ANALYZING THE COMMERCIALIZATION OF UNIVERSITY RESEARCH: A PROPOSED CATEGORIZATION SCHEME

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Abstract: Universities are an increasingly important source of technological innovations of commercial importance. Numerous methods of commercializing these innovations are available including licensing, spin-outs and consulting arrangements. Research on the commercialization of university research has involved various categorizations of these methods. However, these categories are typically limited to a particular method of commercialization and are often inconsistent. Drawing on ideas from transaction cost economics, a comprehensive categorization scheme is proposed. Three primary methods of commercialization are identified: (1) creating a new business based on the innovation, (2) ongoing development and marketing of the innovation to firms that will use the innovation in their business and (3) disposition of the innovation to an established firm. Two hybrid categories are also identified. These categories focus on the substance of commercialization process rather than its form. For example, licensing arrangements are possible in any of the five categories.

Specific criteria are identified that can be used to categorize the commercialization of a particular innovation. These criteria relate to whether the innovation was commercialized by a new firm or an existing firm, equity participation by the researcher, ongoing operational involvement by the researcher and ownership of the right to further develop the innovation.

The existence of a comprehensive categorization scheme has implications for measuring the amount and impact of the commercialization of university research and for helping universities to identify ways to support these activities.

Keywords: University research, commercialization, innovation, categories, licensing, start-ups.

Introduction

University research is a significant source of commercially important technological innovations of commercial importance. In the United States and Canada, more than 2,000 new products based on innovations arising from university research were introduced into the marketplace between 1998 and 2002. More than 4,000 new companies were formed to commercialize university research between 1980 and 2002 and licenses of technology generate more than $1 billion annually in income (Association of University Technology

Managers, 2003). In addition, the relative importance of university research compared to industrial research as a source of innovation is growing (Chesbrough, 2003). Therefore, we expect the commercialization of university research to become an increasingly important issue. For example, Canadian universities have committed to tripling their commercialization performance by 2010 (Association of University and Colleges of Canada, 2002).

Analysis of the commercialization of university research has typically categorized the methods used to commercialize university research as either licensing or creation of start-up firms. There are, however, a number of problems with these categories. First, there is a great deal of diversity within the categories. For example, licensing an innovation on a non-exclusive basis to a number of firms with the researcher/university[1] continuing to develop and market the innovation is very different than licensing the innovation on an exclusive basis to an established firm for substantially all of the economic life of the innovation with the researcher/university having no ongoing involvement with the innovation. Second, the categories are not distinct. For example, a start-up firm founded by a researcher will often need to licensing the innovation from his or her university if the university holds the intellectual property rights to the innovation. This situation involves both creation of a start-up firm and licensing.

The lack of an effective categorization scheme poses a number of problems to the study of the commercialization of university research. It creates difficulties in measuring the impact of commercialization activities. The economic impact of licensing is typically measured by the number of licenses and license income while the impact of start-up firms is typically measured by the number and revenues of start-up firms (see, for example, Read 2003). In the case of the start-up firm described in the preceding paragraph, is the economic activity best measured as the revenues of the start-up firm or the license income to the university? The answer matters since the revenues of the start-up firm are likely to be many multiples of the license income to the university. An effective categorization scheme can also help universities to better support the commercialization of research taking place in their institution. Different approaches to commercialization may require different support such as technology transfer and licensing offices, accelerators and research and technology parks. Finally, an effective categorization scheme can help researchers to better study and understand how commercialization occurs.

Therefore, there is a need for a comprehensive framework that 1) reflects the substance rather than the legal form of commercialization activities, 2) reflects the variety of approaches to commercializing university research (e.g., creation of new firms, sale of technology to existing firms, etc.), and 3) reflects multiple methods of commercialization (i.e. does not just classify start-up firms or just classify licenses). In the following sections, we propose a classification approach that attempts to address these issues.

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1 The roles of the researcher and the university in these activities are affected by national and university policies concerning ownership of the intellectual property associated with the innovation. At universities where the intellectual property is owned by the university, the university may have a greater role in these activities than at universities where the researcher owns the intellectual property.

Literature review

There is a significant academic literature on the commercialization of university research (for a review of this literature see, for example, Agrawal 2001). This literature recognizes that there are various ways of commercializing university research and a number of formal and informal classifications of the methods used to commercialize have been used. At the highest level, del Campo et al. (1999) identify three potential commercialization strategies: 1) licensing, 2) corporate partnerships/sponsored research funding and 3) formation of a start-up company. Similar categories have been used in most of the surveys on the extent of commercialization of university research (see, for example, Association of University Technology Managers 2003, Gu and Whewell 1999 and Read 2003). This classification method focuses on the legal form of the transactions and, as indicated earlier, often does not reflect the economic substance of the transactions. These categories are also not distinct. For example, the Association of University Technology Manager's Licensing Survey for 2002 indicates that 14.6% of licenses were to start-up firms (Association of University Technology Managers, 2003).

At a more detailed level, various subcategories have been used or proposed. Nicolaou and Birley (2003) propose a trichotomous categorization of university spinouts into orthodox, hybrid and technology spinouts depending on the academic inventors involvement with the spinout. These categories reflect substantive differences between spinout firms but, by design, are limited to commercializations involving spinouts. For licensing, the most common subcategories are exclusive and non-exclusive licenses (see, for example, Association of University Technology Managers 2003). However, other subcategories have been used. Shane (2002) in studying who undertakes the commercialization of university research distinguishes between licensing by inventors and noninventors. It appears that the transactions involving licensing by inventors are start-up firms founded by the inventor who license the innovation back from the university because the university holds the intellectual property rights to the innovation. In situations, where the inventor rather than the university held the intellectual property rights, a similar transaction would be classified as a start-up. This example illustrates the difficulties that can arise in the classification of commercialization activities based on their legal form.

In summary, none of the categorization schemes described above meet our goal of a classification system that is both comprehensive and that reflects the economic substance of the transactions rather than their legal form.

Proposed categorization scheme

To address the issues identified above, we propose the following categorization scheme. The descriptions that follow are from the perspective of the university/researcher rather than from the perspective of the firm that commercializes the innovation. We suggest that there are three primary methods of commercializing university research: 1) creating a new business based on the innovation, 2) ongoing development and marketing of the innovation to firms that use the innovation in their businesses and 3) disposition of the innovation to an established firm.

The creation of a new business based on the innovation reflects situations where the innovation forms the basis for the development of a new firm to exploit the innovation.

This new firm acquires or develops the complementary assets needed to commercialize the innovation. OpenText Corporation is a start-up firm based on technologies developed at the University of Waterloo. OpenText acquired or developed distribution channels, customers support services and related technologies in order to commercialize its technologies and has evolved into a world leader in enterprise content management software (OpenText, 2003).

Ongoing development and marketing of the innovation to firms that use the innovation in their business reflects situations where the right to use innovation is 'rented' (licensed) to firms for a fee to use in their businesses. The university/researcher retains ownership of the innovation and is often involved in enhancing the innovation so that it can continue to mine the innovation for additional revenues. Usually in these situations, the innovation is rented to more than one firm. This may occur through non-exclusive licensing such as with the Cohen-Boyer patents for DNA splicing (Eisenstein and Resnick, 2001) but also may involve the use of intermediaries (Arora, 2001) and start-up companies. For example, Rambus Inc. is a firm founded by two university professors that "designs, develops and markets chip-to-chip interface solutions that enhance the performance and cost-effectiveness of its customers' chip and system products" (Rambus, 2002, p. 1). Rambus does not manufacture chips rather it "sell[s] licenses to semiconductor and system companies who then incorporate our interface products into their chips and systems" (Rambus, 2002, p. 2).

Disposition of the innovation to an established firm reflects situations where the innovation is 'sold' to an existing firm. The established firm typically has the complementary assets needed to commercialize the innovation. The innovation may be sold outright or licensed on an exclusive basis so that licensee obtains substantially all of the risks and benefits of ownership of the innovation. The university/research typically retains no ongoing rights to the innovation or its future enhancements.[2] For example, Florida State University has licensed a patented process for the synthesis of the anticancer drug Taxol to Bristol-Myers Squibb (Eisenstein and Resnick, 2001) on an exclusive basis.

These categories represent substantive differences in organizational form. Commercialization of an innovation generally requires that the innovation be utilized in conjunction with complementary assets such as competitive manufacturing capabilities, distribution channels, sales forces, after-sales support, and complementary technologies (Teece, 1986). Ongoing development and marketing of the innovation represents a market form of governance while the other two categories represent hierarchy governance structures (see, for example, Williamson 1975 for further information on market and hierarchy governance structures). Market governance refers to situations where transactions are carried on with third parties outside the firm through the use of contracts and, in this case, reflects situations where the university/researcher, who retain ownership of the innovation, and third parties, who own the complementary assets needed to produce products and services based on the innovation, transact through the use of contracts, typically non-exclusive licensing arrangements. Hierarchies refer to situations where the transactions are internalized so that the economic activities involved in the transaction occur within a single firm. In both the creation of a new business based on the innovation and disposition of the innovation to an established firm, the innovation and the

2 In some cases, the university/research may retain very limited rights to the innovation such as the right to use the innovation in their research.

complementary assets required to commercialize the innovation are brought together in a single firm. In the first situation, they are brought together in a newly created firm while in the latter situation they are brought together in an established firm.

The creation of a new business based on the innovation differs from ongoing development and marketing of the innovation in that the first involves developing and selling products or services based on the innovation while the latter involves selling rights to use the innovation to others who develop and sell products based on the innovation. The creation of a new business based on the innovation differs from disposition of the innovation to an established firm in that, in the first case, the innovation forms the core around which a new business is formed while in the latter case, the innovation supplements an existing business. The difference between ongoing development and marketing of the innovation and disposition of the innovation to an established firm is similar to selling the fruit of a tree versus selling the tree. In the ongoing development and marketing situation, the innovation continues to be grown and harvested by the university/researcher. Disposition of the innovation to an established firm is analogous to selling the tree. The university/researcher has no further economic interest in the innovation.

In addition to the three primary categories identified above, we believe that two important hybrid situations exist: 1) start-up by an outside entrepreneur based on the innovation and 2) transfer of the innovation to an established firm in exchange for equity. Start-up by an outside entrepreneur based on the innovation is similar to the creation of a new business based on the innovation in that, in both cases, the innovation forms the core for a new firm that acquires or develops the complementary assets needed to commercialize the innovation. However, it differs in that the university/researcher's involvement with the innovation is more limited, typically to a minority equity interest in the new firm. The transfer of the innovation to an established firm in exchange for equity is similar to disposition of the innovation to an established firm except that the university retains an equity right in the innovation. These hybrids focus on the retention of an equity interest in the innovation since the sharing of equity has been identified as an important 'break point' in the market-hierarchy continuum of governance forms (Oxley, 1999).

The resulting five way classification is shown in Table 1. The examples in this table illustrate that these classifications are different than the traditional licensing and start-up categories. Start-up firms can occur in any of the first three categories as illustrated by the examples of OpenText and Rambus. Similarly, licensing may be involved across all categories.

This table also includes a reconciliation to categories proposed by other academic researchers. Nicholaou and Birley (2003) propose three categories of university spinouts. These categories are based on the extent of the researchers involvement with the spinout. Orthodox spinouts involve the researcher leaving the university and joining the spinout. Hybrid spinouts involve the researcher retaining their university position but also holding a part time position with the spinout. In a technology spinout, the researcher has no involvement with the spinout firm. Teece (2000) in considering the position of individual inventors suggests that the options available to the inventor include: "(1) licensing the technology to incumbent firms …; (2) using intellectual property as collateral to raise debt funds to establish an organization to exploit the technology; (3) exchanging the patent for equity in a new venture-funded firm; (4) exchanging the intellectual property for cash or

Table 1 Proposed categorization scheme, examples and reconciliation to categories used by other researchers

Methods of commercializing innovations	Create a new business based on the innovation	Start-up by an outside entrepreneur based on the innovation	Ongoing development and marketing of the innovation	Transfer of the innovation to an established firm in exchange for equity	Disposition of the innovation to an established firm
Governance structure	Hierarchy	Hybrid	Market	Hybrid	Hierarchy
Examples	OpenText Corporation		Cohen-Boyer patents for DNA splicing Rambus Inc.		Process for the synthesis of Taxol
Reconciliation to categories proposed by others: Nicolaou & Birley 2003	Orthodox spinout Hybrid spinout	Technology spinout			
Teece 2000	Using intellectual property as collateral to raise debt funds to establish an organization to exploit the technology	Exchanging the patent for equity in a new venture-funded firm	Licensing the technology to incumbent firms who already have the necessary complementary assets in place	Exchanging the intellectual property for equity in an established firm[3]	Exchanging the intellectual property for cash[3]

3 Teece (2000) lists these as a single option for the individual inventor to commercialize an innovation. They have been broken out in this table in order to reconcile them to the categorization scheme proposed in this paper.

equity in an established firm" (p. 55). Our proposed categorization scheme is reconcilable to both of these approaches.

Criteria distinguishing categories

For these categories to be useful, it must be possible to uniquely place the commercialization of a particular innovation into one of these categories. We propose four criteria for doing so. The first criterion is whether the innovation is commercialized by a new firm or an established firm. This criterion distinguishes the creation of a new business from the transfer or disposition of the innovation to an existing business. The second criterion considers the ongoing operational involvement of the researcher with the commercialization of the innovation. This criterion distinguishes start-ups founded by the researcher from start-ups founded by outside entrepreneurs.

The other two criteria relate to the ownership of the property rights to the innovation. The ownership of the property rights can be evaluated based on "three elements: (a) the right to use the asset …, (b) the right to appropriate returns from the asset …, and (c) the right to change the asset's form and/or substance (Furubotn and Pejovich 1974 as cited in Williamson, 1991, p. 287). The right to use the asset will always be held by the commercializing firm. Otherwise, it would be unable to commercialize the innovation. Thus the right to use the asset is not a criterion for distinguishing between categories. Equity represents a residual interest in the assets of the firm and, therefore, can be used to identify the right to appropriate returns from the innovation. Note that we are concerned with the residual rights to returns from the innovation. Running royalties or other forms of licensing income which represent a fixed contracted right to a portion of the return from the innovation do not represent an equity interest. The right to change the asset's form and/or substance is captured by the criterion of whether the university/researcher retains the right to further develop the innovation. If the university/researcher retain the rights to future enhancements of the innovation, this is a sign that they have retained ownership of the property rights to the innovation. These two criteria distinguish between the 'rental' of the innovation to established firms from the 'sale' of the innovation to an established firm.

Table 2 shows how these criteria relate to the five proposed categories of commercialization. The table also demonstrates that each proposed category represents a unique combination of these four criteria.

Implications to university support for commercialization

The proposed categories have implications to how universities support the commercialization of innovations. One standard approach to commercialization is unlikely to be effective for all of these commercialization methods. The creation of a new business based on the innovation by a researcher may require support in building the business skills of the researcher and assistance in assembling the resources needed to commercialize the innovation. University support may take the form of new venture accelerators or incubators. Financing is typically a critical issue for new ventures and so support in the form of establishing close ties between the university and venture capitalists and flexibility in licensing arrangements to minimize cash costs to the new firm in its

Table 2 Criteria for categories and implications for university support of commercialization

	Create a new business based on the innovation	Start-up by an outside entrepreneur based on the innovation	Ongoing development and marketing of the innovation	Transfer of the innovation to an established firm in exchange for equity	Disposition of the innovation to an established firm
Criteria:					
New firm created	Yes	Yes	No	No	No
Ongoing operational involvement by researcher	Yes	Limited	No[4]	Limited	No
University/researcher have equity in commercializing firm	Yes	Yes	No	Yes	No
University/researcher retain right to further develop innovation	Yes	No	Yes	No	No
Examples of university activities to support commercialization	Accelerators / incubators Support for new venture financing Flexible licensing arrangements	Matchmaking with entrepreneurs (e.g., Concept2Company)	Technology transfer offices Regional and industry clusters of transfer offices	Technology transfer offices Research and technology parks	Technology transfer offices Research and technology parks

[4] This does not prevent the reseacher from having ongoing operational involvement in a firm that continues to develop and market the innovation. Rather, it indicates that the researcher has no ongoing operational involvement in a firm that is producing products or services derived from the innovation.

formative years can aid the formation of start-ups (Shane, 2002). University flexibility in teaching assignments can also be important due to the heavy involvement of the researcher typically required in the creation of a new business.

Start-ups by outside entrepreneurs based on the innovation require that entrepreneurs become aware of the innovation. Universities can support this approach to commercialization by developing close ties between the university and local entrepreneurs. Organizations such as Concept2Company (www.concept2company.com) may also help match researchers with entrepreneurs interested in commercializing their innovations.

Ongoing development and marketing of innovations is an activity long supported by university technology transfer offices. Regional and industry clustering of these activities can help to broaden the reach of technology transfer offices increasing the probability that innovations will become known to established firms that might be interested in commercializing the innovation.

Research and technology parks can support the transfer of innovations to established firms by encouraging collaboration and communication between the firms in the parks and the nearby university research community. Table 2 shows the alignment of these activities with the commercialization methods they support. Other activities can also be undertaken by universities to support the commercialization of innovations. Our goal here is not to provide a comprehensive listing of such activities but rather to emphasize that different approaches to commercialization require different forms of support.

Conclusion

The limits of the traditional license vs. start-up dichotomy for classifying methods of commercializing university research have been recognized for some time. These limitations include the great deal of diversity within the categories and the fact that the categories are not distinct. Tentative steps have been taken to better recognize the substance of these transactions. For example, the Association of University Technology Managers gathers information about exclusive vs. non-exclusive licensing arrangements, licensing to start-up companies, licenses with equity and start-ups with equity (Association of University Technology Managers, 2003). While these steps are helpful, they do not overcome the limitations of the license vs. start-up dichotomy on which they are based.

In this paper, we have proposed a scheme for classifying university commercialization methods that we believe is comprehensive, distinct and useful. The classifications are comprehensive in accommodating the variety of commercialization methods in use rather than being restricted to a single approach (i.e., licensing or start-ups). The criteria presented for classifying commercializing transactions are such that the categories are distinct. A particular commercialization will fall into only one of the categories. We also believe that the categories are useful. By separating commercialization methods that differ in their substance, these categories can help to provide useful insights into commercialization processes. We use the example of university support for commercialization activities to illustrate how the categories can be used in the analysis of the commercialization of university research.

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