* appeared three times.

<sup>9</sup> We did not expand the sampling population to the end of calendar year 2022 because the date of an online publication was not consistently available.



**Fig. 2** Proportion of published papers with a keyword of *University*, *Universities*, or *Academic* in the Title, by Calendar Year

**Table 2** Definition of calendar year key variables

Variable	Definition
<i>NumberUses</i>	Number of online published papers per calendar year that contained a keyword of <i>university</i> , <i>universities</i> , or <i>academic</i>
<i>ProportionUses</i>	Proportion of online published papers per calendar year that contained a keyword of <i>university</i> , <i>universities</i> , or <i>academic</i>
<i>Trend</i>	Calendar year of publication minus 1976
<i>NumberPublishedPapers</i>	Number of online published papers per calendar year
<i>BD</i>	= 1 for the decade after the passage of the Bayh–Dole Act (December 1980); 0 otherwise
<i>ED</i>	= 1 for the years after 1996 when the current editorial structure of the journal was established; 0 otherwise
<i>Covid</i>	= 1 in the calendar years after 2019; 0 otherwise

### 3 Empirical analysis

Empirical models were considered to identify covariates with both the calendar year number of papers with a title using a designated keyword (*NumberUses*) and with the calendar year proportion of total published papers represented by that metric (*ProportionUses*). The key variables for the estimation of these two models are defined in Table 2, and descriptive statistics on these variables are presented in Table 3.

Table 4 shows the least-squares regression results from each model to explain the trend over time in the number of published papers using at least one of the designated keywords (column (1)) and the trend in the proportion of published papers using at least one of the designated keywords (column (2)). For the first model, the total calendar year number of published papers, *NumberPublishedPapers*, is held constant. The calendar year number of published papers using at least one of the designated keyword appears from Fig. 1 to be related to the total calendar year number of papers. One might expect, based on Fig. 1, that these two metrics are positively correlated. Held constant in both models are three control variables.

**Table 3** Descriptive statistics on calendar year key variables (n = 46)

Variable	Mean	Standard error	Range
<i>NumberUses</i>	8.543	9.715	0–33
<i>ProportionUses</i>	0.192	0.156	0–0.536
<i>Trend</i>	–	–	1–46
<i>NumberPublishedPapers</i>	33.50	21.277	8–96
<i>BD</i>	0.217	0.417	0/1
<i>ED</i>	0.565	0.501	0/1
<i>Covid</i>	0.065	0.250	0/1

**Table 4** Least-squares regression results based on the data underlying Figs. 1 and 2 (*p* values in parentheses)

Variable	(1) <i>NumberUses</i>	(2) <i>ProportionUses</i>
<i>Trend</i>	0.092 ( <i>p</i> = .498)	0.008 ( <i>p</i> = .002)
<i>NumberPublished-Papers</i>	0.338 ( <i>p</i> < .0001)	–
<i>BD</i>	1.241 ( <i>p</i> = .513)	0.056 ( <i>p</i> = .219)
<i>ED</i>	2.592 ( <i>p</i> = .361)	0.064 ( <i>p</i> = .328)
<i>Covid</i>	0.296 ( <i>p</i> = .923)	–0.052 ( <i>p</i> = .455)
<i>Intercept</i>	–6.685 ( <i>p</i> = .0003)	–0.047 ( <i>p</i> = .257)
R <sup>2</sup>	0.834	0.624
F-level	40.22	16.98
N	46	46

9 of the 46 observations on *NumberUses* were 0, thus the use of a Probit or negative binominal specification of the model is inappropriate. Also, one cannot reject the null hypothesis of no autocorrelation in either model based on Durbin–Watson statistics

The research environment provided through the Bayh–Dole Act of 1980 is one control variable. The act provided universities right of first refusal for title to federally funded research results, and many scholars have associated the passage of this act with increased research on university patenting activity.<sup>10</sup> The effect of the Bayh–Dole Act on papers published in the *JTT* that relate to university and academic behavior, *BD*, is assumed for estimation purposes to be present for a decade (see Table 2). We hypothesize that the estimated coefficient on *BD* will be positive.

Given the editorial changes discussed above, post-1996 editorial dynamics are denoted in the models by the variable *ED*. We offer no hypothesis about the algebraic sign on *ED*.

Finally, the post-Covid-19 years are also held constant by the variable *Covid*. In the post-2019 period it became difficult for editors of all journals to find suitable reviewers for submitted papers. It is an empirical issue as to whether that factor affected the topic selection of researchers who, in many instances, were transitioning to online teaching, or the time for a review of submitted papers to be completed. Thus, we offer no hypothesis about the algebraic sign on *Covid*.

<sup>10</sup> See, for example, Link et al. (2011) and Link and Van Hasselt (2019, 2023). A detailed discussion of the Bayh–Dole Act is in, for example, Link and Oliver (2020).

**Table 5** Least-squares regression results based on first-differences in the data underlying Figs. 1 and 2 (*p* values in parentheses)

Variable	(1) $\Delta$ <i>NumberUses</i>	(2) $\Delta$ <i>ProportionUses</i>
<i>Trend</i>	-0.027 ( <i>p</i> = .851)	-0.002 ( <i>p</i> = .641)
$\Delta$ <i>NumberPublishedPapers</i>	0.353 ( <i>p</i> < .0001)	-
<i>BD</i>	-1.980 ( <i>p</i> = .455)	-0.004 ( <i>p</i> = .957)
<i>ED</i>	-0.481 ( <i>p</i> = .897)	0.043 ( <i>p</i> = .669)
<i>Covid</i>	1.012 ( <i>p</i> = .802)	0.015 ( <i>p</i> = .891)
<i>Intercept</i>	1.410 ( <i>p</i> = .576)	0.026 ( <i>p</i> = .709)
R <sup>2</sup>	0.503	0.006
F-level	7.91	0.06
N	45	45

The regression results in column (1) of Table 4 suggest that annual changes in *NumberPublishedPapers* are positively and significantly related to annual changes in *NumberUses*. Holding constant *NumberPublishedPapers*, the estimated coefficient on *Trend* is positive but it is not significantly different from zero. The regression results in column (2) suggest a mild yet significant trend in the proportion of calendar year published papers that use a designated keyword in the title. None of the control variables are significant in either model.

However, an inspection of the data pattern of *NumberUses* (see Fig. 1) and *ProportionUses* (see Fig. 2) over time suggests that neither of the two time series is stationary. To obtain reliable coefficients from a time series regression estimated by ordinary least squares, all variables must be stationary.<sup>11</sup> Accordingly, we implemented Augmented Dickey-Fuller (ADF) tests for *NumberUses*, *NumberPublishedPapers*, and *ProportionUses*. The ADF tests the null hypothesis that a variable follows a unit root process, and is therefore nonstationary, against the alternative that the series is stationary. The test fails to reject the null hypothesis for each of these three variables.<sup>12</sup> But, first differencing each variable and re-running the ADF tests shows the differenced series to be stationary. Table 5 shows the least-squares results using first differences ( $\Delta$ ) of the variables.

The results in Table 5 show that the estimated coefficient on *Trend* is again positive and not significantly different from zero. In other words, university related research (as proxied by the three defining key words) has consistently remained as the dominant (i.e., most frequently used keywords) focus of academic and policy research published in the *JIT* since 1977.<sup>13</sup>

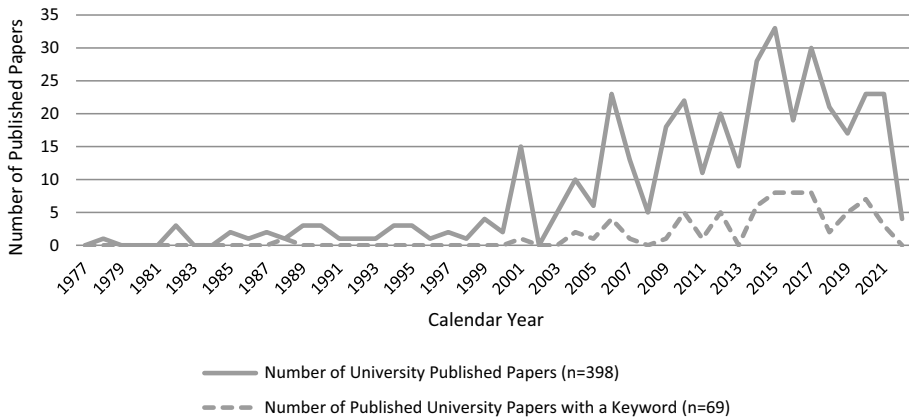
To investigate trends relating to academic entrepreneurship within the context of technology transfer research, we reviewed the 398 published papers that used at least one of the designated keywords (i.e., *university*, *universities*, *academic*) in the title to identify those papers that also used *entrepreneur*, *entrepreneurial*, or *entrepreneurship* as a keyword in

<sup>11</sup> A time series is stationary if its first two moments do not depend on the time at which it is observed. Stationarity is required, as a regression of nonstationary time series can lead to spurious results which do not reflect a meaningful underlying relationship.

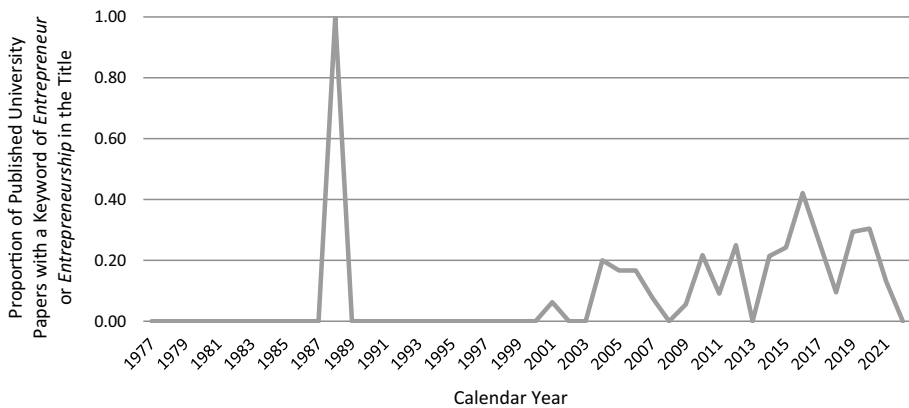
<sup>12</sup> Statistical information on each ADF test is available from the authors on request.

<sup>13</sup> See footnote 7.





**Fig. 3** Total number of published university papers and number of published University Papers with a Keyword of *Entrepreneur* or *Entrepreneurship* in the Title, by Calendar Year



**Fig. 4** Proportion of published University Papers with a Keyword of *Entrepreneur* or *Entrepreneurship* in the Title, by Calendar Year

the title.<sup>14</sup> Of the 398 published university papers, 69 additionally used at least one of the entrepreneur-related keywords in the title.

Figure 3 shows by calendar year the number of published university papers and the number of published university papers using *entrepreneur*, *entrepreneurial*, or *entrepreneurship* as a keyword. Both of these time series are nonstationary based on an ADF test. When the first differences of each variable are used in a regression model similar to that in column (1) in Table 5, the estimated coefficient on *Trend* is again insignificant.

Figure 4 shows the proportion of published university papers using at least one of the keywords of *entrepreneur*, *entrepreneurial*, or *entrepreneurship*, by calendar year. The time series of proportions shown in this figure is stationary. Table 6 shows the least-squares

<sup>14</sup> For recent work on the entrepreneurial university see, for example, Menter (2023) and Radko et al. (2023).

**Table 6** Least-squares regression results using the proportional data, by calendar year, from Fig. 4 (*p* values in parentheses)

Variable	(1)	(2)
<i>Trend</i>	0.010 ( <i>p</i> = .067)	0.009 ( <i>p</i> = .0009)
<i>BD</i>	0.164 ( <i>p</i> = .110)	0.038 ( <i>p</i> = .453)
<i>ED</i>	-0.030 ( <i>p</i> = .769)	-0.026 ( <i>p</i> = .664)
<i>Covid</i>	-0.106 ( <i>p</i> = .418)	-0.098 ( <i>p</i> = .125)
<i>Intercept</i>	1.418 ( <i>p</i> = .179)	-0.139 ( <i>p</i> = .012)
R <sup>2</sup>	0.153	0.494
F-level	1.54	8.05
N	39	38

7 of the 46 calendar year proportions could not be calculated because the number of published university papers is 0. The regression results in column (2) are based on the datum for 1988 being deleted

results of the trend in this metric. In column (1), the estimated coefficient on *Trend* is positive and marginally significant suggesting a change in the scope of technology transfer research from focusing on university activity per se to focusing on *academic entrepreneurship*. Each year, on average, the proportion of published university papers in the *JTT* using an entrepreneur-related keyword has increased by about 1 percentage point. Also, from Fig. 4, it is visually clear that the upward trend in academic entrepreneurship as defined therein began in the early 2000s. Albeit that this is a small increase, it nevertheless is suggestive of a trend in the scope of a research area that falls under the umbrella of technology transfer. Also, the regression results show that the Bayh–Dole Act (*BD*) has a marginally significant impact on the proportion of published university papers addressing academic entrepreneurship topics; however, care should be exercised in generalizing from this finding because it is driven by the 1988 datum as shown in Fig. 4.

In Fig. 4, the 1988 datum is perhaps an outlier and thus could be omitted. There were only 8 published papers in the sampling population for that calendar year (all other calendar years had double digit numbers of published papers; see Fig. 1) and only 1 paper contained the keyword *university*. After deleting that observation, the data still show stationarity, and the corresponding regression results are in column (2) of Table 6. The results in column (2) show about the same level of response over trend as in column (1) although the estimated coefficient is more significant, the positive effect of *BD* is no longer marginally significant, and the negative effect of *Covid* on the percent of published papers related to academic entrepreneurship is marginally significant. One might reasonably conclude that the Bayh–Dole Act of 1980 has not had a measurable impact on the scope of research activity related to academic activity or more specifically to research published in the *JTT*.

## 4 Discussion

Our focus on the scope of technology transfer research emphasizing university activity is motivated by the passage of the Bayh–Dole Act of 1980. Our empirical findings show that the role of universities or the academy in technology transfer has consistently, as revealed by an insignificant coefficient on *Trend*, been emphasized in the titles of papers published in the *JTT*, although the extant literature has for the most part been neglected to be explicit in how the term *technology transfer* has been defined (see Table 1). Our

analysis did not reveal that the Bayh–Dole Act has a statistically significant impact on university-related research within the technology transfer literature. However, the research emphasis on *academic entrepreneurship* appears to have become more emphasized over time (see Table 6), especially since the early 2000s (see Fig. 4).

In an effort to extrapolate from our study of the role of universities in technology transfer research to other research areas of emphasis, we did a word count of all words in all titles of papers published in the *JTT* (having deleted pronouns and prepositions), and we used our findings to explore several identified research areas. As might be expected, there are a number of frequently used words that are not related to the scope of emphasis of research (e.g., *case, event, role, study*). From this exploration, we identified the following use of keywords in the titles of published papers based on a sampling population of ( $n = 1,578$ ). Papers related to innovative activity were published 257 times based on at least one of the following words being in the title: *innovate, innovation, or innovativeness*. Papers related to entrepreneurship were published 153 times based on at least one of the following words being used in the title: *entrepreneur, entrepreneurial, or entrepreneurship*. Papers related to collaboration were published 79 times based on at least one of the following words being used in the title: *collaboration or collaborative*. Finally, papers related to commercialization activity were published 49 times based on at least one of the following words being in the title: *commercial, commercializing, or commercialization* (with standardization to U.S. spelling).

Though our analysis was motivated by interest in academic entrepreneurship and associated keywords embodied within 69 papers (see Fig. 3), we also note that papers generally related to entrepreneurship—reflected by keywords *entrepreneur, entrepreneurial, or entrepreneurship*—were published 153 times. It may therefore be the case that other keywords and their combination relate to our original research question of interest and may therefore be a topic for future investigation. It is our hope that as artificial intelligence (AI)-based technology becomes more widely used as a research tool, then the findings presented here will be re-examined and expanded upon by scholars.

We also noted infrequent use of the term *entrepreneurial university* among publications within our analysis. Though the term *entrepreneurial university* has also been used for more than two decades (e.g., Etzkowitz et al., 2000), the concept frames the emergence of an impact-oriented mission at research universities and the extent to which it relates to traditional teaching and research missions (e.g., Guerrero et al., 2016). Interestingly, scholars have also framed academic entrepreneurship as an integral component of the entrepreneurial university (e.g., Hayter, 2016). This perspective therefore opens the possibility that academic entrepreneurship may not only be framed as a sub-category of technology transfer but also one of the many functions of the entrepreneurial university, the impact of which must be considered within the context of other commercialization functions and university missions. Following Hayter et al. (2020), scholars would therefore do well to avoid myopic conceptualization of academic entrepreneurship and technology transfer, among other areas of related scholarly focus, and instead focus on their emergence and interrelationship.

## Declarations

**Conflict of interest** The authors have no competing interests to declare that are relevant to the content of this article.

## References

- Association for University Technology Managers – AUTM (undated). “What Is Tech Transfer?” <https://autm.net/about-tech-transfer>
- Bar-Zakay, S. N. (1971). Policymaking transfer: The need for national thinking laboratories. *Policy Sciences*, 2, 213–227.
- Comptroller General of the United States. (1979). *Interagency laboratory use: Current practices and recurring problems*. General Accounting Office.
- Doctors, S. I. (1969). *The role of federal agencies in technology transfer*. MIT Press.
- Doutriaux, J. (1987). Growth pattern of academic entrepreneurial firms. *Journal of Business Venturing*, 2, 285–297.
- Editorial (1977). Editorial. *Journal of Technology Transfer*. 1:5.
- Etzkowitz, H., Webster, A., Gebhardt, C., & Terra, B. R. G. (2000). The future of the university and the university of the future: Evolution of Ivory tower to entrepreneurial paradigm. *Research Policy*, 29, 313–330.
- Federal Coordinating Council for Science, Engineering, and Technology. (1977). *Directory of Federal Technology Transfer*. U.S. Government Printing Office.
- Federal Laboratory Consortium for Technology Transfer (undated). “What Is Technology Transfer (T2)?” <https://federallabs.org/about/what-is-tech-transfer/video-overview>
- Gilmore, J. S., & Price, C. R. (1969). *The environment and the action in technology transfer 1970–1980*. Denver Research Institute, University of Denver.
- Guerrero, M., & Urbano, D. (2014). Academics’ start-up intentions and knowledge filters: An individual perspective of the knowledge Spillover theory of entrepreneurship. *Small Business Economics*, 43, 57–74.
- Guerrero, M., Urbano, D., Fayolle, A., Klofsten, M., & Mian, S. (2016). Entrepreneurial universities: Emerging models in the new social and economic landscape. *Small Business Economics*, 47, 551–563.
- Hayter, C. S. (2016). A trajectory of early-stage spinoff success: The role of knowledge intermediaries within an entrepreneurial university ecosystem. *Small Business Economics*, 47, 633–656.
- Hayter, C. S., & Link, A. N. (2018). Why do knowledge-intensive entrepreneurial firms publish their innovative ideas? *Academy of Management Perspectives*, 32, 141–155.
- 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. *Journal of Technology Transfer*, 43, 1039–1082.
- Hayter, C. S., Rasmussen, E., & Rooksby, J. H. (2020). Beyond formal university technology transfer: Innovative pathways for knowledge exchange. *Journal of Technology Transfer*, 45, 1–8.
- Jolly, J. A., & Creighton, J. W. (1977). The technology transfer process: Concepts, framework and methodology. *Journal of Technology Transfer*, 1, 77–91.
- Link, A. N., & Oliver, Z. T. (2020). *Technology transfer and U.S. Public Sector Innovation*. Oxford University Press.
- Link, A. N., & van Hasselt, M. (2019). On the transfer of technology from universities: The impact of Bayh–Dole act of 1980 on the institutionalization of university research. *European Economic Review*, 119, 472–481.
- Link, A. N., Siegel, D. S., & van Fleet, D. D. (2011). Public science and public innovation: Assessing the relationship between patenting at U.S. national laboratories and the Bayh–Dole Act. *Research Policy*, 40, 1094–1099.
- Link, A. N., & van Hasselt, M. (2023). *Small firms and US technology policy: Social benefits of the US small business innovation research program*. Edward Elgar.
- Mathisen, M. T., & Rasmussen, E. (2019). The development, growth, and performance of university spin-offs: A critical review. *Journal of Technology Transfer*, 44, 1891–1938.
- Menter, M. (2023). From technological to social innovation: Toward a mission-reorientation of entrepreneurial universities. *Journal of Technology Transfer*. <https://doi.org/10.1007/s10961-023-10002-4>
- National Academy of Engineering. (1974). *Technology transfer and utilization: recommendations for redirecting the emphasis and correcting the imbalance*. U.S. Government Printing Office.
- Radko, N., Belitski, M., & Kalyuzhnova, Y. (2023). Conceptualising the entrepreneurial university: The Stakeholder approach. *Journal of Technology Transfer*, 48, 955–1044.
- Roncancio-Marin, J. J., Dentchev, N. A., Guerrero, M., & Diaz-Gonzalez, A. A. (2022). Shaping the social orientation of academic entrepreneurship: An exploratory study. *International Journal of Entrepreneurial Behavior & Research*, 28, 1679–1701.

- Schmitz, A., Urbano, D., Dandolini, G. A., de Souza, J. A., & Guerrero, M. (2017). Innovation and entrepreneurship in the academic setting: A systematic literature review. *International Entrepreneurship and Management Journal*, *13*, 369–395.
- Seely, B. E. (2003). Historical patterns in the scholarship of technology transfer. *Comparative Technology Transfer and Society*, *1*, 7–48.
- Siegel, D. S., & Wright, M. (2015). Academic entrepreneurship: Time for a rethink? *British Journal of Management*, *26*, 582–595.
- Teich, Albert H. (1979). Statement of Dr. Albert H. Teich. in Committee on Science and Technology, *The Role of Federal Laboratories in Transferring Technology to State and Local Governments* (pp. 1–12), Committee on Science and Technology.
- Tuma, E. H. (1987). Technology transfer and economic development: Lessons of history. *The Journal of Developing Areas*, *21*, 403–428.
- Urbano, D., & Guerrero, M. (2013). Entrepreneurial Universities: Socioeconomic impacts of academic entrepreneurship in a European Region. *Economic Development Quarterly*, *27*, 40–55.
- World Intellectual Property Organization (WIPO, undated). “Intellectual Property and Technology Transfer,” <https://www.wipo.int/technology-transfer/en/index.html>

**Publisher’s Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.