CHAPTER 9

University High-Tech Alliances: Promising Economic Opportunities as well as Dangers

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In the long run, only more scientific technologically driven innovation can provide the new, more powerful tools required to help ensure a better future for all. Fostering collaborative partnerships in scientific research has emerged as a critical imperative to sustaining this innovation (Hasselmo & McKinnel, 2001).

INTRODUCTION

Just as the pace at which science, mainly in universities, has advanced at breath-taking speed, so has the desire of industry to benefit from the new knowledge. Collaboration is taking many forms. Such venerable collaboration as teaching and training firms' personnel, including managers and executives, and faculty serving as directors and consultants is being greatly expanded. However, individual consultancies are increasingly replaced by team efforts, at times by entire university departments. A relatively new form of collaboration, a manifestation of the high-tech revolution, seeks to benefit directly from universities' unique research capabilities. Today, high-tech firms seek to "contract out" to universities specific research undertakings by providing corporate funding. These arrangements between universities and high-tech firms, to be referred to as research alliances, are the focus of this paper, together with the collaborative efforts spawned by them.

The attractiveness to industry of such alliances is directly related to the excellence and breadth of research universities and their comparative advantage in effectively carrying out high quality research. In the United States, overall university research budgets have grown steadily, and so has corporate

funding, which in 1998 reached $2.6 billion or 9 percent of all research performed by U.S. universities and colleges. It about equaled the contributions made to them by state and local governments combined (National Science Foundation, 1998, Table B-35). State governments have also increasingly realized the value of the research done by their universities and by their alliances with industry. For example, already in 1990 the Georgia Research Alliance was founded. While the state invested $242 million in its six universities during the 1990s, private matching funds amounted to $65 million. Such states as Michigan, Wisconsin, and Ohio have taken similar steps, but they have been dwarfed by California. In 2000, California established its Institute for Science and Innovation, earmarking $300 million in state moneys to fund three institutes, which are to carry out high-tech research programs for four years. These state funds must be matched by more than twice that amount from corporations (Markoff, 2000).

WHY ALLIANCES?

A major reason for forming research alliances is clearly the self-interest of both high-tech firms and research universities. Not only do the two benefit from collaboration; so do regional and national economies, as well as society at large.

For universities, positive driving forces include the quest for new revenue sources and intellectual gains from collaborating in research with scientists in industry who work on real world problems, who often have vast experience and who have developed a distinct culture and way of thinking. As a consequence, the quality and scope of the research can be enhanced, while costs are reduced. Industry (and government laboratories) brings to the effort expensive state-of-the-art equipment and instrumentation, as well as financial resources. Alliances also facilitate the placing of the university's graduates.

Industry benefits, since universities bring to the table world-class scientists and a well-educated staff, as well as patents and an environment that stimulates inquiry and creativity. For example, the top 173 American universities' 1996 royalty and license fee earnings were $592 million. Industry benefits further, since outsourcing of research enables it to engage the very best scientists who are often unwilling to work in the private sector. Firms thus gain greater flexibility in manning their research efforts.

Society at large can benefit, since alliances tend to stimulate the creation of new knowledge, innovation and inventions, particularly when they lead to the formation of high-tech industry clusters.

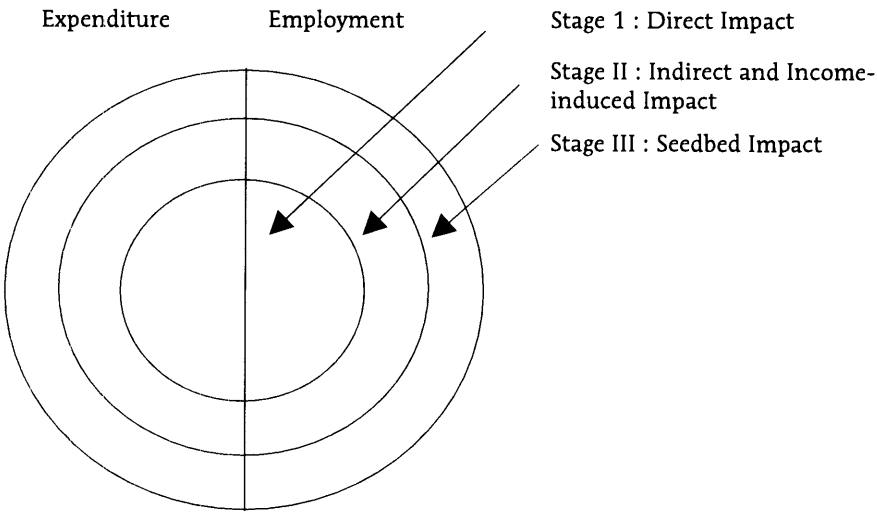
Additionally, university research, especially if carried out in cooperation with high-tech industry, can generate regional as well as national economic

benefits. Thus, when California Governor Gray Davis announced the establishment and funding of the California Institutes of Science and Innovation, he said, "It's my hope to replicate Silicon Valley...The most important thing a state government can do to improve local economies is to support research universities." (Markoff, 2000). Corporate funding has followed rapidly. For example, one of the institutions immediately received $140 million from companies such as IBM, Sun Microsystems, Qualcomm and Sony. Regional and national economies benefit when alliances generate innovations, which stimulate synergies from complementary integration and productivity gains from vertical disintegration through outsourcing, as well as scale economies from horizontal integration. Universities and their research alliances can have a seedbed effect stimulating the emergence of high-tech clusters, which further raise productivity and foster innovation.

REGIONAL ECONOMIC IMPACT

Research alliances can benefit not only the partners—they can also affect the economic health of the region in which they are located, with spillovers to the rest of the state and nation. For an analysis of the effects on expenditure and employment, regional impact analysis can be applied (Caffrey & Isaac, 1971). The analysis can be extended to three stages, as presented in Figure 1. Thus, in stage I we have the direct impact on the regional economy from the university's spending the funds of the corporate research contract on labor,

Figure 1: Three Impact Stages of University High-Tech Industry Research Alliances



material, and services. Stage II reflects the indirect and income-induced effects, and stage III the seedbed effect of the research grant. All of these effects have significant geographical dimensions, so that the alliance's total impact on local and regional economics is significantly greater than the sum of direct expenditures funded by the research contract.

Thus, two major interrelated forces are responsible for the regional economic impact of the university-high tech industry alliances. One force involves the inter-industry multiplier effect of money expended by the alliances on labor services and material, as they cycle through the economy several times. A second force relates to the emergence of high-tech clusters, which stimulate innovation and economic growth.

Inter-industry multiplier effect

Economists refer to the recycling of monies spent on labor, material and service in an economy as the indirect and income-induced "multiplier effect", so crucial in Stage II. The impact of each unit spent is "multiplied" as it is spent again in the economy. For example, the salaries paid by the university to faculty members and staff are spent by them to buy food, transportation, clothing, schooling, etc. To produce these and other goods and services, producers must buy a host of inputs, including labor. The extent of the effect can be estimated by using inter-industry multipliers, which have been calculated by modeling regional economies and making econometric estimates of their magnitude (Jaffe, 1989).

High-tech clustering and its effect

The economic impact of the research alliance does not stop here. The alliance's activities, especially those in the high-tech arena, often spawn new economic activities that benefit from proximity to the university. This is the seedbed effect, which is associated with clustering (agglomeration) of commercial activity and has further indirect and income-induced effects (Stage III).

The study of agglomeration has a long history. Alfred Marshall, the renowned 19th century English economist, provided insight into the advantages of what he called "localization" and therefore, agglomeration, of economic activity. He declared (in 1885):

> "The Localization of Industry promotes the education of skill and taste, and the diffusion of technical knowledge. Where large masses of people are working at the same kind of trade, they educate one another.
> Again, each man profits by the ideas of his neighbors: he is stimulated by contact with those who are interested in his own pursuit to make

> new experiments; and each successful invention, whether it be a new machine, a new process, or a new way of organizing the business, is likely when once started to spread and to be improved upon.
> In a district in which an industry is localized a skilled workman is sure of finding work to suit him; a master can easily fill a vacancy among his foreman; and generally the economy of skill can be carried further than in an isolated factory however large. Thus both large and small factories are benefited by the localization of industry and by the assistance of subsidiary trades."

Thus, just as Marshall's localization effects are long term, cumulative and depend on cooperation in knowledge creation and innovation, so does high-tech clustering.

To be a player in the knowledge-based high-tech economy (which is often referred to as a crucial part of the New Economy), requires successful and timely innovation and inventions for which there will be a responsive demand. Significant parts of this New Economy, especially pharmaceuticals and computer software, show two defining characteristics: 1) exceptionally high development costs of new products and therefore very high start-up costs of new companies, while production costs are extremely low, and 2) exceptionally rapid obsolescence of new products and processes.

As a result, the rewards in knowledge-based enterprises go to enterprises that innovate quickly and then capture the largest possible market share before being pushed aside by new innovations. Moreover, many innovative products in the New Economy have a very short life expectancy, for example 12-16 months for a typical semiconductor product (Hall & Ziedonis, 1999).

Today, firms in many high-tech industries are consumed with the defining requirement of achieving monopoly power, however temporary it turns out to be. Achieving this condition is significantly facilitated by locating near great research universities, which thus become increasingly surrounded by growing clusters of symbiotic enterprises. These clusters benefit from synergies and positive externalities on the demand side and from cost savings on the supply side. In turn, they attract human capital of the highest quality while providing an environment conducive to the lively exchange of knowledge and ideas.

Reflecting these defining characteristics of knowledge-based high-tech economic activities and effectively responding to them, high-tech clusters have emerged. They facilitate expeditious creation of new ideas, knowledge, processes and products, all very costly to create and yet frequently short-lived.

A high-tech cluster is thus a geographic concentration of horizontally and vertically interconnected companies and associated institutions, which have

located themselves around research universities and other research centers. All these activities are linked by commonalities and complementaries, and benefit from positive externalities. Physical proximity among those who work on the cutting edge of knowledge continues to be extremely valuable, even in an age where the cyberspace revolution has shrunk distances in space and time. Thus, according to *The Economist* (1999, p. 71): "Even in the days of instantaneous communication, there is no substitute for researchers pressing flesh...and the ability to sit in the bar and chew the fat with colleagues and rivals."

Demand-related horizontal interactions tend to be crucial for initiating the clustering process. Benefits from these interactions include the ease and timeliness with which information, knowledge, ideas and novel concepts are exchanged between cap and gown and among high-tech industries. Many of the interactions are informal and unplanned and at times the idea exchange might not be recognized until much later.

In addition to horizontal, demand-related forces, there exist also significant vertical, supply-related ones. As firms form clusters, they need inputs, not only scientists and staff, but also products and services so that they can efficiently carry out their missions. This supply-related growth follows the demand-related one, but in due time both tend to interact. Being located in a high-tech cluster, and thus having access to a large labor pool and to specialized inputs, can raise a firm's productivity and competitiveness. Much of a firm's outsourcing can be local and thus involve lower transaction costs than non-local outsourcing does, but only up to a point. When clusters get too large and too cluttered with enterprises, negative externalities tend to raise their ugly heads and with them transaction costs tend to increase.

Horizontal and vertical interactions sooner or later affect each other. For example, as suppliers of inputs exchange information and ideas with high-tech firms and universities, they in turn contribute knowledge and ideas to their scientists and their students, and consequently in the long run improve the productivity of suppliers of goods and services. Because of these manifold interactions, technological developments, dynamics of the market and government regulation, high-tech clusters are in a continual state of flux.

The fact that research alliances can have a major impact on the regional economy is borne by some estimates of the 1998 economic impact of California's twelve research universities. It was estimated that their $254 million in corporate research contracts may have increased California's level of economic activity by perhaps as much as $1.4 billion. Employment may have increased by as much as 18,200 jobs (Hirsch, 2000).

THREATS, RISKS AND REMEDIES

When research universities lower their walls to the outside world, a variety of collaborative efforts with high-tech industry can follow. Among them, research alliances stand out because of their financial size and impact, but also because of the risks and controversies they can generate. Other forms are joint ventures of universities with high-tech firms and faculty assuming a financial interest in start-up companies or serving as directors, managers, lead scientists or consultants. While collaborative efforts with industry can be rewarding, they move universities far away from the cloistered environment, which in the earlier years was considered so essential to the creative pursuit and transmission of knowledge. Research alliances, in particular, carry with them the seed of commercialism in the university. This can pose serious threats to the institution's ethos and culture. Alliances can compromise its academic mission and, most importantly, interfere with its traditional role as honest arbiter of knowledge and guarantor of undisputed objectivity in the public interest.

This threat can become even more serious when corporate research funding brings to university administrators a business background and ethos, which can profoundly conflict with the venerable academic culture and mission.

Research universities must be concerned with the following major dangers:

- Inter-departmental imbalances, i.e. skewed priorities among departments, schools and research centers,
- Intra-departmental imbalances,
- Faculty conflicts of interest and commitment,
- Curtailment of faculty rights, and
- Financial risk of the universities.

Inter-departmental imbalances

Universities consider it their mission to offer a broad, balanced liberal education, particularly on the undergraduate level. However, massive corporate support for the sciences and engineering can have a seriously distorting effect. The humanities and arts go begging and serious frictions between them and the rest of the university have become common.

In the hope of mitigating such imbalances, a percentage of financial gains from corporate contracts could be allocated to disciplines important to a great university, yet hard to fund by contracts and other outside sources. Such a tax could be levied especially on corporate research funding in recog-

nition of the fact that the quality of research that accrues to the firm is made possible by the breadth of the overall academic excellence of the university.

Intra-departmental imbalances

Not only the disciplinary priorities become distorted and imbalanced, so can priorities within academic units. Are not faculty members likely to be drawn to research areas in their discipline where funding is plentiful? Equally promising and deserving specialties, and perhaps those which might bring tomorrow's breakthroughs, can wither on the vine. As a consequence, serious conflicts can arise within departments and schools. The effects of departmental imbalancing, which result from large corporate contracts funding interdisciplinary research, could be mitigated by transferring these contracts into a research center. As a result, mono-disciplinary research would be carried out mainly in departments, while inter-disciplinary research with corporate funding would move into a research center.

Conflicts of interest and commitment

The nature of research in the sciences and engineering is changing at a rapid pace and so are collaborative efforts. The ever more complex research environment has led to ambiguities about the rights and responsibilities of faculty. Attractive funding opportunities offered by collaborating firms and the prospect of financial gain can skew faculty decisions, erode interest in university affairs and weaken commitment to the university's mission.

> A 'conflict of interest' arises when an academic staff member is in a position to influence either directly or indirectly University business, research, or other decisions in ways that could lead to gain for the academic staff member, the staff member's family, or others to the detriment of the University's integrity and mission of teaching, research and public service (University of Illnois, 1998).

Increased entrepreneurship by faculty and the rising financial influence of industry can become a combustible mixture, which can readily lead to short-changing undergraduate and graduate students. Collaboration with industry can result in faculty employing, and perhaps exploiting, graduate students in outside research in which faculty have a financial interest. Conflicts of interest can also arise when a faculty member assumes an executive, managerial, salaried or consulting position in an outside organization, conducts a professional practice, or uses university facilities and equipment for non-university research. In these circumstances, bias in research results can come about in return for special favors.

The challenges facing universities are especially grave in relation to drug companies—paid drug studies. Pharmaceutical companies often fund the studies, and then pay faculty for delivering lectures and for consultancies. They even list academic scientists as lead authors of papers, although the studies are actually designed and the data analyzed by drug company employees. How common such practices are is revealed in a recent study, which finds a third of one medical school's investigators have such relationships (Boyd & Bero 2000).

Separately, there is the risk of institutional conflicts of interest. It occurs when universities have financial interests in the corporate sponsors of their research. Such investment can color decisions and attitudes towards collaborating faculty and should be avoided. Universities have experimented with a number of policies designed to help check faculty's conflicts of interest. Devising such policies tends to run into difficulties, since not infrequently faculty and administration views differ. They conflict most decidedly in regard to two crucial areas: 1) maximum level of financial interest in a company that a faculty member can have while engaging in a university activity which involves that company and 2) circumstances under which the university administration is to be merely informed or formal approval is required by faculty, and when this step is to be taken, i.e., *ex ante* or *ex post*.

In relation to the first issue, for example, the University of California, San Diego (UCSD) adopted in 1999 the following policy. Financial interests in a company cannot amount to:

- Annual income in excess of $10,000 from the company, or
- Equity interest of more than 5 % or $10,000 in the company, or
- Management responsibility in the company.
- This standard for determining a significant financial interest should be applied to:
- Acceptance of contracts, grants, and gifts from companies in which the Principal Investigator has a financial interest,
- Acceptance of UC grants whose industrial partner is a company in which the Principal Investigator has a financial interest,
- Conducting clinical trials for companies in which the Principal Investigator has a financial interest,
- Acceptance of federal contracts and grants whose Principal Investigator or other researcher has a financial related to the project,
- Subcontracting of work by UCSD to a company in which the Principal Investigator or other researcher has a financial interest,
- Employment of a graduate student or postdoc in a company in which the student's or postdoc's advisor has a financial interest.

A second, somewhat lower, but still onerous, level of conflict relates to faculty's commitment to the University.

> A 'conflict of commitment' exists when the external activities of an academic staff are so substantial or demanding of the staff member's time and attention as to interfere with the individual's responsibilities to the unit to which the individual is assigned, to students, or to the University (University of Illinois, 1998).

In the hope of addressing the risk of conflicts of commitment, most universities limit the number of days faculty can spend on external activities. These policies are all too often ambiguous and tend to be disregarded by faculty, particularly since no penalties are usually invoked.

Not unlike policies to rein in conflicts of interest, so also those addressing conflicts of commitment face the two challenges of defining the maximum time faculty can devote to outside work, and in what form, and when notification of the administration is required.

Engagements of the following sort are the concern:

- Consulting,
- Assuming an executive or managerial position in a for-profit or non-for-profit business,
- Administering, outside the University, a grant that would ordinarily be conducted under the auspices of the University,
- Employing students in outside research projects in which the faculty member has a financial interest,
- Conducting a professional practice.

Faculty who staff research alliances tend to establish working relations with their counterparts and officers in the sponsoring firm. Consulting opportunities often follow and, at times, even part ownership, part-time positions as senior scientists and board membership. These roles can reduce commitment of time and devotion to the university, leaving the university facing a difficult choice. Either it can seek to rein in activities that short-change it and thereby risk losing outstanding faculty, or it can accommodate faculty and risk that they give the university less and less time and devotion.

This dilemma might be solved by moving faculty determined to engage in major outside activities into a new faculty status. This new status would resemble the position of Professor in Residence in medical schools, which provides for part-time university employment while limiting privileges.

More generally, for the sake of minimizing conflicts of commitment, a policy should be developed, which defines clearly what are unacceptable levels of outside activities and whether, and if so when, university approval is to

be obtained. Disseminating this information effectively and broadly is essential.

Curtailment of faculty rights

All too often academics, used to an exclusive right to determine what, when and where to publish, find this freedom impinged upon by corporate sponsors. Corporations are keen on having the right to review manuscripts and to delay their publication. Likewise, they tend to insist on confidentiality and seek ownership of patents and copyrights related to research that they have funded.

There exists no magic formula to solve these opposing interests. Cases differ from one to the next. Still, universities can help themselves by developing contract terms that represent their minimum requirements of faculty rights. Faculty and administration are well advised to closely cooperate in developing these minimum conditions. They should be made known to potential funding sources, which would then know already at the start of contract negotiations what conditions would be deal breakers.

Financial risk of universities

Collaborative arrangements between universities and high-tech industry, while often financially rewarding, can carry with them significant financial risks for the university. One is heightened financial instability. It results from the fact that the sum total of research contracts varies greatly from year to year and requires different faculty specialties. For example, for the first time in UC Berkeley's history, it entered in 1998 into a five-year alliance with a corporation, which signed a $25 million research contract. Tooling up for such a temporary effort can lead to a "boom and bust" cycle.

Moreover, universities often face difficult negotiations about intellectual property rights. It is to be expected that the corporate research sponsor and the university tend to be at odds about general patents and copyrights ownership and royalties. They also tend to differ in their views about rights and background rights—licensing rights a university has gained in connection with earlier research, often using funds from other sponsors (Hasselmo & McKinnel, 2001). While faculty members are considered co-owners of intellectual property, those who produced the rights to an existing license are often not party to the new research agreement under discussion. Thus, awarding background rights to a new sponsor can be highly unfair to select researchers. Moreover, giving away background rights can hamper the ability to continue earlier areas of research and to license new technology to other firms that are contemplating entering new research contracts.

Finally, risk arises when corporate sponsors do not pay the full indirect cost, i.e., the research cost accruing to the university above researchers' sala-

ries and the cost of new materials. For example, federally financed research in universities in the late 1990s covered only 70-90 percent of its full cost, with indirect costs accounting on average for 50 percent of overall cost (Goldman & Williams, 2000). The payment of insufficient indirect cost tends to be aided in negotiations when firms are supported by faculty who are eager to see their research funded.

Paying less than the full indirect cost not only forces the university to subsidize the corporate sponsor, but also disadvantages departments with little or no outside funding. They often end up indirectly subsidizing the best-endowed department. A common result is tension within the university and some unhappy departments.

If, under some circumstances, subsidies are acceptable to the university administration, it is important to be frank about them. To this end, universities should develop transparency in their accounting methods and transactions. Admittedly, such a step will often require lengthy discussion with faculty. However, once agreement is reached, it should be widely publicized.

CONCLUSION

As the walls between academia and the outside world are coming down and research alliances proliferate, universities will increasingly place one foot in the world of commerce, while the other foot remains in the world of academia. Alliances can greatly contribute to the economic growth, employment and income of a region. Participating corporations gain access to great research capabilities and universities gain income and interesting research opportunities. But universities also expose themselves to severe risks. These include inter-departmental and intra-departmental imbalances, faculty conflicts of interest and commitment to the university, curtailment of faculty rights as well as financial risks to the university. Since research alliances promise to continue to be part of the high-tech world for years to come, universities (and their corporate partners) are well advised to develop model contracts. Some could be for single projects, while others could be model master contracts to be used in cases of add-on collaboration. Such contracts, which must be particularly sensitive to issues of profound university concern, can greatly benefit from previous contract negotiations. These model contracts can streamline negotiations. In their form and content they tend to fall between individually drafted and boilerplate contracts.

In conclusion, when forming research alliances, universities should make sure that these alliances will make major contributions to both the university and to high-tech industry. At the same time, the alliances must safeguard the defining values of academia. The latter issue is of paramount importance since, to paraphrase John Maynard Keynes, perhaps the great economist of

the 20th century, academia must be, "the trustee...of the possibility of civilization".

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