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An Entrepreneurial Approach  
Edited by Thomas J. Allen and Rory P. O'Shea  
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## 1 Introduction

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The increasing challenge of competing in a global economic context is forcing regions to reconsider and often revise their approaches to economic development. With knowledge now the fundamental basis of competitive advantage, regional economic development agencies are looking for ways to create and develop new and innovative technology-based startups. The growing acceptance of the importance of university spin-off activity to national economies has been reflected in burgeoning policy and research publications seeking to identify the drivers of spin-off activity in research universities. Interest in the spin-off phenomenon among national policy makers and university heads has been sparked largely by recognition of the emergence of the need to generate knowledge-based jobs.

Technology transfer is an important driver in innovation and the creation of sustainable growth. According to the National Science Foundation, U.S. federal government agencies allocated more than \$32 billion annually to university researchers around the country to conduct scientific research.<sup>1,2</sup> This continuing investment expands human knowledge and helps to educate the next generation of science and technology leaders. Furthermore, this research can also have a big impact on the “discovery of innovation” element of the commercialization process (Klofsten and Jones Evans 2000; Murray 2004; Owen-Smith and Powell 2004). Mansfield has also highlighted the central role of university innovation in U.S. productivity growth. In a random sample of seventy-six major American firms in seven manufacturing industries, Mansfield (1991) investigated the extent to which technological innovations are based on

<sup>1</sup> Technology transfer is defined as “the process of transferring scientific findings from one organization to another for the purpose of further development and commercialization.” (AUTM 2013).

<sup>2</sup> The federal government provided \$32.6 billion (59%) of the \$54.9 billion of academic spending on S&E R&D in FY (academic) 2009. *Sources:* National Science Foundation, National Center for Science and Engineering Statistics, Survey of Research and Development Expenditures at Universities and Colleges.

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Table 1.1: *Number of university spin-offs generated in the United States (2005–2011: AUTM)*

Year	No. of spin-offs
2011	670
2010	651
2009	596
2008	595
2007	555
2006	553
2005	628

academic research. He found that about one-tenth of the new products and processes commercialized between 1975 and 1985 in some high tech industries could not have been developed without academic research.

In the United States, spin-off activity has been on an upward trajectory over the past decade. AUTM survey figures show that there has been modest growth in U.S. start-ups generated from intellectual property. The survey reveals that university start-up activity has risen from just over 628 companies in 2005 to over 670 university spin-offs in 2011 (see Table 1.1).

According to a longitudinal study of spin-off performance of U.S. universities conducted by O'Shea *et al.* (2005), the Massachusetts Institute of Technology achieved the highest ranking for all universities in the United States between 1980 and 2001, while the University of California system and Stanford University achieved second and third highest ranking, respectively, over the same period (see Table 1.2).<sup>3</sup> However, O'Shea *et al.* also found that 80 percent of universities spun off less than two companies in any given year over this period, despite attracting large investment from both federal and industry sources. This mean value also masks a highly skewed distribution in the data in which the most productive university, MIT, spawned 31 spin-offs in one year alone (O'Shea *et al.* 2005).

Given the growing dissatisfaction with universities' performance in commercialization, many policy makers are now investigating ways in which universities can improve their IP strategy.<sup>4</sup> For many institutions,

<sup>3</sup> O'Shea, Rory P., Allen, Thomas J., Chevalier, Arnaud, and Roche, Frank (2005), Entrepreneurial orientation, technology transfer and spinoff performance of U.S. universities. *Research Policy*, 34(7), pp. 994–1009.

<sup>4</sup> In October 2011, President Obama released a Presidential Memorandum to agencies, titled Accelerating Technology Transfer and Commercialization of Federal Research in Support of High Growth Businesses. The memorandum required agencies that

Table 1.2: *Spin-off rankings of top ten U.S. universities*

Rank 1995–2001	University	No. of spin-offs 1995–2001
1	Massachusetts Institute of Technology	132
2	University of California system	118
3	Stanford University	73
4	California Institute of Technology	67
5	University of Washington	51
6	University of Minnesota	49
7	University of Michigan	42
8	University of Georgia	41
9	University of Utah	40
10	Johns Hopkins University	35

Source: O'Shea *et al.* (2005).

the path to enhanced start-up creation has proved difficult. Successful spin-offs are difficult to initiate, if only because of our inability to make sense of the framework conditions necessary to provide assistance to universities in creating support structures, policies, and interventions to improve start-up success rates (Roberts and Malone 1996). There remains a disconnect between what researchers know about the nature of spin-off behavior and what practitioners need to know to improve the formation rates of new technology companies.<sup>5</sup> In the academic literature there are many models that seek to explain spin-off activity from institutions of higher education. Many of these studies have neither been effective in explaining spin-off behavior nor been particularly suited to the needs of institutional officials who seek to stimulate spin-off activity on campus. A recurring criticism is the narrow and process-driven interpretation of the technology transfer office (TTO), which establishes the primary objective of technology transfer as one of revenue generation and the primary function of the TTO as the management of university

conducted intramural research to improve their technology transfer results by “establish[ing] goals and measure performance, streamlin[ing] administrative processes, and facilitate[ing] local and regional partnerships in order to accelerate technology transfer and support private sector commercialization.” Other important reports published in relation to academic commercialization included National Research Council, *Managing University Intellectual Property in the Public Interest* (2010); and Wendy H. Schacht, *The Bayh–Dole Act: Selected Issues in Patent Policy and the Commercialization of Technology*, Congressional Research Service, March 16, 2012.

<sup>5</sup> In June 2012, the House Committee on Science, Space, and Technology’s Sub Committee on Technology and Innovation held a hearing entitled “Best Practices in Transforming Research into Innovation: Creative Approaches to the Bayh Dole Act.” The session was held to learn about different approaches universities are taking in order to accelerate the transfer of results of federally-funded research to the private sector.

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intellectual property rights. This, in turn, promotes short-term revenue maximization objectives and practices that neither reflect nor enhance the rich and diverse nature of university–industry collaboration (Kenney and Patton 2009; Litan *et al.* 2007; Perkmann *et al.* 2013). Therefore, the challenge lies in identifying and replicating the processes that facilitate swift movement of technology from research laboratories to the front line of industry (Allen 1984; Phan and Siegel 2006). With increasing pressure on universities to generate economic returns from government research support, policy makers and academics must find ways to stimulate technology-based entrepreneurship in universities. This book represents an effort to address this challenge and bridge the gap between research and the entrepreneurial world.

The purpose of the volume is to attempt to coordinate multiple perspectives on the issue of university spin-off creation, thereby highlighting the complexity of the phenomenon. By drawing from a multiplicity of frameworks, the aim of the book is to explore different international institutional settings and show how universities engender university-wide entrepreneurship on campus. We aim to uncover the attributes of successful spin-off programs in relation to regional context. Ultimately, we want to provide answers to the difficult questions administrators and policy makers ask about enhancing university start-up activity. The volume shares the experiences of twelve leading international research universities and R&D institutes in selected countries around the globe that have developed, or are in the process of developing, successful spin-off strategies to improve their start-up rates on campus. We aim to provide an international comparison of approaches adopted by these universities to maximize the dynamics of start-up activity. We also attempt to draw reasoned conclusions on the effectiveness of the approaches to spin-off programs and to establish what lessons might be transferable across the institutional contexts to inform approaches in this area.

This book focuses on three distinct but related goals. First, research has suggested that university spin-offs are an important aspect of regional economic development, yet scholars still debate the appropriate policies and operational structures to facilitate the creation of these ventures. A central limitation of extant spin-off literature is its failure to develop a framework to make sense of what appear to be a multitude of different commercialization approaches and their associated impacts. To address this matter, we attempt to give order to the growing body of research on spin-off research by focusing on the “individual,” “organizational,” “institutional,” and “environmental” dimensions of spin-off behavior. Second, this work investigates what can be done to increase start-up

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formation from “leading” research and “mid-range” universities. We argue that a systemic and contingent approach should be undertaken to understand the full dynamics of academic entrepreneurship on campus. This volume builds on the principles of contingency theory, which suggest that different organizational arrangements are valid for different strategy conditions and that increased effectiveness can be attributed to internal consistency or fit among the pattern of relevant contextual, structural, and strategic factors. Third, in order to analyze university contributions to economic development, the study examines universities’ technology transfer policies, practices, and structures and their associated economic development impact. The study examines how a university defines itself as part of a region and the impact of the local context on spin-off activity. By examining existing theories and analyzing university relationships with both government and industry, we explore ways in which universities contribute to regional economic development.

### Structure of the book

The twelve university-specific studies in this volume begin with U.S.-based studies and then turn to studies based in Europe and Asia. In Chapter 14, the book also analyzes the commercialization structures of two university-affiliated technology development institutes in France and Belgium to reflect the specific institutional context of continental Europe with regard to the development and professionalization of R&D centers. The forewords for this book were authored by Professor Ed Roberts and Professor Don Siegel. Ed is the David Sarnoff Professor of Management of Technology at the MIT Sloan School of Management and Chair of the MIT Entrepreneurship Center. Ed is the author of the seminal technology entrepreneurship book *Entrepreneurs in High Technology* (Oxford University Press, 1991), and this work has been an inspiration to the field ever since. Don currently serves as the President of the Technology Transfer Society and is also editor of the *Journal of Technology Transfer*.

We selected this particular group of universities in part to represent the international diversity of research institutions. Some are large private research universities; others are public in scope and therefore are diverse in terms of mission, selectivity, size, and location. The primary purpose of the project was to discover what a diverse range of institutions across the globe do to promote spin-off success, so that other universities that aspire to enhance the quality of entrepreneurship culture and programs might learn from their example. It is also worth noting that we do not claim that all of these institutions are the “best” or the most “entrepreneurially

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effective” in the world. At the same time, their performance is noteworthy, and they offer many examples of promising practices that could be adapted and used productively at other institutions.

### **Book chapters**

In Chapter 2, Etzkowitz reviews the concept of the entrepreneurial university, the various contextual issues that have shaped the nature of university start-up activity to date, and the ways universities have responded to these challenges. Etzkowitz traces the historical development of academic entrepreneurship within academic institutions and the changing role of universities in developing regional economies. He outlines how universities are becoming increasingly central players in regional and national economic development. He also postulates that academics are increasingly embracing a university–industry “engagement” model, in which firm formation as a means of knowledge transfer and contribution to society is becoming more of an accepted norm internationally.

In Chapter 3, O'Shea, Fitzgerald, Chugh, and Allen develop and integrate differing research perspectives on academic entrepreneurship to move toward a conceptualization of spin-off behavior. The chapter highlights four major streams of work that influence the rate of spin-off activity: (1) the academic's reasons for engaging in entrepreneurial activity (individual characteristics studies); (2) the attributes of universities, such as human capital, commercial resources, and institutional activities (organizationally focused studies); (3) the broader social context of the university, including the barriers or deterrents to spin-offs (institutional and cultural studies); (4) the external characteristics such as regional infrastructure that impact spin-off activity (external environment studies). In addition, the chapter incorporates two further streams of research that deal with (5) the development and performance of spin-offs and (6) the spillover effect of spin-offs on the regional economy. The authors argue that recent studies on university entrepreneurship focusing on one or the other of these dimensions have, until now, largely remained separated and ignorant of one another. As such, the literature has remained blind to some key aspects of understanding that can only be brought to the fore if the different theoretical explanations are combined.

Chapter 4, by Fishman, O'Shea, and Allen, explores the dynamic “ecosystem” factors that contribute to the success of MIT as an entrepreneurial university. The chapter explains how events within an institution can shape the process of spin-off behavior within that institution, and how external forces impacted on the institution's orientation.

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In particular, the chapter reveals the importance of financial and human capital endowments specific to MIT, the historical mission of the university, and the role of key academic entrepreneurs and academic leaders in harnessing the entrepreneurial spirit within the university. The chapter also argues that spin-off success needs to be understood in the context of the regional environment. The chapter concludes that university administrators and academics can learn from the case of MIT, but efforts at transposing or replicating single elements of MIT's model may only have limited success given the interrelated nature of the drivers of spin-off activity. The chapter makes a theoretical contribution to our understanding of the self-reinforcing path-dependent processes associated with commercialization policies and activity.

Chapter 5, by Tim Lenoir, analyzes Stanford University's role in fostering both entrepreneurial activity and technical innovation at the university. Lenoir argues that Stanford has been shaped as an incubator of entrepreneurial activity largely by positioning itself as a premier research institution in a number of fields, several of which have been critical to the economy. According to the author, this "steeple of excellence" strategy of attracting and retaining the best scientific and engineering talent engaging in frontier research – as opposed to applied science – was an essential factor that contributed to the rise of entrepreneurial science at Stanford. However, while the author maintains that pursuing excellence in research is a necessary condition for entrepreneurial success, it was Stanford's ability to embed an institutional culture of entrepreneurship across campus that gave rise to entrepreneurial success within the university. The paper also documents the pivotal role that Stanford's Provost, Frederick Terman, played in setting out the economic development mission of the university to influence local and regional development.

Chapter 6, by Walshok and Lee, investigates the role of the University of California, San Diego in the creation of industrial clusters. The chapter argues that while it was essential to have top-quality academics at the university, the dynamic relationship between the entrepreneurial science community at the university and science-based entrepreneurship in the region provided a central catalyst for the emergence of high start-up activity from the university. According to the authors, having a world-class research university alone is not sufficient; there need to be institutional mechanisms that support enterprise creation both within the university and in the surrounding local community.

Chapter 7, by Feldman, Desrochers, and Bercovitz, reviews the original "hands-off" inventor ownership patent policies of Johns Hopkins University and assesses their role in promoting knowledge transfer at the

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university prior to the Bayh–Dole Act academic entrepreneurship.<sup>6</sup> From examining the Johns Hopkins and CellPro patent infringement case, the authors highlight the consequences of applying a more aggressive academic stance toward patenting and revenue generation in the context of the Bayh–Dole statute of 1980. By drawing from the Dalkon Shield case and other examples, the authors also reveal the potential reputational risks that are associated with academic institutions looking to cash in on intellectual property rights. This chapter has important implications for universities looking to devise commercialization policies.

Chapter 8, by Breznitz, describes the role of Yale University in the development of the biotechnology cluster in the New Haven region of Connecticut. Although Yale is one of the strongest universities in life sciences in the United States, its traditionally passive attitude toward the commercialization of academic research was shown to be an obstacle for transferring technologies into the region. However, after the arrival of President Richard C. Levin in the mid-1990s, the university undertook changes in personnel and structures at the Technology Transfer Office, hiring as director a senior manager from a major pharmaceutical company, to promote further biotechnology-based industrial growth in the region. Yale's approach was to implement a number of "top-down" initiatives in order to create a more entrepreneurially driven environment at the university. The author assesses the effect of these change strategies on academic commercialization at the university. In its conclusion, the chapter looks at how universities can have an important impact on local industrial and economic development.

Chapter 9, by O'Gorman and Roche, considers the commercialization programs of University College Dublin, an ambitious research university undergoing change in its technology transfer operations. They reflect on the interventions and structures that have been instituted to engender academic entrepreneurship on campus and consider the effectiveness of the introduction of "top-down" university programs, as well as a number of government interventions undertaken to accelerate the commercialization process. The authors assert that organizational interventions are a useful strategy that, when taken in concert with other multilevel government-led initiatives, can influence spin-off behavior.

Chapter 10, by Wright and Filatotchev, examines a number of entrepreneurship support mechanisms initiated by Kings College London in its drive to accelerate academic entrepreneurship on campus. The

<sup>6</sup> The Bayh–Dole Act (P.L. 96–517, Patent and Trademark Act Amendments of 1980) created a uniform patent policy among the many U.S. government agencies funding research. As a result of this law, universities retain ownership to inventions made under federally funded research. In return, universities are expected to file for patent protection and to ensure commercialization upon licensing.



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authors highlight the range of financial and training supports employed by the university, including third-party seed funding and incubator alliances, to enable inventions to be commercialized successfully via start-up companies. The chapter also highlights the multifaceted nature of partnerships that KCL has undertaken with industry and government to enhance academic entrepreneurship on campus.

Chapter 11, by Andries, Van Looy, and Debackere, explores the complex effect of complementary university incubation processes on spin-off company formation and development. Their paper argues that universities need to move beyond providing incentive mechanisms and physical facilities, in order to foster the development of spin-offs. Drawing from the case of KU Leuven, the authors demonstrate how spin-off incubators can develop appropriate support processes that allow new ventures to experiment with and adapt their business models, while transforming their technology platforms into viable and sustainable market value propositions.

Chapter 12, by Wong, Ho, and Singh, identifies the key roles that research-intensive universities in newly industrialized regions need to play to contribute effectively to the entrepreneurial development of their economies. The chapter then analyzes how the National University of Singapore (NUS), the leading university in Singapore, adopted an integrated “global knowledge enterprise” model that involves coordination by a new organizational vehicle called NUS Enterprise. The chapter explores a number of innovative programs launched by NUS Enterprise and shows how they fit together to achieve synergies. It also discusses the critical factors necessary for such an integrated model to be successfully implemented and draws relevant lessons for universities in other newly industrialized economies facing similar challenges.

Chapter 13, by Zhou, explores how a midrange research university in China's Liaoning Province, Northeastern University, is attempting to play an increasing role in the formation of regional industries and technological innovation. The study highlights the role government can play in becoming a “regional innovation organizer” where university–industry cooperation has traditionally been weak. The chapter also highlights how a “government-pulled triple helix” made it easier to achieve large-scale innovation projects. The study also illustrates how a university, by specializing in research fields in which it holds a comparative advantage, can play an important role in kickstarting the economic development of a region.

Chapter 14, by Knockaert, Clarysse, and Mustar, compares and contrasts the commercialization structures and formal policies of two leading independent research and development institutes in Europe, IMEC and INRIA. While the central focus of the analysis is on the research

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institutes (i.e., rather than specifically universities), the chapter provides a useful insight as to how two leading research and development institutes in Belgium and France have developed structures and policies to help overcome the “Valley of Death” issues that entrepreneurs face in the commercialization of academic research.

The final chapter addresses the central question of what can be done to improve spin-off activity within active research universities. Drawing from previous chapters in this volume, the editors develop a “spin-off performance model” that outlines five central strategies that can be employed to promote academic entrepreneurship on campus. Using this model, the authors suggest that if academic entrepreneurship is to emerge successfully within university campuses, there is a need for policy makers to recognize that a comprehensive systems approach to the identification, protection, and commercialization of university intellectual property must be adopted. Recommendations for enhanced practices and spin-off interventions are also explained and reviewed in this chapter.

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