HIGHER EDUCATION INSTITUTION AND TECHNOLOGY TRANSFER

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ABSTRACT

Technology is essential for improving the economy of a nation, especially in developing countries where industrial growth is assigned a very important role. Higher education institutions (HEIs) are potential sources for research and technological developments. Frequently, however, research from HEIs is not smoothly or successfully transferred to industry. The importance of this topic is reflected in a rapid increase in the number of journal publications that seek to explain and suggest policies that would increase the transfer activity. In this paper, the academic literature is reviewed to identify what the technology transfer is and its attributes. Then lessons taken from the technology transfer practice at the developed countries are presented. Existing research are synthesized by presenting a framework that captures the determinants and consequences of technology transfer activity from HEI to industry. Recommendations for further research based on key milestones to achieve stronger link between academia and industry are proposed.

Keywords: technology, Higher Education Institution, industry, and technology transfer

I. INTRODUCTION

Technology, as widely accepted, is essential for improving the economy of a nation, especially in developing countries where industrial growth is assigned a very important role (Lee and Win, 2004). Technological advance is frequently linked to economic progress and social benefits (DTI, 2000). Advancing technologies also forms much of the business of university scientific research. Frequently, however, research from higher education institutions (HEIs) is not smoothly or even successfully transferred to industry. The aim of this literature review is to provide a framework of technology transfer activity from HEI to industry as a basis for further research.

Several terms used throughout this study require brief descriptions in order to clarify their meanings. Khalil (2000) coined a definition of technology as “all the knowledge, products, processes, tools, methods, and systems employed in the creation of goods or in providing services”. Further to this, other author emphasize the importance of “the creation of systems” and “the operation of those systems” (Sasmojo, 2002).

In the context of this study, technology transfer may be narrowly defined as “the process whereby inventions or intellectual property from academic research is licensed or conveyed through use rights to industry” (Association of University Technology Managers (AUTM), 2000).

Technology transfer is a natural product of communication process (Speser, 2006). On the context of the transfer between HEIs and industry sectors, a minimum of three stakeholders are
identified, academic institutes, Technology Transfer Offices (TTOs), and industry. AUTM (1998) defined TTO as an entity within university that manage and perform technology transfer activities. These stakeholders have their own motivation when performing the deal between them (Siegel et al., 2004; Lee and Win, 2004), which are presented in Table 1.

Table 1: Key Stakeholders in the Transfer of Technology from HEIs to Industry (adopted from Siegel et al. (2004))

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Actions</th>
<th>Primary motive(s)</th>
<th>Secondary motive(s)</th>
<th>Organizational Culture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientist in HEIs</td>
<td>Discovery of new knowledge and technology</td>
<td>Recognition within the scientific community – publication, grants</td>
<td>Financial gain and desire to secure additional research funding</td>
<td>Scientific</td>
</tr>
<tr>
<td>Technology Transfer Office</td>
<td>Works with faculty members and firms/entrepreneurs to structure deals</td>
<td>Protect and market the university's intellectual property</td>
<td>Facilitate technological diffusion and secure additional research funding</td>
<td>Bureaucratic</td>
</tr>
<tr>
<td>Firms or entrepreneurs</td>
<td>Commercialize new technology</td>
<td>Financial gain, market creation</td>
<td>Access to competency, maintain control of proprietary technologies</td>
<td>Business – entrepreneurial</td>
</tr>
</tbody>
</table>

For example, a primary motive of university scientists is recognition within the scientific community, which comes from publications in top-tier journals, presentations at prestigious conferences, and research grants from government. Faculty members may also be motivated by personal financial gain and/or a desire to secure additional funding for graduate students and laboratory equipment.

Different mechanism can be applied in technology transfer between HEIs and industry according to their motivations and available resources ((Rogers et al., 2000; Lee and Win, 2004) :

- Collegial interchange, conference, and publication;
- Consultancy and technical service provision;
- Exchange program;
- Joint venture of R&D;
- Cooperative R&D agreement;
- Licensing;
- Contract research;
- Science park, research park, technology park or incubators; and
- Start-ups of new companies (spin-offs).

Differences in the motives, actions, and organizational cultures of the three key stakeholders underscore the importance of organizational and managerial factors in the transfer process. Although this field of study has become increasingly important, little has been understood on the determinants and consequences of technology transfer activity, especially on Indonesian context.

II. LESSONS FROM THE DEVELOPED COUNTRIES

2.1 Benefits

Best lessons regarding technology transfer arguably came from the United States. University technology transfer has become an important mechanism for economic growth in the U.S. as well
as providing them with strategic advantages (Liu and Jiang, 2000; Wayne, 2003). Carlsson and Fridh (2002) examined that technology transfer has different objectives to the parties involved, especially on three aspects: commercial, academic institution, and community. On the commercial side, the main objective, of course, is profitable exploitation of an innovation or idea. On the academic side, the primary purpose of a technology transfer program is to assist the institution, on behalf of its faculty and inventors, in the dissemination of research results for the public good. The income generated through this mechanism is important but is only a part of the total benefit to the institution. And the benefit for the community is considered, though arguably, as the biggest and the most important of the three aspects. An economic impact model developed by AUTM has shown that nearly US$ 30 billion of the economic activity in U.S. can be attributed to the results of academic licensing, supporting 250,000 jobs in the fiscal year 1999. In 1996, the comparable figures were US$ 25 billion and 212,500 jobs (Carlsson and Fridh (2002); Decter, 2007). Carlsson and Fridh (2002) further conclude that the primary purpose of a technology transfer program is for the university to assist its researcher in disseminating research results for the public good. Success in this endeavour is only partially reflected in income generated for the university or the number of business start-ups.

2.2 Critics

Despite its benefits, the rapid growth of commercial-related technology transfer from HEIs has been controversial. Powers (2000) on his dissertation listed three potential conflict areas:

- Conflict of interest; for-profit business are usually dependent on proprietary rights to a technology in order to survive and prosper as a business. As such, they are reluctant to give their contracted faculty researcher free reign to publish the results of their work.
- Conflict of commitment; this refers to potential misallocation of time and energy to the three central roles of the professoriate – teaching, research, and service.
- Conflict over internal equity centre on the belief that internal institutional budget allocations inappropriately favour entrepreneurial units, create a culture of haves and have-nots, and unnecessarily cause rifts between disciplines, a direct threat to collegiality.

Wayne (2003) added that private appropriation of governmentally funded research can be considered counter-intuitive by quoting Eisenberg (1996):

“...by allowing private firms to hold exclusive rights to inventions that have been generated at public expense, it seems to require the public to pay twice for the same invention – once through taxes to support research that yielded the invention, and then again through higher monopoly price and restricted supply when the invention reaches the market.”

Debate about benefits and drawbacks of technology transfer activity will always exist. But two main actors of this activity - academician and industry - however, will always have a different role. Education and research on science and technology will always be HEI’s main concern. HEIs are not particularly adept at downstream activities such as production, marketing, and distribution of commercial products. These functions are better suited for private industry to accomplish. Therefore, an entity which acts as “bridge” between these two parties holds a vital role on guiding the deal while helps them to stay on their “tracks”.

2.3 Technology Transfer Offices

An entity form that adopted by many of U.S. universities, and later imitated in other countries, is Technology Transfer Office (TTO) or Technology Licensing Office (TLO). TTO was a response from universities as U.S. government issued U.S. Patent and Trademark Act of 1980 (well known as Bayh-Dole Act). This Congressional action allowed universities to claim rights to inventions created under federal research funds.
Universities were now permitted to license patents and technologies while retaining ownership and royalty rights (Wayne, 2003; Decter et al., 2007). Since then, TTO has become important medium on promoting technology transfer process. On his report, Markman et al. (2005) labeled TTO as technology intermediaries that conveyed innovation from laboratory scale to achieve industrial scale. 

In terms of organizational structure, creating a specialized TTO within a university can be instrumental in developing relations with industry by reducing the critical asymmetry of information problem typically encountered in the scientific knowledge market (Stadler et al., 2006). Carlsson and Fridh (2002) conducted detailed research on TTO attributes: organization, staffing, staff expertise, risk management, legal aspect, funding (on research and TTO activity), patent/licensing activities, policies and procedures for start-ups. Leute (2005) reported patenting and licensing practices at Stanford University’s TLO, and observed the relation between the models of royalty sharing between faculty and the effectiveness of the activities. 

Two points should be carefully planned when establishing a TTO according to Markman et al. (2005) are organization structure and licensing strategies. Based on interviews with 128 TTO directors in U.S., they found an important association between technology stage, transfer strategy, and the choice of licenses. Figure 1 summarized the theoretical models illustrates that early-stage inventions are licensed, primarily through sponsored research, to large firms. Large firms are also the primary recipients of technologies at the prototype stage, transferred through cash strategies. In contrast, new ventures are the primary licensing targets of technologies at the proof of concept stage or those that have been reduced to practice. 

2.4 Enablers 

The study of HEIs technology transfer activity within the “entrepreneurial university” framework came to the fore with Robert’s (1991) seminal study on entrepreneurial activity in MIT (O’Shea, 2004). O’Shea further noted that many subsequent studies of technology transfer activity have followed Roberts’ early work by investigating the factors that stimulate the creation of spin-off companies from universities. Most recent research by Decter et al. (2007) concluded that government intervention policy is still needed as an instrument to promote the transfer activity. A study by Clarke (1998) as quoted by O’Shea (2004) has provided us with more comprehensive enablers attributed on the successful HEI. They include: 

- Strong top-down leadership and policies that support and encourage the process of academic entrepreneurship and which merge entrepreneurial orientation objectives with the traditional academic values of the university;
• Strong ties between the university and industry in research projects of mutual gain and "robust" structures, policies and procedures to enable such activity (for example, industrial liaison offices and flexible contracting procedures);
• A diversified funding base such as industry and private benefactors, though much of university funding is still derived from government sources;
• A strong academic base; and
• An entrepreneurial culture that embraces change and sustains the fundamental values of the institution.

2.5 Obstacles

Despite their 20 years of experience on technology transfer activity, U.S. universities were not always successfully performed it. From all research results, half of it goes to patent application. Half of the applications were granted patent, but only one third of those been able to be licensed to industry and only 10-20% of licenses generated quite significant income (Carlsson and Fridh, 2002). Siegel et al. (2004) conclude from their research that there are numerous impediments to effectiveness in the technology transfer process: cultural and informational barriers among the three key stakeholder types (university administrators, academics, and firms/entrepreneurs), TTO staffing and compensation practices, and inadequate rewards for faculty involvement in the transfer and finally, many faculty members have decided to circumvent the formal process. On more recent research, Decter et al. (2007) identified several barriers to technology transfer from HEIs to industry in U.K.:
• The tendency “to publish not patent”, this may hindrance to the availability to protected technologies in U.K.;
• U.K. industry is perceived to be less interested in, and more sceptical of, university technology;
• U.K. university technology transfer policies are more diverse than in U.S. and technology is more difficult to access; and
• Lack of resources and experienced staff in some U.K. universities TTO.

Researcher in Indonesia who interested in this field of study can get a lot of fruitful and unpleasant experiences from learning the technology transfer practice from the developed countries. Even U.K. feels that they still need to learn from the U.S. on this field. Humphreys (2003) on her publication wrote:

"Boston and Silicon Valley are well studied examples. We know why they are so successful, but each was set up under unique conditions. There is much to learn from them, but local conditions will never permit exact replication. Any sort of technology transfer mechanism has to be designed around the culture of the institute where the research is and the culture of the market which the technology will transfer into. I don't think it is national cultures that make the difference, it is individual institutions and regions."

III. MACRO LEVEL STUDIES

3.1 Governmental and industrial support mechanisms in the spinout process

Some academics and economists voiced concerns that the exploitation of academic knowledge will jeopardise the basic role of the university (Lee, 1996; Mazzoleni & Nelson, 1998; Rogers, 1986), that encouraging commercialisation will alter the institutional rules and conventions under which research takes place (Dasgupta & David, 1994) and that spinouts have very little impact on the local or regional development of the economy (Harmon et al. 1997). Others (currently the dominant view) have positive attitudes towards university commercialisation activities and believe that the economic development momentum that has been generated at institutions in recent years should be vigorously pursued in a proactive manner (Chrisman, Hynes, & Fraser, 1995). A body of research documented how governments and the industry support and nurture the creation of new ventures from public research institutions.
3.2 Technology and market driven commercialisation

This research stream focused on explaining which inventions will be successfully commercialised by firm formation, looking at the technology and market factors that are beneficial to spinout creation. Shane (2001) attempted to reconcile earlier contradictory findings, and proposed that the tendency for an invention to be exploited through firm creation varies with the attributes of the technology regime (the age of the technical field, the tendency of the market toward segmentation, the effectiveness of patents, and the importance of complementary assets), testing his framework empirically. Lowe (1993) also provided a conceptual framework of favourable market preconditions for technology transfer mechanisms in general, by revealing spinout companies are most likely to form when complementary assets are of high availability to university and/or inventor and the technology used is under strong legal and technical protection.

IV. MESO LEVEL STUDIES

4.1 University support mechanisms: Incubators and Technology Transfer Offices

The changing role of universities from ‘knowledge production’ to ‘capitalisation of knowledge’ with the objective of improving regional or national economic performance as well as the university’s financial advantage and that of its faculty (Etzkowitz, Webster, Gebhardt, & Terra, 2000) led to increasing commercialization activities among universities in the last two decades. Many universities introduced technology incubators (see Link & Scott, 2005; Mian, 1997), science and technology parks (usually larger, often government-funded developments to accommodate local NTBFs in general and not only spinouts) and subsidy programs (Shane, 2002b). Of 52 UK universities in 1987, 34 had formal science parks (Monck, Porter, Quintas, & Storey, 1988). Cooper (1984) argued that incubators affect the spinout rate and the patterns of success of newly found ventures by mentoring them and by providing human capital support. However, the evaluative literature on science and technology parks is neither conclusive on their effectiveness (see Di Gregorio and Shane, 2003; MacDonald, 1987; Miller & Cote, 1987; Massey, Quintas, & Wield, 1992) nor on a framework for their systematic understanding (Phan, Siegel, & Wright, 2005).

4.2 University based determinants of spinout activity

Besides tangible organisational units such as incubators and TTOs, universities can offer a supportive organisational culture towards entrepreneurship. Henrekson and Rosenberg (2001) found that pertinent incentive structures that promote entrepreneurial culture can explain why an overall flourishing economy like Sweden has modest success with academic entrepreneurship. Recent studies debated which university related determinants of spinout activity can explain inter-university variation of spinout creation. Lockett and Wright (2005) examined the determinants of spinout formation under the lens of the knowledge based view of the firm and found that the business development capabilities of technology transfer offices and the royalty regime of the universities are positively associated with spinout formation. Feldman, Feller, Bercovitz, and Burton (2002) found that the university’s use of equity is positively correlated to prior experience with technology transfer, to success in relation to other institutions, and to structural characteristics related to the type of university. Recent studies used the resource based view to give further evidence that the resource stock of universities and the combination of resources are highly important to explain inter-university variations of spinout activity (Link & Scott, 2005, O’Shea, Alle, Chevalier, & Roche, 2005).

4.3 Effectiveness of spinning out as a university technology transfer mechanism

Rogers, Takegami, and Yin (2001) identified 5 different technology transfer mechanisms from universities (spin-offs, licensing, meetings, publications, and cooperative R&D agreements) out of which technology licensing and spinning out of ventures were the ones with the highest
commercialisation value. A stream of research examined favourable conditions for universities to commercialise technology in form of USOs as opposed to licensing. Universities have traditionally exhibited great reluctance to take equity positions in spin-off firms (Brown, 1985). Shane (2002a) suggested that university inventors become entrepreneurs because of the failures in the market of knowledge, suggesting that “inventor entrepreneurship is a second-best solution to the commercialization of new technology”. However, agreements in which a university takes equity position in a company in exchange for providing the right to use university intellectual property is becoming an emerging mechanism and the focus of interest of many universities (Feldman et al., 2002). Jensen and Thursby (2001) argued that equity investments not only provide the same development incentives as royalties (because both are based on output sales) but also generate greater revenue. This is consistent with the study by Bray and Lee (2000) who found that spinning-out is a far more effective technology transfer mechanism compared to licensing, as it creates a 10 times higher income, and therefore argued that licence positions are only taken when “technology is not suitable for a spin-off company”.

V. MICRO LEVEL STUDIES

5.1 Role of founders and founding team during the spinout formation process

Nicolaou and Birley (2003a) proposed a trichotomous categorisation of university spinouts based on the founder role of academics, namely technological, hybrid and orthodox spinouts. An orthodox spinout involves both the academic inventor(s) and the technology spinning out from the institution, a hybrid spinout involves the technology spinning out and the academic(s) retaining his or her university position, but holding a position within the company, and a technology spinout involves the technology spinning out but the academic maintaining no connection with the newly established firm.

The literature generally debated the effect of the involvement and role of academic and/or surrogate entrepreneurs on the performance of spinouts. Doutriaux (1987) and Roberts (1991a) reported that many spinouts start on a part-time basis (the academics keep their position at the university and “moonlight” into the new firm) and questioned their success. In an early study, Olofson and Wahlbin (1984) linked academic exodus with growth, finding that spinouts with the highest growth rates were the ones involving academics who left the university. The advantage of keeping the academics involved in the spinout process and close to the new venture can be due to the increasing effectiveness of the technology transfer achieved (Roberts & Hauptman, 1986).

5.2 Networks with university and industry

Networks can facilitate the emergence of ventures by providing four substantial benefits namely, augmenting the opportunity identification process, providing access to loci of resources, engendering timing advantages, and constituting a source of trust (Nicolaou & Birley, 2003a). During their pre- and post-formation stages, spinouts and their founders are involved in networks with two different entities, namely their parent organisation (university) and the industry (industry partners, investors, contractors etc.). Recognising the importance of networking in the spinout phenomenon, researchers explored the effect of networks on spinouts structure and performance.

5.2.1 Networks with the university

Keeping post-formation links with the parent institution, can provide spinouts with tangible resources such as laboratory facilities and access to research equipment (Steffensen et al., 2000) as well as intangible resources such as access to human capital and scientific and business knowledge (Rappert, Webster, & Charles, 1999).

Research focused on the characteristics as well as on the effects of ties between universities and spinout companies. It was found that the proximity to parent institutions had beneficial effect on spinout performance after the spinout formation (Lindelof and Lofsten, 2004; Roberts, 1991a), and that the network relations between USO and universities are based on small number of strong ties.
to universities, with a high degree of trust and informality (Johansson, Jacob, & Hellstrom, 2005). In contrast, Lee, Lee, and Pennings (2001) examined external networks of technology start-ups (not spinouts from academic institutions) and found that only networks to venture capital investors predicted start-up performance. Rappert et al. (1999) confirmed that due to their origins, university spinouts had a wider range of contacts and attached a greater importance to formal and informal contacts in universities than similar start-ups formed independently of universities.

5.2.2 Networks with industry

Interaction with industry is essential in order to gather relevant information about the new business, to find external support and services, to access external resources not available in-house, to promote the new company, and to look for business advice (Birley, 1985). As a result inter-industrial networks can have positive impact, cultivating new venture success and growth (Van de Ven et al. 1984). University spinouts are networking with several industrial parties during their pre and post start-up phase like venture capital investors, partners, competitors, and customers.

Grandi and Grimaldi (2003) investigated academic founding teams, their intention to set up relations with industrial partners and the frequency of their interactions. They found that when certain articulation of roles emerges in teams and when they are incomplete, they are more likely to interact with external agents. Further, founders of spinouts will interact (even increasingly) after spinout formation with their own ties of personal networks (Grandi and Grimaldi, 2003), which makes social capital endowments of founders in pre-formation stages crucial.

Nicolaou and Birley (2003b) found a link between pre-formation networking (the academics’ embeddedness in a network of endoinstitutional and exoinstitutional ties) and the spinout structure (orthodox, technology or hybrid spinout). They then suggested that the structure of a spinout, depending on the ties the academic founders, could influence its growth trajectories (i.e. performance). This logic (networks affect structure which affects performance) requires further empirical testing.

VI. THE DETERMINANTS AND CONSEQUENCES

Our review of literature suggests six primary research streams or domains. This classification of domains is in line with the work of O’Shea (2004). The first four focus on the determinants of the technology transfer process, while the remaining two factors focus on the consequences

6.1 Individual Attributes

A number of studies highlight the importance of personality, motivation, and characteristic in influencing academic entrepreneurship. This stream of research shares a common theme: that spin-off behaviour is a reflection of individual actions and therefore is largely due to the personality, ability or willingness of the individual to engage successfully in entrepreneurial behaviour (Carlsson and Fridh, 2002; D’Este and Patel, 2005; Lee and Win, 2004; Leute, 2005).

6.2 Organizational Determinants

Social scientists operating at the organizational level have adopted a different approach to the study of spin-off activity (O’Shea, 2004). Specifically, researchers have sought to establish links between technology transfer activity and the level and nature of research funding; the quality of the researchers, the nature of the research within the university; and the presence of technology incubators and technology transfer offices (Liu and Jiang, 2001; Markman et al., 2005; Wayne, 2003).

6.3 Institutional Determinants

The central tenet of the third stream of research is that university technology transfer activity is a reflection of institutional behavior (O’Shea, 2004). This research suggests that universities that

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have cultures that support commercialization activity will have higher levels of commercialization and higher rates of technology transfer activity. In contrast, university environments that do not encourage entrepreneurship will have less spin-off activity (Humphreys, 2003; Powers, 2000; Shane, 2002).

6.4 External Determinants

This stream of research emphasizes the impact of broader economic factors on academics within universities. Three factors that could be argued will impact on spin-off activity are access to venture capital, the legal assignment of inventions (for example, in the US, the enactment of the Bayh-Dole Act) and the knowledge infrastructure in the region (Dai et al., 2004; Decter et al., 2007; Humphreys, 2003).

6.5 The Performance of Technology Transfer from HEI to Industry

A small but growing number of studies deal with the performance of academic technology transfer (O’Shea, 2004). Powers (2000) analyzed the effects of particular resource factors on three measures of technology transfer performance, the formation of start-up companies, the number of IPO companies to whom a university had licensed a technology, and the level of licensing income received. Anderson et al. (2006) measured the technology transfer performance of 54 universities using a Data Envelopment Analysis (DEA) approach as a productivity evaluation tool.

6.6 The Economic Impact of Technology Transfer from HEI to Industry

University spin-offs are an important subset of start-up firms because they are economically powerful group of high-technology companies (Shane and Stuart, 2002 on O’Shea, 2004). As already mention on the previous section, nearly US$ 30 billion of the economic activity in U.S. can be attributed to the results of academic licensing, supporting 250,000 jobs in the fiscal year 1999 (Carlsson and Fridh, 2002). Technology transfers from HEIs to industry are also important economic entities because they create jobs, particularly for a highly educated workforce. Rogers et al. conducted study on the technology transfer process in New Mexico. They concluded that technology transfer from national R&D laboratories and from research universities provides the main basis for economic growth by metropolitan regions in the U.S.
VII. CONCEPTUAL FRAMEWORK

We have categorized the academic literatures on technology transfer into a number of streams of research which is apparently very close to the work of O’Shea (2004). We now seek to integrate these perspectives into a HEI-industry technology transfer framework. This framework (Fig. 2) represents a conceptual integration of elements found in the academic entrepreneurship literature. The framework assumes a socio-psychological perspective, in that we suggest that spinoff creation not only varies due to the characteristics of individual academics but also due to variation in environments and university contexts. We believe this framework will provide a useful organizing scheme for understanding existing literature and for explaining the determinants and consequences of technology transfer activity. The framework suggests that four factors influence the rate of technology transfer activity between HEIs and industry:

1. Individual Attributes;
2. Organizational Determinants;
3. Institutional Determinants; and
4. External Determinants.

And these next two streams of research dealt with the consequences of technology transfer activity between HEIs and industry:

5. The Performance of Technology Transfer from HEI to Industry
6. The Economic Impact of Technology Transfer from HEI to Industry

To conclude, we argue that technology transfer activities are increasingly important for economic development. Policy makers and HEIs will increasingly seek to understand how best higher educational institutions can contribute to both their traditional functions (education and research) and the added function of making the regional or national economy more competitive.
this paper we suggest a conceptual framework that should aid researchers in completing a much-needed assessment of the impact of organizational policies, practices and structures on university entrepreneurship. The integrative framework we present suggests that university heads and policy makers can encourage and develop university entrepreneurship by using a comprehensive systems approach for the identification, protection and commercialization of university intellectual property.

REFERENCES


Decter, M., David B., Michel L. (2007), University to business technology transfer, Technovation


D’Este, Pablo and Pari Patel (2005), University – Industry Linkages in the U.K.: What are the factors determining the variety of university researchers’ interactions with industry?, Paper presented at The DRUID Tenth Anniversary Summer Conference, Copenhagen, Denmark.


Leute, K. (2005), Patenting and Licensing of University-Based Genetic Inventions – A View from Experience at Stanford University’s Office of Technology Licensing, *Community Genetics*.


Liu, Hong and Yunzhong Jiang (2001), Technology transfer from higher education institutions to industry in China: nature and implications, *Technovation*.


Rogers, Everett M., Shiro T., Jing Yin (2001), Lessons learned about technology transfer, Technovation


Sasojo, Saswimadi (2004), Sains, Teknologi, Masyarakat, & Pembangunan, Program Pascasarjana Studi Pembangunan, Bandung


Shane, Scott (2002), Executive Forum: University technology transfer to entrepreneurial companies, *Journal of Business Venturing*


Shane S. (2002b). University technology transfer to entrepreneurial companies. *Journal of Business Venturing, 17*(6), 537–552


UNICO (2001). Annual Survey on University Technology Transfer Activities, NUBS


