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Benchmarking University-Industry Technology Transfer in the Inland Northwest

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It is with great pleasure that I introduce you to the monograph series of the Institute for Public Policy and Economic Analysis from Eastern Washington University. I hope this research from Eastern faculty sheds new light on a particular aspect of life in the Inland Northwest.

The goal of the Institute is for our highly-qualified faculty to provide analysis and data that are relevant to your lives. The vision of a regional university that our Board of Trustees has adopted speaks directly to the notion of relevance to the Inland Northwest. Without relevance to the communities that make up this dynamic and beautiful corner of our country, our university is not fully living up to its mission.

Of course, our main mission at Eastern Washington University is to educate students to the highest levels possible, for the sake of their own careers, the future of the communities in which they will reside, and ultimately their growth as individuals. An increasingly important mission of Eastern is also to encourage faculty research. Not only does this help keep our faculty professionally current, but makes them better teachers, through the sharing of research opportunities with their students.

However, not all faculty research at Eastern need be written for professional audiences. In this day of increasingly specialization and complexity, I see an imperative for an informed citizenry. What better source can our region find to translate this knowledge into jargon-free, accessible information than a university like Eastern?

Since coming here six years ago, I am convinced there is a level of excellence at Eastern Washington University that is worthy of recognition and support. The university is a catalyst in the progress of the region – its economy, culture and way of life. The Board of Trustees and I regard the Institute for Public Policy and Economic Analysis as a striking example of our commitment to this region. My office and that of the Institute director welcome all comments on how we might better serve.

Stephen M. Jordan, Ph.D.

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I. Executive Summary

This monograph presents the first of a two-part research study focused on technology transfer in the Inland Pacific Northwest. The second part will present more detailed findings about the economic impact of start-up companies in the Inland Northwest. This part presents benchmark findings about technology transfer at the Inland Northwest research centers: Eastern Washington University (EWU), University of Idaho (UI), Washington State University (WSU) and Pacific Northwest National Laboratory (PNNL). The study utilizes a survey instrument developed by the Southern Technology Council (STC).

That instrument was used to carry out two types of analysis. First, data for the Inland Northwest institutes were compiled for FY1998, the last available data from the STC study, and compared to the STC findings as well as to findings from two other sources, AUTM and EPSCoR. Second, data for the Inland Northwest institutes were compiled for FY1998-2003 to analyze trends over the last five years.

The STC study examined eight technology transfer benchmarks, divided into three categories:

- Input benchmarks
    - U.S. patent applications
    - U.S. patents awarded
- Output benchmarks
    - Licensing
    - License income
- Economic impact benchmarks
    - In-state licensing
    - Start-up licensing
    - License income from in-state licenses
    - Start-up companies formed

The STC study measured these variables on ratios and absolute levels. The absolute measures showed a bias towards large research universities. Therefore, this study primarily uses ratio measures. Nevertheless, it must be noted that EWU, UI, WSU and PNNL are, based on their classifications, not really comparable.

FY1998 Benchmark Comparisons with the STC Findings

- **EWU** scored at the bottom for each of the benchmark measures. This is no surprise since hardly any of EWU's peer institutions made it into the STC rankings.

- **UI**'s ratio measures were comparable to the other institutes and it seemed to be doing a reasonably good job, considering its relatively small R&D budget in 1998. For the input and output benchmarks, UI scored close to the STC median for the *patent application ratio* and for *license income as a percentage of R&D expenditure*. It showed lower than the STC median values on the *number of patents awarded per $10 million R&D and active licenses per $10 million R&D*.

  For the economic impact benchmarks, UI scored considerably higher than the STC medians on the *percentage of licensees and options to in-state licensees* and for *in-state license income as a percentage of all license income*. This indicates that UI was much more in-state oriented than the institutes included in the STC study. Compared to the other Inland Northwest institutes, a similar observation can be made: UI had a particularly strong focus on regional impact.

- With a research budget of over $95 million in FY1998, **WSU** was positioned within the top 100 of U.S. research universities. For the ratio measures, WSU scored relatively high on *patent applications* and on the *number of active licenses*. The *number of patents awarded* was comparable to the STC median but lower than the AUTM study median. For license income, WSU scored below the medians of the AUTM and STC studies and below UI. This indicates that although WSU was able to develop patents and license these, it did not necessarily generate a lot of income from these licenses. WSU did not emphasize regional economic impact through start-up companies. Although a good percentage of the active licenses were to in-state licensees, no license income was generated from these licenses.

- Because of the size of its R&D budget, it is not surprising that **PNNL** scored highly on the absolute measurement of the benchmarks. For ratio measures, however, PNNL scored relatively poorly on several of the benchmarks. For the input benchmark *patent applications per $10 million R&D* and the output benchmark of *license income as a percentage of R&D expenditure*, it scored lower than UI, WSU and the median values of the STC, AUTM and EPSCoR studies. For the *number of patents awarded per $10 million R&D*, it scored lower than WSU and the median for the STC, AUTM and EPSCoR values. PNNL scored relatively well on the economic benchmarks for *in-state license income as percentage of all license income* and for *start-up companies per $10 million R&D*.

Overall, the findings for the FY1998 comparison showed that the Inland Northwest institutes were, with the exception of EWU, "middle-of-the-road" institutes. They performed neither exceptionally well, nor exceptionally poorly.

Inland Northwest Indicators for 1999-2003

- **EWU** is clearly a small institution with regard to research and technology transfer. EWU's research budget (FY2003: $1.2 million) and technology transfer office (FY2003: 0.05 FTE) are small compared to the other Inland Northwest institutes. It is therefore not surprising that the benchmark values for the last five years are low for EWU. The one exception is FY2002, when EWU had one patent application. Since EWU has such a small R&D budget, this had a big impact on the ratio measure for patent applications. This shows that for an institute like EWU, it does not take much to start scoring relatively high on ratio benchmark measures.

  In general, EWU is trying to improve its position but finds it difficult to do this. The challenge is that EWU's mission is oriented toward teaching. As a result, it is difficult for faculty to get course releases to carry out research. In addition, a large amount of research is required to develop patents and this research requires funding. It is challenging for EWU to acquire this funding, as it typically requires a reputation. EWU still has to build this reputation.

- Over the last five years, **UI** has increased its R&D budget (FY2003: $85 million) and technology transfer FTEs (FY2003: 3 FTEs). Its performance on the *number of patent applications* and the *ratio for patent applications per $10 million R&D* has fluctuated, varying from 1.0 to 2.8 applications per $10 million of research expenditures. The *ratio of patents awarded per $10 million of research expenditures* has declined. The *active licensing ratio* has improved, although UI's *license income as a percentage of R&D* has fluctuated. *In-state licensing* decreased from 1999 to 2002 but improved in FY2003. The *income generated by in-state licenses compared to all licenses* has been around 10%. Although data for start-up licensing are mostly absent, UI created a higher number of start-up companies between 2001 and 2003 than WSU. This is quite impressive considering UI's smaller R&D budget.

Compared to the other Inland Northwest institutes, UI is performing, as expected, between EWU and WSU. The noticeable exception is that UI has continued to perform better with regard to start-ups and in-state licensing. UI will probably increase its technology transfer activities such as patenting and licensing in the future. An obstacle has been the number of technology transfer FTEs available. With more technology transfer FTEs available, higher outcomes may be reached at UI.

- Over the last 5 years, **WSU** has increased both its R&D budget (FY2003: $175 million) and technology transfer FTEs (FY2003: 5.5 FTEs). The *number of patent applications* and the *number of patents awarded* have, in general, declined since 1998. The number of patents awarded went from 0.94 in FY1998 to 0.80 patents per $10 million research expenditures in FY2003. The active *licensing ratio* has declined and *license income as a percentage of R&D* has fluctuated. *In-state licensing* has been around 45%, and start-up licensing has improved. The *number of start-up companies per $10 million R&D* has fluctuated between 0 (FY1998 and FY2001) and nearly 0.20 (FY2000).

Compared to the other Inland Northwest institutes, WSU is generally performing better than UI and PNNL. WSU scores higher than PNNL on input benchmarks -- patent applications and patents awarded. WSU has also, for most of the research period, performed above PNNL on output benchmarks -- number of active licenses and license income. Yet for the ratio of active licenses, WSU shows a decreasing trend while PNNL's has been increasing. For the economic impact benchmarks, WSU performed better than the other institutes on the ratio of start-up companies formed, whereas WSU performed less well on in-state license income.

UI has performed better than WSU on the ratio of start-up companies in the last two years. Due to changes in the WSU administration, interest in technology transfer in the last couple of years has increased. There is more push for industry sponsored research and faculty involvement. WSU is also trying to find more licensees within the state but the number of in-state licenses was and is limited. Much of WSU's research and intellectual property is oriented toward agriculture and the regional impact of this is limited.

- **PNNL** is clearly the largest institute included in this study. Its research expenditures (FY2003: $582 million) and emphasis on technology transfer (FY2003: 25 FTEs) are quite high compared to the other institutes. For both input and output benchmarks, PNNL's FY2003 performance improved compared with FY1998. Especially for *license income as a percentage of R&D expenditure*, this improvement has been substantial, from 0.11% to 0.34%. For the economic benchmarks, PNNL has a relatively low *ratio of in-state licenses in effect* and *ratio of in-state license income*. However, its *ratio of start-up licenses in effect* is much larger than at the other institutes although declining. The *ratio of new start-up companies formed* is also relatively low.

  Compared to the other institutes, PNNL clearly outperforms in absolute terms. However when ratio measures are used, WSU performs better than PNNL on most measures. A problem with the PNNL ratio measurement is that all R&D investments are included. For PNNL, R&D investments include large, expensive equipment. Organizations with heavy equipment investments may be disadvantaged in these comparisons.

Overall, the findings for the last five years show that the University of Idaho and Washington State University are still "middle-of-the-road" institutes. Over this interval, they performed neither exceptionally well nor exceptionally poorly. EWU is an institute that has not scored high, but this is reasonable since it is not a research university. PNNL performs very well on the absolute measures but a little less on the ratio measures.

With regard to specific regional impacts, the ratio of in-state licenses in effect has declined at all four institutes. The percentage of new licenses awarded to start-up and small companies has also declined.

Research focuses vary among the regional institutes. Biotechnology has been an important field for both UI and WSU, and will probably remain important for WSU. Information technology and energy have become more important for PNNL, and together with materials, will probably remain important.

Furthermore, the Inland Northwest institutes receive low industrial support for their research. Roughly 4% of their total research expenditures is supported by industry, whereas this average for U.S. universities is closer to 7%.

2. Background

The goals of this research are:

1. To benchmark the university industry technology transfer from four Inland Pacific Northwest research institutes: Eastern Washington University (EWU), Washington State University (WSU), the University of Idaho (UI) and Pacific Northwest National Laboratory (PNNL), compared to benchmarks for FY98 based on the metrics used by the Southern Technology Council (STC)[1].
2. To provide an overview of the trends in benchmark values for the four Inland Northwest institutes based on the STC metrics.
3. For start-up companies, based on technologies from these four institutes, to provide a first-order approximation of the regional economic impact.

The study was initiated because technology-led economic development has gained increasing momentum in the U.S., and in particular in the greater Spokane area, as a key strategy for lifting employment and per capita income levels above their stagnant trend lines of the past 15 years. An example of this type of strategy is the recently developed plan for the Innovation Economy[2]. Across the U.S., universities are recognized as the source of much new technology. In fact, in the past 10-15 years, a new model for the American university, as a partner in its regional and state economy, has emerged. Universities that are exemplary in their participation in state and local economic development have been identified and their approaches analyzed[3]. More general studies have been carried out to identify how much technology is generated (patents) and transferred[4].

Although several studies have been conducted on technology transfer across the U.S., relatively little is known about the relative size and success of the four Inland Northwest research institutes. This monograph is the first of two and deals with the first two research questions. It will be followed by a report that focuses on the third research question. Combined, the research aims to quantitatively assess technology transfer from the Inland Northwest research institutes to aid regional discussion of policy related issues.

3. Literature Review

Three strands of literature deal with regional effects of industry-university technology transfer. One focuses on the innovation process and includes industry-university technology transfer as a part of the innovation process. Another strand focuses on technology transfer processes and includes industry-university technology transfer as one of the many types of technology transfer. Yet another strand focuses on economic geography and includes the university as one of the potential contributors to economic development. To provide the context for this research study, each will be briefly introduced in the following sections.

3.1 Innovation

In the last 40 years, a number of studies have been carried out that demonstrate that technological change is an important contributor to productivity growth, and therefore to growth in the income and wealth of nations[5 6]. This has led attention to technological change. Technology in this instance is usually loosely defined, and technological change is commonly seen as innovation. Innovation has been defined as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption."[7] And "technological innovation involves the situationally new development and development and introduction of knowledge-derived tools, artifacts, and devices by which people extend and interact with their environment"[8]. It is the commercialization of innovations, or new technologies, that leads to economic growth[9]. Commercialization of new technologies can broadly be viewed across the entire path from idea to ultimate consumer.

This process of innovation diffusion is described in detail by several researchers[10 11 12]. The university plays an important role in this process, since it is involved, through its research, in the process of creating new knowledge. One way in which this is manifested is in the creation of patents. Transferring patents (technology) from the university to industry is one of the steps in the innovation diffusion process. Because of the relationship between innovation and the economy, a number of studies have focused on national characteristics of innovation[13 14 15], national characteristics of university-industry R&D collaboration[16], national characteristics of the technology transfer system[17], and in particular on the relationship between national technology transfer systems and the economy[18 19]. As will be discussed below, recent emphasis has also been placed on the regional environment.

There are three important findings from innovation studies. First, location is an important factor[20]. Second, innovation is not a linear process from research to development to production to marketing. It is much more complicated and involves a number of feedback loops[21]. Third, innovation involves three dynamics: the economics dynamics of the market, the internal dynamics of knowledge production, and the governance of the interface at different levels. These dynamics are combined in the Triple Helix of University-Industry-Government relations[22 23 24]. It is thus a combination of university, industry and government that leads to economic growth.

3.2 Technology Transfer

There are at least 16 types of technology transfer[25]. As a consequence, the terms 'technology transfer' can have very different meanings in different contexts. Another consequence is that the large body of literature covers a variety of viewpoints which are not necessarily comparable. For example, studies on the transfer of production technology from developed countries to developing countries[26 27] have little in common with studies on technology transfer from research to development[28 29] or from development to manufacturing[30].

One of the reasons for this is that "technology" is defined differently for the different types of technology transfer. In the case of production technology transfer from developed to developing countries, technology is often seen as a combination of hardware (machines) and software (knowledge)[31 32]. In the specific situation of technology transfer from university to industry, technology is often seen as information[33] or patents[34].

Actually, the process of innovation diffusion is often a series of technology transfers of different types. Technology transfer from university to industry can occur through a variety of channels, including: formal cooperation in R&D between academia and industry, university seminars, scholarly journal publications, faculty consulting, industrial associates programs, industrial parks, high technology firm spin-offs, technology licensing, labor markets for scientists and engineers, and local professional associations of scientists. Although many of the studies on technology transfer focus on the process of technology transfer, that is, how it is or how should it be carried out, a number of studies focus specifically on the economic impact of technology transfer. For example, in the transfer of production technology from developed to developing countries, studies have been conducted to determine the impact on the developing countries' economy[35 36]. In the case of industry-university technology transfer, studies are concerned with evaluating the appropriateness and outputs of public funded research[37 38], the economic benefits of university (public) research [39], and the contribution of R&D to productivity[40].

3.3 Economic Geography

Economic geography is concerned with the various ways in which people earn a living and how the goods and services they produce are spatially expressed and organized[41]. In other words, it links economics with location. One result from these types of studies is that assessments can be made about a nation's competitiveness compared to other nations[42] or in particular, about their high technology competitiveness[43]. It is clear that location affects competitiveness[44 45], and local factors are particularly important[46]. Understanding what causes competitiveness[47] leads to policy insights.

An important finding is that industries tend to be highly localized. This is true for innovation-related[48] as well as for manufacturing-related industries in the U.S.[49] It is important to understand the causes for this phenomenon, because they provide valuable policy insights. In the case of manufacturing industries, localization occurs for both high and low technology industries, indicating that localization is not solely a matter of technological spillovers[50].

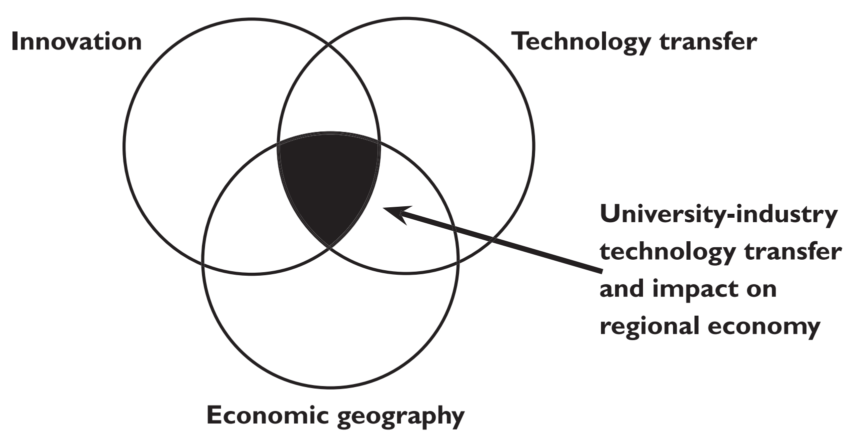
Second, although initial manufacturing may have occurred in specific locations by "accident" (the inventor just happened to live there), concentration grows for two reasons: Cost of transactions over space, and economies of scale. Because of economies of scale, producers have an incentive to concentrate production of each good or service in a limited number of locations. Because of the costs of transacting across distance, the preferred locations for each individual producer are those where demand is large or supply of inputs is particularly convenient, which in general are the locations chosen by other producers. Thus concentrations of industry, once established, tend to be self-sustaining[51].

For economic development at the country level, the growth of a nation's economy, as measured by GDP per capita, can according to one school of thought, be modeled by a simple function based on two variables. One is the skill of a society, that is, available knowledge, and the other, the initial growth rate[52] [53]. Knowledge is therefore a critical ingredient for economic prosperity. Since universities are institutes that focus on knowledge creation, it is not surprising that the role of universities in innovation and the link to the knowledge economy has received increasing attention[54].

4. University-Industry Technology Transfer and its Impact on the Regional Economy

The three fields as discussed above have an overlap: the impact of university-industry technology transfer on the regional economy. See figure 1.

Figure 1: Strands of Literature and their Overlap



The previous sections showed how university-industry technology transfer is part of the "bigger picture". From this point on, the focus will be on the "detailed picture". That is, the study takes up only a small part of the innovation diffusion process and only one type of technology transfer process, university-industry technology transfer.

Some regions are exemplary in university-industry technology transfer, and technopolises[55] have been created in these regions. Examples are MIT and the creation of Route 128 near Boston, Stanford University and Silicon Valley in California, Cambridge University and the Cambridge area in the U.K. and Chalmers University of Technology and the Goteborg area in Sweden. The Research Triangle Park in North Carolina, where three universities are located (North Carolina State University, University of North Carolina, Chapel Hill and Duke University), is another area that seems to be developing into a technopolis.

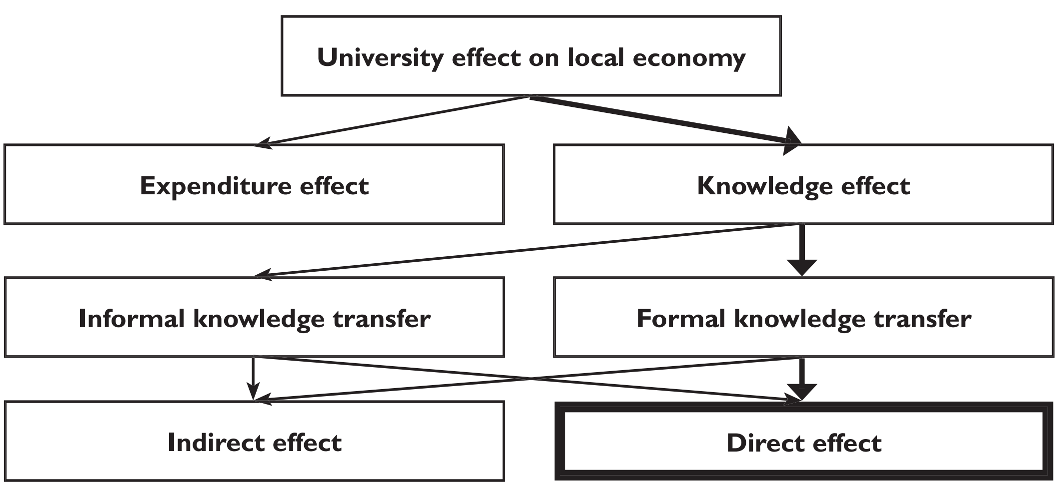
An overriding question is whether these results can be replicated in other regions as well, and in particular in the Inland Northwest. The answer to this question is beyond the scope of this research. However, this paper is intended to facilitate a better understanding of the issues, to provide a benchmarking assessment of how the Inland Northwest universities are doing, and to aid policy makers.

The presence of a university has two effects on the local economy: *expenditure* effects and *knowledge* effects[56]. Expenditure effects are a result of the spending by university, faculty and staff, students and visitors, which generate changes in regional income and employment. Knowledge effects refer to changes in the quality of production factors induced by the knowledge produced at universities.

Varga (1998)[57] states that there are several forms of knowledge transfers. Some of them are mediated via a local network of university and industry professionals. This type of knowledge transfer is commonly referred to as "knowledge spillover". In this study, it will be identified as *informal technology transfer*. Other types of university knowledge transfer are more formalized and conveyed through explicit local university – industry relations. In this study, this will be identified as *formal technology transfer.*

Varga (1998)[58] also states that there are both direct and indirect ways in which universities can affect regional economies via technology transfers. Market introduction of a new product or technology that bears the influence of academic research at a nearby university, such as a patent or license, is considered a direct economic effect. In addition to this direct effect, universities can contribute to the local economy by attracting new high technology companies into the area. Because some of the activities of these companies, such as research and development or prototype manufacturing, are very knowledge intensive, a closely located university can constitute a very attractive environment for these facilities. Attracting talented people[59,60] and the retention of talented people[61,62] in the region or state are also related to indirect knowledge effects.

Figure 2: University Effects on the Local Economy



In this study, we are only interested in formal and direct knowledge effects. The direct and formal knowledge effects can be quite substantial. Premus, Sanders and Jain (2003)[63] indicate that in the U.S., the volume of technology transfer through patenting and licensing doubled between 1994 and 2000. In 1998, U.S. universities granted roughly 3,000 licenses to industry, generating about $500 million in royalty income.

It is important to note that informal (direct) knowledge effects can also be substantial but are hard to measure. For example, both the University of Idaho and Washington State University carry out considerable research in agriculture. It can be argued that WSU's research on grapes has had a significant impact on the growth of the grape and wine industry in the state of Washington. However, much of this has been carried out in an informal way: it has not been part of formal patent and licensing activities. Since this study only looks at formal technology transfer, these informal, and hard to measure, effects are not included. This, by necessity, means that this study does not provide a complete picture of Inland Northwest technology transfer activities.

4.1 Benchmarking Formal Technology Transfer

There are several channels by which technology can be transferred from university to industry: formal cooperation in R&D between academia and industry, university seminars, scholarly journal publications, industrial parks, firm spin-offs and technology licensing. Not all of these channels necessarily lead to a local effect. For example, a journal publication is essentially accessible anywhere in the country or even the world. Economic effects are therefore not necessarily local.

However, some specific channels of industry-university technology transfer are more likely to lead to local effects. These channels include business incubators[64] and industry-university cooperative research centers[65 66]. For example, NSF has heavily invested in three types of industry-university cooperative programs: Industry-University Cooperative Research Centers, Engineering Research Centers and Science and Technology Centers, to increase competitiveness of U.S. industries.

Although the aforementioned channels may have significant impacts on the regional economy, this study is limited to another specific channel: start-up companies. This, in turn, relates to patents and licensing. In this report, we focus on formal technology transfer benchmarking figures. A follow-up report will examine the extent and impact of start-up companies on the regional economy.

4.2 The Southern Technology Council Benchmarking Study

To assess the technology transfer activities from the Inland Northwest universities, the study from the Southern Technology Council (STC)[67] is used as a guideline. The STC has carried out four technology transfer benchmarking studies[68]. The most recent study[69] included 72 research institutions located in Puerto Rico, 15 Southern states and nine other states eligible for the NSF's Experimental Program to Stimulate Competitive Research (EPSCoR). EPSCoR is a joint program of NSF and several states. It promotes the development of the states' science and technology resources. EPSCoR operates in those states that have historically received low amounts of Federal research and development funding. The program focuses on states that have demonstrated a commitment to develop their research bases and improve the quality of science and engineering research conducted at their universities and colleges[70]. Idaho is included in the EPSCoR program but Washington is not.

The 72 institutes comprise a range of institutions. One of the important classifications of universities is the Carnegie classification of institutions of higher education. This classification distinguishes among doctorate-granting institutions, master's colleges and universities, baccalaureate colleges, associates colleges, specialized institutions, and tribal colleges and universities. Doctorate granting institutions are divided into doctoral/research universities–extensive, and doctoral/research universities-intensive. Both of these categories are universities that have a heavy emphasis on research. The master's colleges and universities are divided into Master's colleges and universities I, and Master's colleges and universities II[71]. Table 1 shows the distribution of institutes in the STC study. It follows from table 1 that the STC study was highly focused on research extensive universities. Table 2 shows the Carnegie classification of the Inland Northwest institutes.

Table 1: Distribution of Institutes Included in the STC Study According to Carnegie Classification

Research-extensive	Research-intensive	Master's colleges I	Specialized	Not classified
41	20	3	5	3

Table 2: Carnegie Classification of Inland Northwest Institutes

Institute	Classification
Eastern Washington University	Master's colleges and universities I
Washington State University	Doctoral/research universities – extensive
University of Idaho	Doctoral/research universities – extensive
Pacific Northwest National Labs	Not classified

Only one of the Inland Northwest universities, the University of Idaho, was included in the 2001 STC study. The STC study examined eight variables divided into three categories.

- **Input benchmarks**
  - U.S. patent applications: the number of applications filed in a fiscal year
  - U.S. patents awarded: the number of patents issued in a fiscal year
- **Output benchmarks**
  - Licensing: the total number of licenses in effect in a particular year
  - License income: license revenue for a particular year
- **Economic impact benchmarks**
  - In-state licensing: licenses in force in a particular year to in-state licensees
  - Start-up licensing: licenses in force in a particular year to start-up licensees
  - License income from in-state licenses: license revenue for a particular year from in-state licensees
  - Start-up companies formed; the number of start-up companies formed in a particular year

The STC study measured these variables on absolute and ratio levels (per $10 million R&D for input, output and start-up companies formed, and percentages of total licensing for the other three economic impact benchmarks). No individual performance benchmarks are provided in the STC study, but the report does provide the top seven institutions for each input, output and the last economic impact (start-up companies formed) benchmark measures. It also provides the top five institutes for the other three economic impact benchmarks. Appendix A provides an overview and analysis of the STC findings. In particular it shows, for each of the measures used in the STC study, the best-in-class institutions.

Since the STC study emphasizes research extensive institutes, but not all of the Inland Northwest institutes fall into this category, a quick analysis will be carried out to determine whether the technology transfer benchmarks are biased towards any type of Carnegie classification. Tables 3 and 4 show the Carnegie classification of the top seven (or five) institutes for the eight ratio benchmarks and absolute benchmarks, respectively. Table 3, for example, shows that for the eight ratio benchmark measures, the best performing institute was classified as research extensive for three benchmarks, research intensive for three benchmarks, and a master's college I for one benchmark. For one benchmark, the top ranked institute was not included in the Carnegie classification.

Table 3: Distribution of STC Benchmark Institutes for Ratio Measures and Carnegie Classification

	Institute's Carnegie classification				
Benchmark position of institute	Research-extensive	Research-intensive	Master's colleges I	Specialized	Not classified
Best	3	3	1		1
2nd	3	1	2	1	1
3rd	3	3		1	1
4th	3		3	1	1
5th	3	3	1	1	
6th	2	3			
7th	3	1			1
TOTAL	20	14	7	4	5

Table 4: Distribution of STC Benchmark Institutes for Absolute Measures and Carnegie Classification

	Institute's Carnegie classification				
Benchmark position of institute	Research-extensive	Research-intensive	Master's colleges I	Specialized	Not classified
Best	8				
2nd	8				
3rd	8				
4th	8				
5th	7	1			
6th	5				
7th	5				
TOTAL	49	1	0	0	0

Table 3 indicates that for ratio measures, the best performing institutes are found in all categories. There is not necessarily a bias towards any particular university category. Table 4 shows that for absolute benchmark measures, the overwhelming majority of best performers are research extensive universities. That is, for absolute measures there is a bias towards research extensive universities. This is not surprising since these are the universities the with the most resources.

4.3 The AUTM study

Another relevant benchmarking study is the annual study by the Association of University Technology Managers (AUTM). AUTM carries out an annual survey which discusses the same variables as the STC input and output benchmarks, but for a larger sample of universities. Table 5 provides an overview of the key figures for the benchmarking figures from the STC and AUTM studies based on 1998 data (provided in [72]).

Table 5: Overview of Key Benchmarking Figures for the STC and AUTM Studies

Benchmark Measure	STC '97-'98	AUTM '98
	Absolute benchmarks	
Patent applications per $10 million R&D	Range: 0-9.2 Median: 1.9	Range: 0-14.3 Median: 2.6
Number of patent applications	Range: 0-187.5 Median: 10.8	Range: 0-567 Median: 23.6
U.S. patents awarded per $10 million R&D	Range: 0-7.7 Median: 0.9	Range: 0-6.9 Median: 2.6
U.S. patents awarded	Range: 0-56.5 Median: 5.3	Range: 0-224 Median: 10.5
Licenses and options in effect per $10 million research expenditure	Range: 0-19.6 Median: 3.0	Range: 0-51.9 Median: 5.5
Number of licenses and options in effect	Range: 0-474 Median: 16	Range: not available Median: 46
License income as percentage of research expenditure	Range: 0-49% Median: 0.4%	Range: 0-64.2% Median: 0.8%
License income	Range: 0-$46.6 mil Median: $196,000	Range: not available Median: $901,000
	Ratio benchmarks	
Percentage of licenses and options to in-state licensees	Range: 0-100% Median: 13.5%	Range: not provided Median: not provided
Number of licenses and options to in-state licensees	Range: 0-191 Median: 2	Range: not provided Median: not provided
Percentage of licenses and options to start-up licensees	Range: 0-100% Median: 4.2%	Range: not provided Median: not provided
Number of licenses and options to start-up licensees	Range: 0-50 Median: 1	Range: not provided Median: not provided
Percentage of license income from in-state licenses	Range: 0-100% Median: 0%	Range: not provided Median: not provided
License income from in-state licenses	Range: 0-$2 million Median: not provided	Range: not provided Median: not provided
Number of start-up companies formed per $10 million in R&D spending	Range: 0-0.51 Median: 0.01	Range: 0-2.86 Median: 0.28
Number of start-up companies formed	Range: 0-12 Median: 1	Range: 0-36 Median: 2

5. Methodology

5.1 Benchmarking Technology Transfer in the Inland Northwest

As stated in 4.2, university-industry technology transfer in the Inland Northwest was benchmarked by using the STC survey instrument. Data were collected from four Inland Northwest institutes: Eastern Washington University (EWU), University of Idaho (UI), Washington State University (WSU) and Pacific Northwest National Laboratory (PNNL). The benchmarking variables from the STC survey were analyzed for fiscal year 1998 and thereafter. Starting with 1998 allows a comparison of the Inland Northwest institutes' performance with the latest available STC data. Since the STC report includes a comparison with AUTM data and a separate assessment of EPSCoR states, the Inland Northwest institutes can also be compared with the AUTM and EPSCoR data for 1998. The years after 1998 allow an assessment of performance improvements. Section 4.2 demonstrated that the STC data are biased towards research extensive universities.

Table 2 showed the classification of the Inland Northwest institutes. It is clear from this table that EWU is not in the same research category as WSU and UI. Also, because of the bias toward research universities in the STC study, a realistic comparison with peer institutions from the STC study is not possible for EWU. To put the four target research institutes in perspective, Table 6 provides some indicators in total research expenditures (including sources other than NSF) for fiscal years 1998-2002 based on National Science Foundation reports[73 74 75 76 77]. Across the 72 STC institutes, R&D expenditures for FY1998 ranged from $6.7-653.6 million.

Table 6: 1998 - 2002 Total R&D Expenditures (in $million) and Rank by the National Science Foundation

University	**FY 1998** (rank out of 547)	**FY 1999** (rank out of 589)	**FY 2000** (rank out of 589)	**FY 2001** (rank out of 601)	**FY 2002** (rank out of 617)
EWU	2.4 (325)	2.4 (338)	2.1 (356)	2.6 (344)	2.3 (380)
WSU	95.4 (90)	96.9 (94)	104.8 (93)	107.9 (98)	112.5 (99)
UI	59.0 (119)	62.5 (119)	61.3 (126)	67.5 (127)	76.8 (125)
PNNL	512.2	488.3	520.5	534.4	555.5
University of California-Los Angeles	447.4 (3)	477.6 (4)	530.8 (3)	693.8 (2)	787.6 (2)
Average expenditure for top-100 university	*207.5*	*221.9*	*243.1*	*263.9*	*291.7*

6. Findings

In 6.1, the data are presented for FY1998 and compared with the STC study. Section 6.2 presents the same benchmarking measures for the Inland Northwest institutes for the last five years, thereby allowing the inspection of more recent trends. Section 6.3 provides some information on technology areas and section 6.4 on the level of industry support.

6.1 Benchmarking Fiscal Year 1998

Figures 3-10 provide an overview of the performance of Inland Northwest institutes for FY1998 compared with the AUTM, EPSCoR and STC studies. In these figures, a ratio measure is used. A ratio measure provides a more meaningful comparison because issues of scale are 'filtered out'. Comparisons of absolute measures for each of the variables can be found in Appendix B. For the STC, EPSCoR and AUTM data, median values are given.

Summary for 1998

EWU

EWU scored at the bottom for each of the benchmark measures. This is no surprise, considering the analysis of section 4.2 which showed that hardly any of EWU's peers made it into the STC rankings.

UI

The UI is an institute with a modest R&D budget and a small technology transfer office (see also section 6.2). The absolute numbers for UI were, compared to the other institutes and studies, low (see Appendix B). But since UI's R&D budget was relatively small, its ratio measures were comparable to the other institutes. In other words, UI seemed to be doing a reasonably good job considering its relatively small R&D budget in 1998.

For the input and output benchmarks, UI scored close to the STC median for the patent application ratio and for license income as a percentage of R&D expenditure. It showed lower values on the number of patents awarded per $10 million R&D and active licenses per $10 million R&D. For the economic impact benchmarks, UI scored considerably higher than the STC study medians on the percentage of licensees and options to in-state licensees and for in-state license income as a percentage of all license income. This indicates that UI was much more in-state oriented than the institutes included in the STC study. Compared to the other Inland Northwest institutes, a similar observation can be made: UI had a particularly strong focus on regional impact.

WSU

With a research budget of over $95 million in FY1998, WSU was positioned within the top 100 U.S. research universities. For the absolute measures (Appendix B), it is therefore not surprising that WSU had high values, although its license income from in-state licensees and the number of licenses to start-up companies were low in 1998.

On the ratio measures, WSU scored relatively high on patent applications (figure 3) and the number of active licenses (figure 5). The number of patents awarded was comparable to the STC study but lower than the AUTM study. For license income, WSU scored below the median values of the AUTM and STC studies and UI. This indicates that although WSU was able to develop patents and license these, it did not necessarily generate a lot of income from these licenses.

Figures 7-10 show that WSU did not emphasize regional economic impact through start-up companies. Although a good percentage of the active licenses were to in-state licensees, no license income was generated from these licenses.

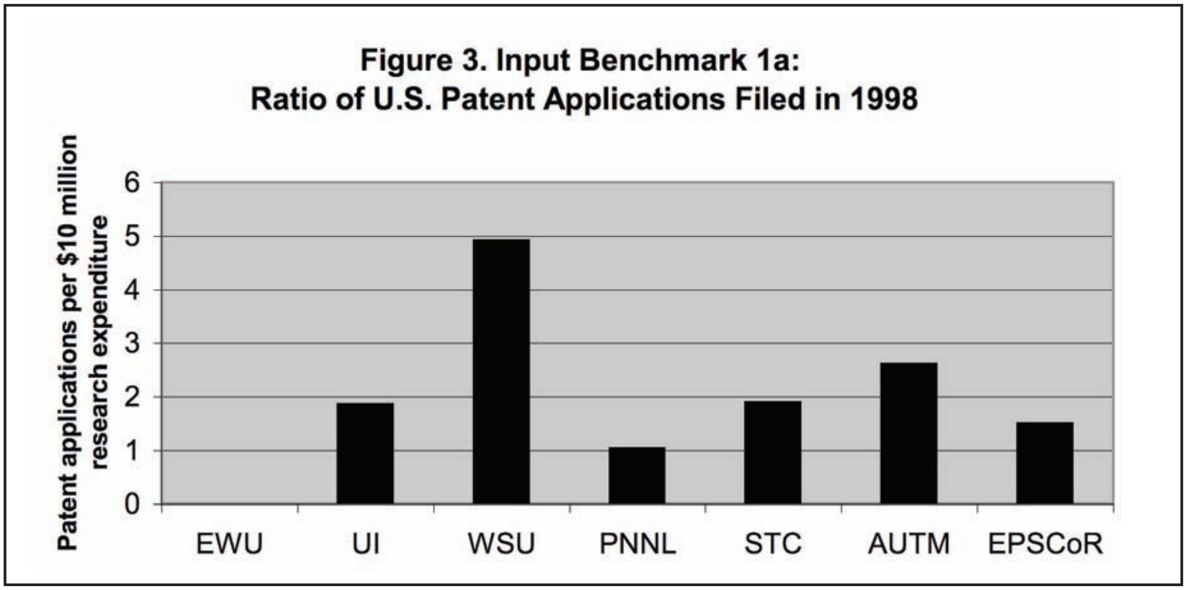
PNNL

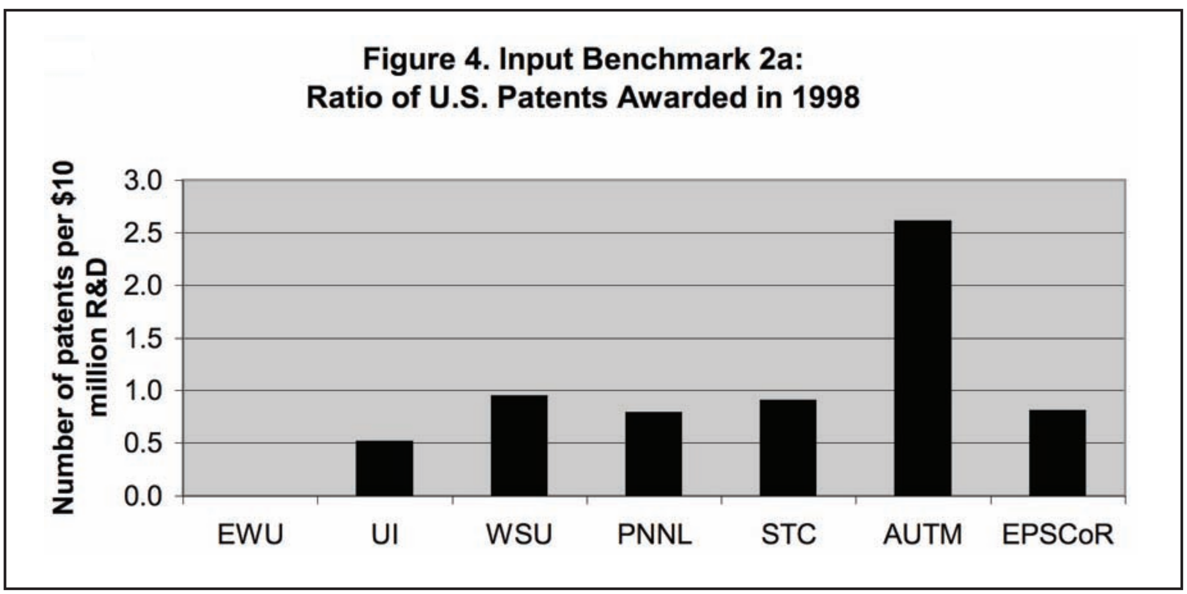
PNNL enjoyed a very large R&D budget compared to the other Inland Northwest institutes. However, it must be noted that this R&D budget included capital expenditures such as expensive equipment. Because of the size of its R&D budget, it is not surprising that PNNL scored highly on the absolute measurement of the benchmarks (see Appendix B).

For ratio measures, PNNL scored relatively poorly on several of the benchmarks. For the input benchmark patent applications per $10 million R&D and the output benchmark of license income as a percentage of R&D expenditure, it scored lower than UI, WSU and the median for the STC, AUTM and EPSCoR values. For the number of patents awarded per $10 million

R&D, it scored lower than WSU and the median values of the STC, AUTM and EPSCoR studies. PNNL scored relatively well on the economic benchmarks for in-state license income as percentage of all license income and for licenses to start-up companies per $10 million R&D.

Note that figures 4 and 10 (and also figures 14 and 20) show the large sums needed to generate one patent and the even larger sums necessary to support the generation of one new (local) business. The second, follow-up report will discuss these issues in more detail.





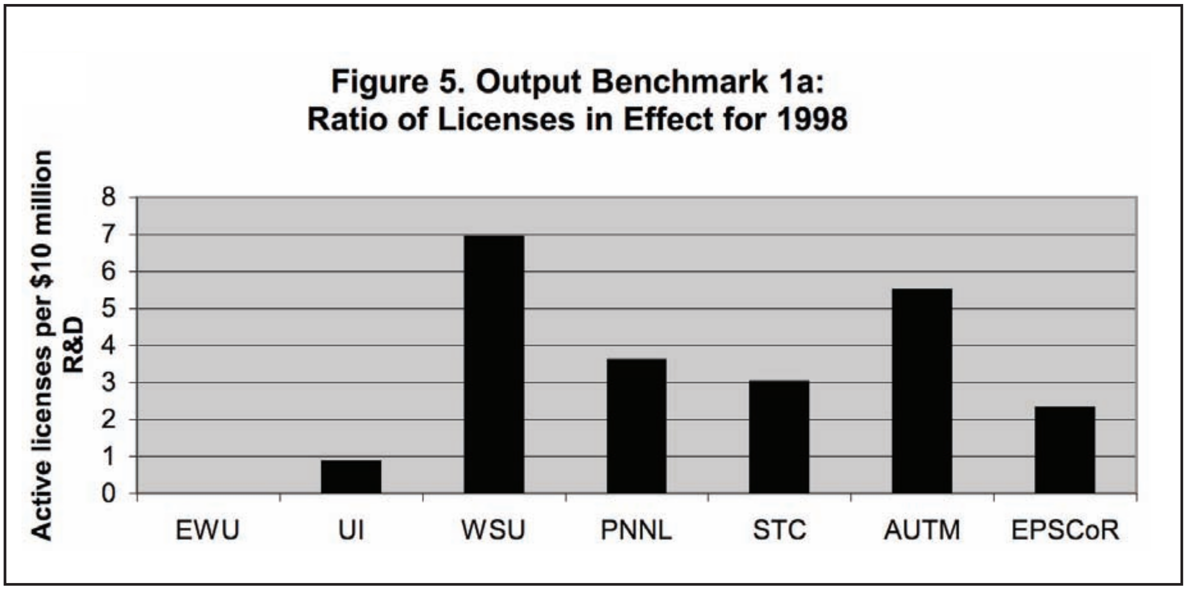


Figure 5. Output Benchmark 1a:
Ratio of Licenses in Effect for 1998
Active licenses per $10 million R&D
0
1
2
3
4
5
6
7
8
EWU
UI
WSU
PNNL
STC
AUTM
EPSCoR

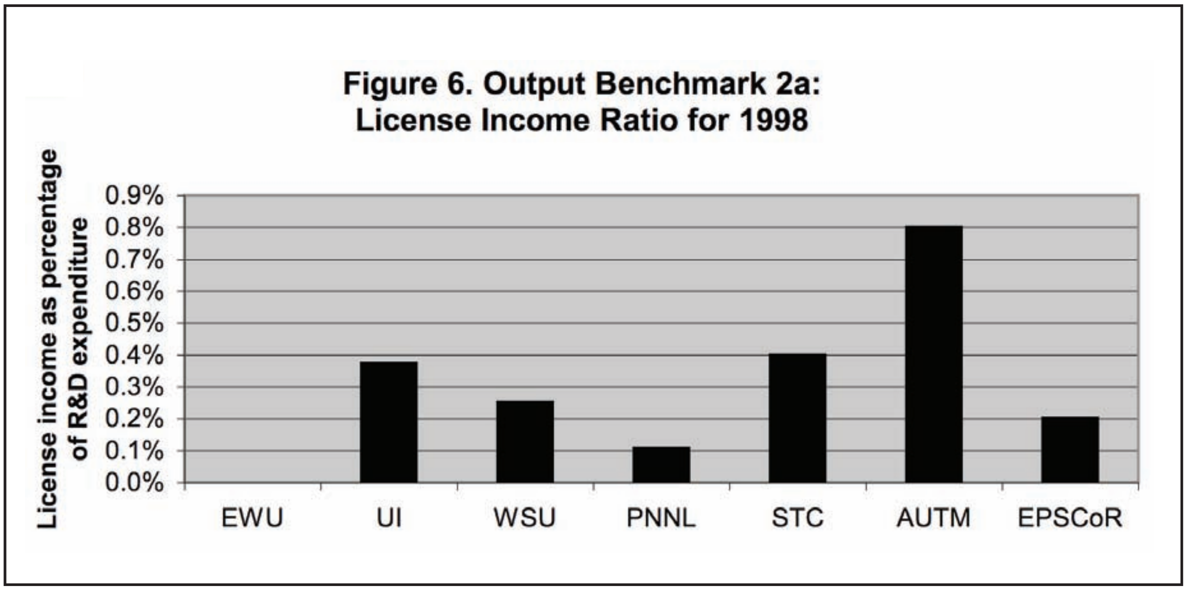


Figure 6. Output Benchmark 2a:
License Income Ratio for 1998
License income as percentage of R&D expenditure
0.0%
0.1%
0.2%
0.3%
0.4%
0.5%
0.6%
0.7%
0.8%
0.9%
EWU
UI
WSU
PNNL
STC
AUTM
EPSCoR

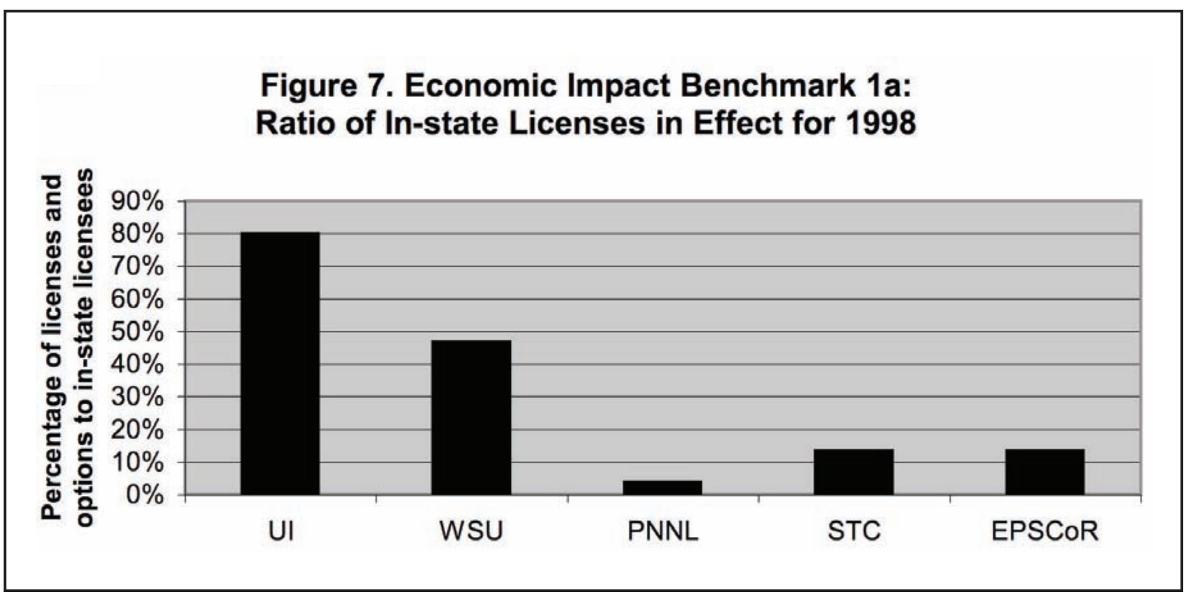


Figure 7. Economic Impact Benchmark 1a:
Ratio of In-state Licenses in Effect for 1998
Percentage of licenses and options to in-state licensees
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
UI
WSU
PNNL
STC
EPSCoR

Figure 8. Economic Impact Benchmark 2a: Ratio of Licences in Effect to Start-up Licensees for 1998

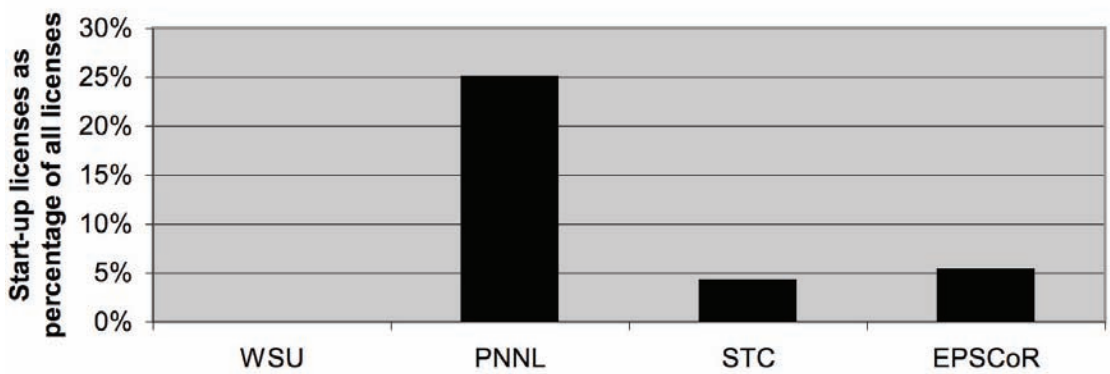


Figure 9. Economic Impact Benchmark 3a: Ratio of License Income from In-state Licenses for 1998

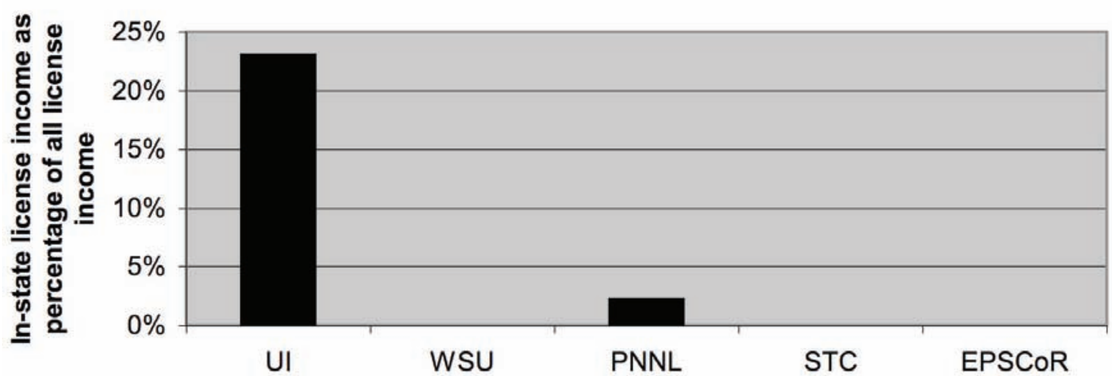
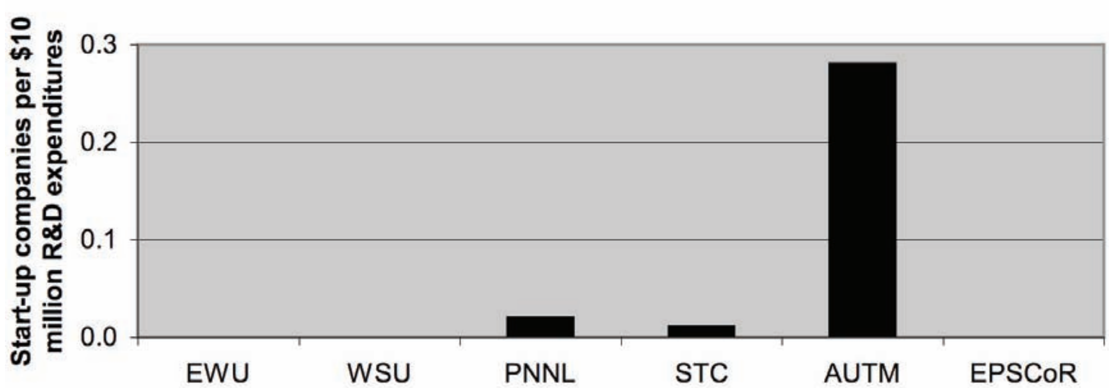


Figure 10. Economic Impact Benchmark 4a: Ratio of Start-up Companies Formed in 1998



For figures 3-10 the following remarks should be taken into consideration

- **EWU**
    - o EWU essentially had no patent applications, no patents awarded, no license income, etc. Therefore, EWU values in the figures are "0".
    - o EWU is not included in figures 7, 8 and 9 since total license income is "0".
- **UI**
    - o The number of start-up licenses in force and the number of new start-up companies for FY 1998 were not available for UI. Therefore UI is not included in figures 8 and 10.
- **WSU**
    - o For FY 1998, all data were complete for WSU. In figures 8, 9 and 10 the WSU value is "0".
- **PNNL**
    - o For economic impact figures, PNNL did not keep track of licensees' location or size. However, it was possible for technology transfer office employees to estimate the percentage of in-state licensees and to estimate the percentage of licenses to start-up companies. Therefore PNNL data in figures 7 and 8 are based on these estimates.
- **STC**
    - o The median value for STC for in-state license revenue ratio (figure 9) is "0".
- **AUTM**
    - o The AUTM study does not look at issues of state or regional development. Therefore AUTM has not been included in figures 7, 8 and 9.
- **EPSCoR**
    - o The median values for EPSCoR in figures 9 and 10 is "0".

6.2 Inland Northwest Indicators for the Last Five Years: 1999-2003

Figures 11-21 show performance on each benchmark measure for the last five years for the Inland Northwest institutes. The data reveal some interesting trends. Similar to section 6.1, a ratio measure is used. Comparisons of absolute measures for each of the variables can be found in Appendix C.

EWU

EWU is clearly a small institution with regard to research and technology transfer as indicated in figures 11-20. EWU's research budget and technology transfer office are small compared to the other Inland Northwest institutes. It is therefore not surprising that the benchmark values are low for EWU. The one exception is FY2002, when EWU had one patent application. Since EWU has such a small R&D budget, this had a big impact on the ratio measure for patent applications (figure 13). This shows that for an institute like EWU, it does not take much to start scoring relatively high on ratio benchmark measures.

It must be noted that despite the weak emphasis on technology transfer, there is some activity at EWU. For example, during the interview it became apparent that EWU was in negotiations for a new license contract. EWU was also working on a patent application, expected to be finalized in FY2004. EWU also had two patent applications and patents issued before FY1998.

In general, EWU is trying to improve its position but it finds it difficult to do this. The challenge is that EWU's mission has been oriented toward teaching. As a result, it is difficult for faculty to get course releases to carry out research. In addition, a large amount of research is required to develop patents and this research requires funding. It is challenging for EWU to acquire this funding, as it typically requires a reputation. EWU still has to build this reputation.

UI

Over the last five years, UI has increased its R&D budget and technology transfer FTEs. Its performance has fluctuated on the number of patent applications (see Appendix C) and the ratio for patent applications per $10 million R&D (figure 13). The ratio of patents awarded per $10 million of research expenditures has declined. The active licensing ratio (figure 15) has improved, although UI's license income as a percentage of R&D has fluctuated (figure 16). In-state licensing decreased from 1999-2002 but improved in FY2003 (figure 17). The income generated by in-state licenses compared to all licenses has been around 10% (figure 19). Although data for start-up licensing are mostly absent, UI created a higher number of start-up companies between 2001 and 2003 than WSU (see Appendix C). This is quite impressive considering UI's smaller R&D budget.

Compared to the other Inland Northwest institutes UI is performing, as expected, between EWU and WSU. The noticeable exception is that UI is performing better with regard to start-ups and in-state licensing.

Interestingly in the FY1998 comparisons, UI was performing better than the STC study results of in-state licensing, but since then this outcome has worsened. UI also finds it challenging to create start-up companies because the immediate community is not as entrepreneurial as would be desired. UI indicated that although UI and WSU are more research oriented, EWU, because of its location near Spokane, is probably in a much better position to create more research results such as disclosures and patents (if it would do more research).

WSU

Over the last five years, WSU increased its R&D budget and technology transfer FTEs. The number of patent applications and the number of patents awarded have, in general, declined since 1998 (figures 13, 14 and Appendix C). The active licensing ratio (figure 15) has declined, and the license income as a percentage of R&D has fluctuated since FY1998 (figure 16). The percentage of in-state licenses has been around 45% (figure 17) and the percentage of start-up licenses in effect has improved (figure 18). The number of start-up companies per $10 million R&D has fluctuated between 0 (FY1998 and FY2001) and nearly 0.20 (FY2000).

Compared to the other Inland Northwest institutes, WSU is generally performing better than UI and than PNNL. WSU is performing better than PNNL on the input benchmarks, -- patent applications and patents awarded (figure 13 and 14). WSU has also, for most of the research period, performed above PNNL on output benchmarks-- number of active licenses and license income (figure 15 and 16). For the ratio of active licenses, WSU's position has decreased while PNNL's has increased.

For the economic impact benchmarks, WSU has performed better than the other institutes on the ratio of start-up companies formed (figure 20). Its record over the period is lower than those of the other institutes for license income from in-state licensees (figure 19).

PNNL

PNNL is clearly the largest institute included in this study. Its research expenditures and emphasis on technology transfer are quite high compared to the other institutes. On the input and output benchmarks, PNNL's FY2003 performance improved compared with FY1998. Especially for license income as a percentage of R&D expenditure, this improvement has been substantial (figure 16). For the economic benchmarks, PNNL has a relatively low ratio of in-state licenses in effect (figure 17) and ratio of in-state license income (figure 19). However, its ratio of start-up licenses in effect is much larger than at the other institutes although it is declining (figure 18). The ratio of new start-up companies formed is also relatively low (figure 20).

Compared to the other institutes, PNNL clearly outperforms in absolute terms, as can be seen from Appendix C. However, when ratio measures are used, WSU performs better than PNNL on most of the measures as discussed above.

During the interview, the PNNL respondents indicated that one of the problems with the ratio measurement is that it looks at R&D investments. For PNNL, R&D investments include large expensive equipment. Therefore, organizations with heavy equipment investments may be disadvantaged.

It is worth noting that economic development analysts frequently look at technology transfer to start-up companies. Both the UI and PNNL show decreasing percentages for licenses awarded to new and small companies (figure 21). For WSU, it appears as if this ratio is increasing, but this is largely due to the decreasing total number of licenses awarded, as figure C.8 shows.

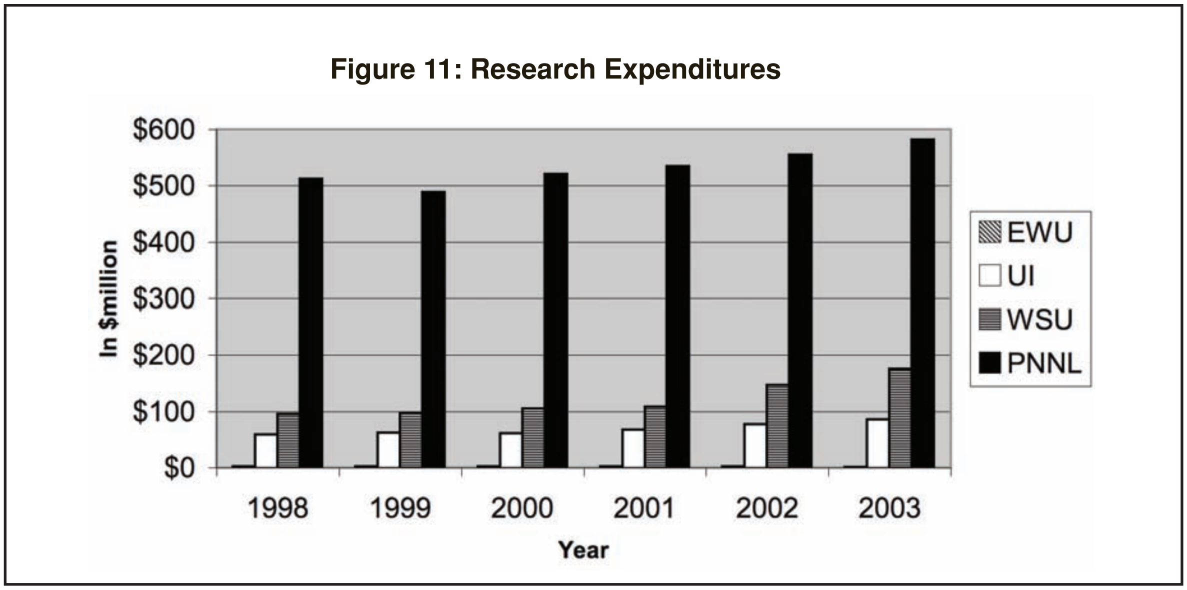


Figure 11: Research Expenditures
In $million
$600
$500
$400
$300
$200
$100
$0
1998
1999
2000
2001
2002
2003
Year
EWU
UI
WSU
PNNL

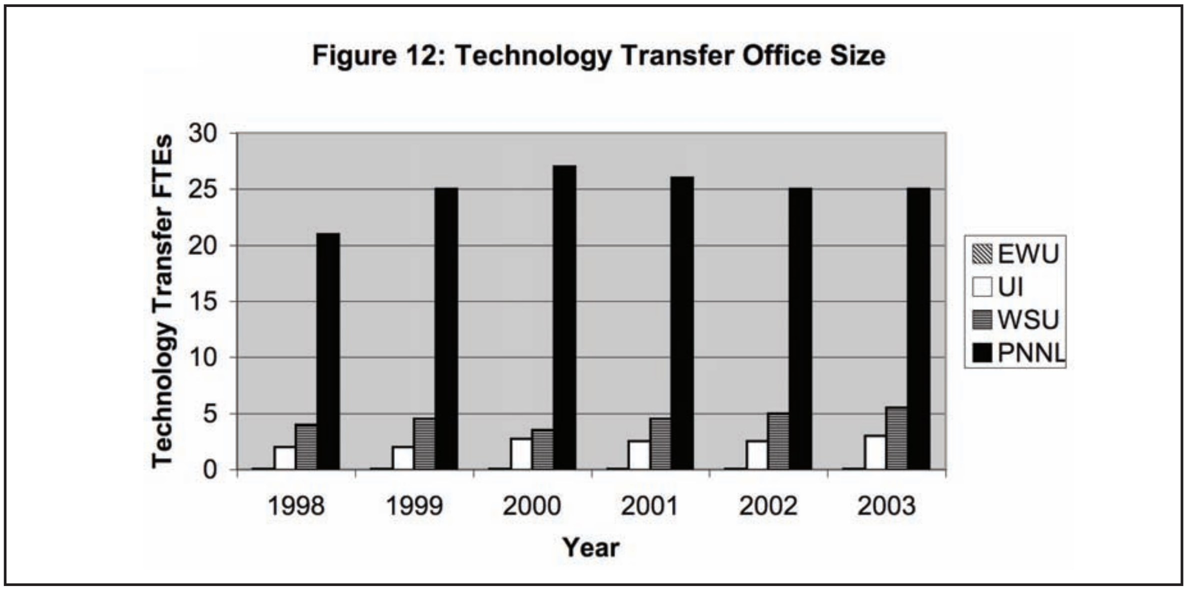


Figure 12: Technology Transfer Office Size
Technology Transfer FTEs
30
25
20
15
10
5
0
1998
1999
2000
2001
2002
2003
Year
EWU
UI
WSU
PNNL

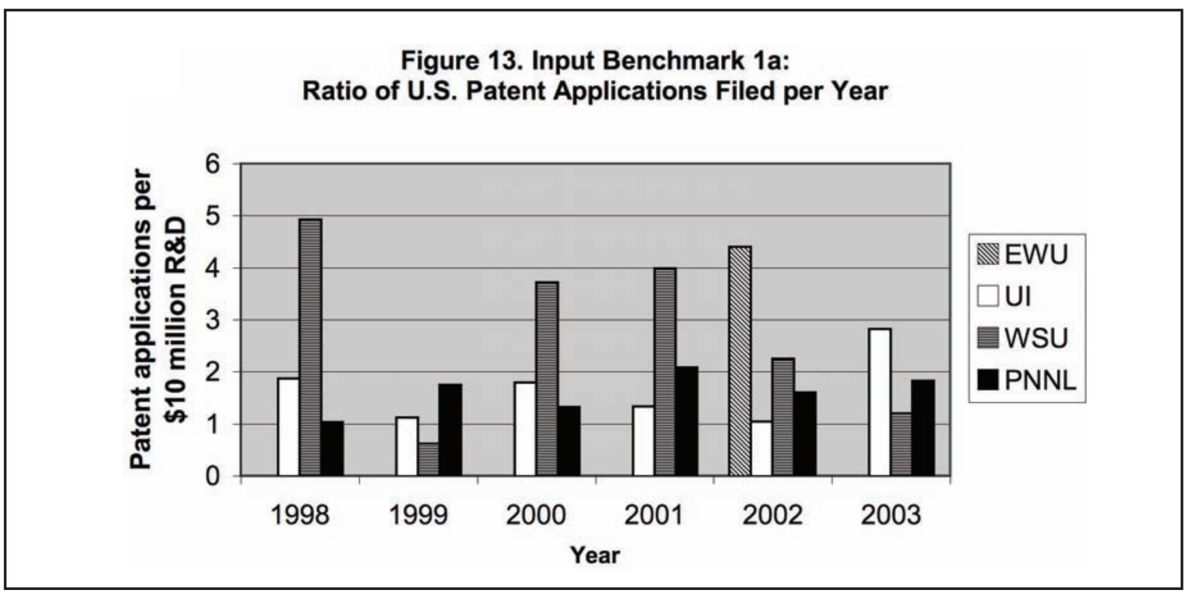


Figure 13. Input Benchmark 1a:
Ratio of U.S. Patent Applications Filed per Year
Patent applications per $10 million R&D
6
5
4
3
2
1
0
1998
1999
2000
2001
2002
2003
Year
EWU
UI
WSU
PNNL

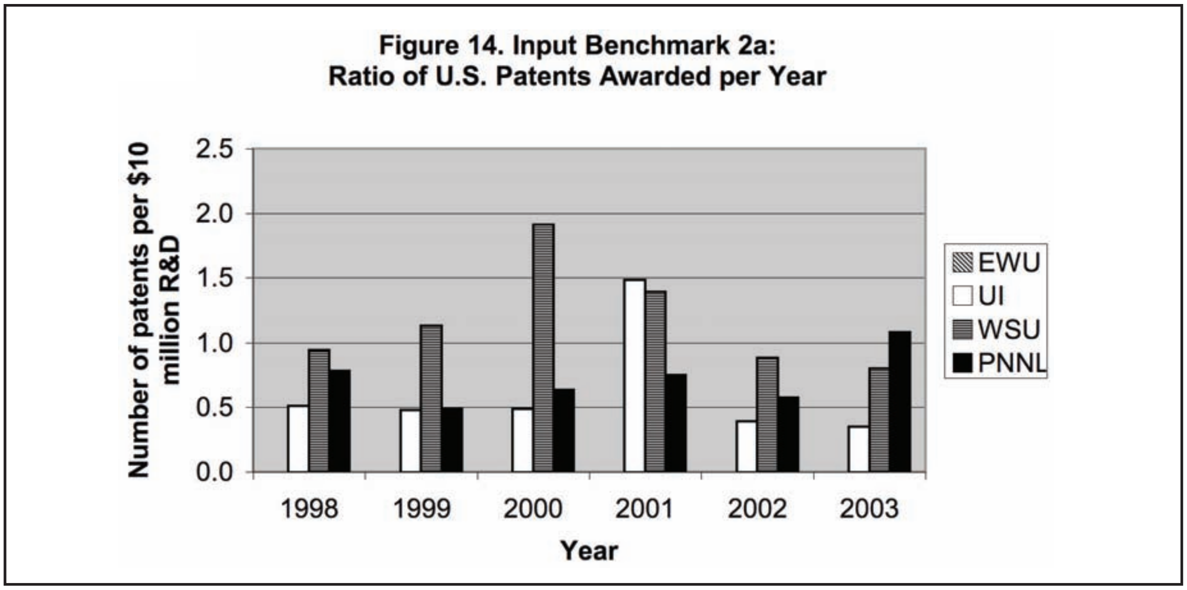


Figure 14. Input Benchmark 2a:
Ratio of U.S. Patents Awarded per Year
Number of patents per $10 million R&D
2.5
2.0
1.5
1.0
0.5
0.0
1998
1999
2000
2001
2002
2003
Year
EWU
UI
WSU
PNNL

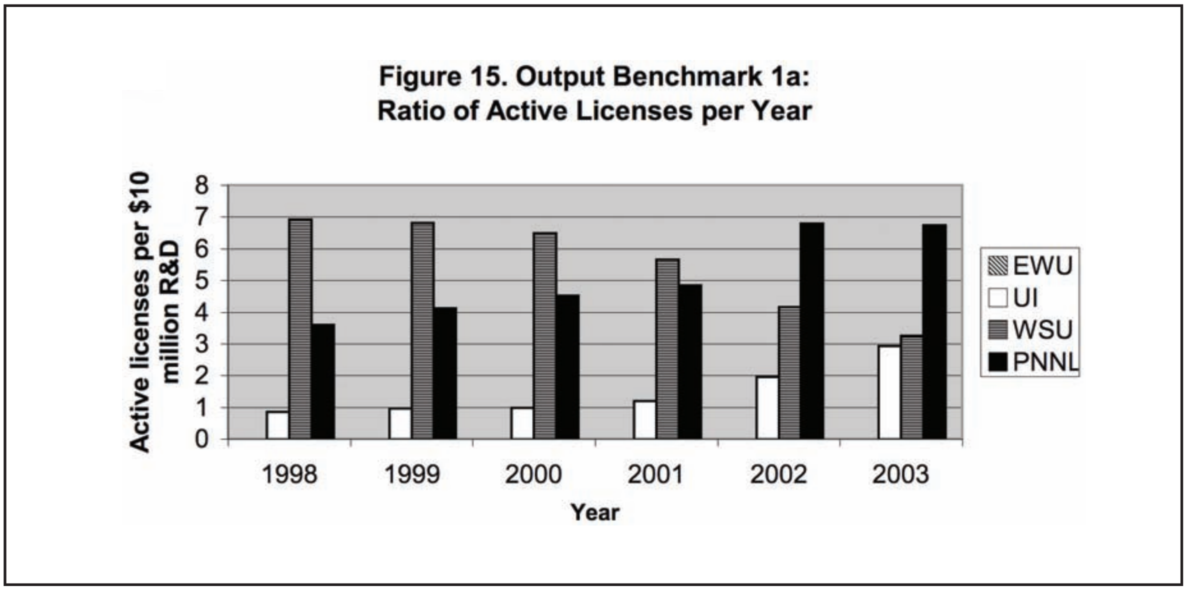


Figure 15. Output Benchmark 1a:
Ratio of Active Licenses per Year
Active licenses per $10 million R&D
8
7
6
5
4
3
2
1
0
1998
1999
2000
2001
2002
2003
Year
EWU
UI
WSU
PNNL

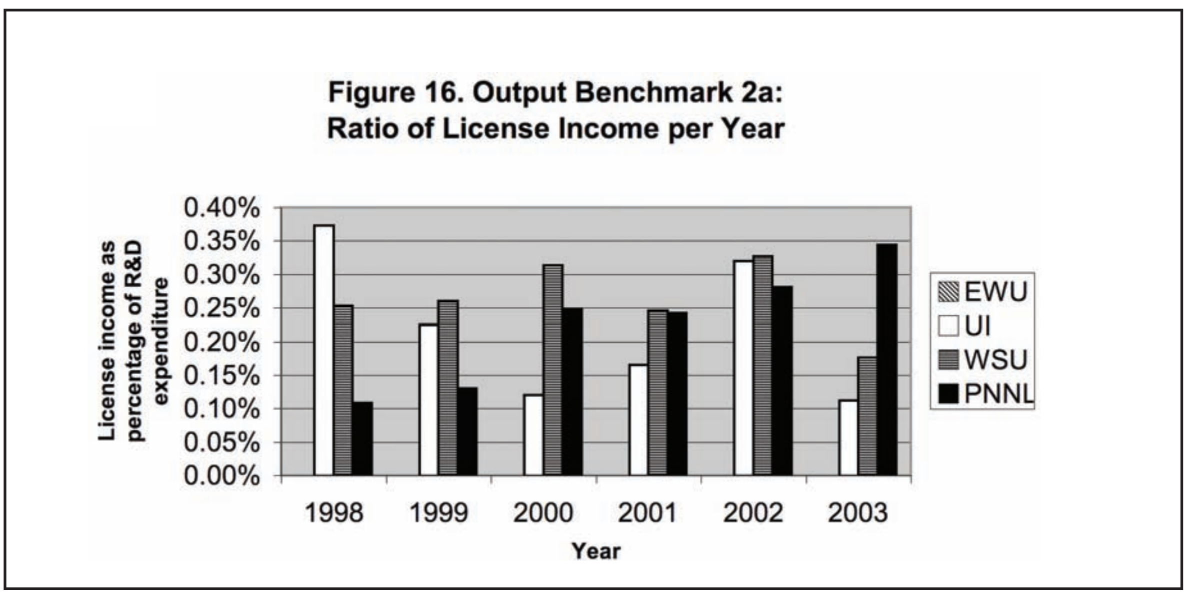


Figure 16. Output Benchmark 2a:
Ratio of License Income per Year
License income as percentage of R&D expenditure
0.40%
0.35%
0.30%
0.25%
0.20%
0.15%
0.10%
0.05%
0.00%
1998
1999
2000
2001
2002
2003
Year
EWU
UI
WSU
PNNL

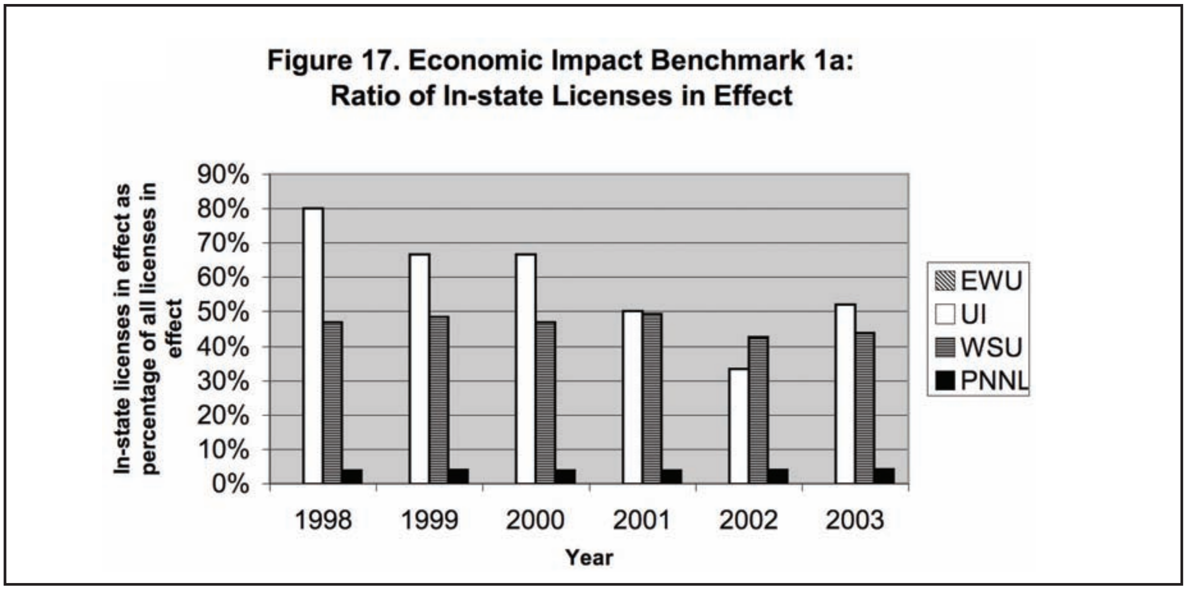


Figure 17. Economic Impact Benchmark 1a:
Ratio of In-state Licenses in Effect
In-state licenses in effect as percentage of all licenses in effect
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1998
1999
2000
2001
2002
2003
Year
EWU
UI
WSU
PNNL

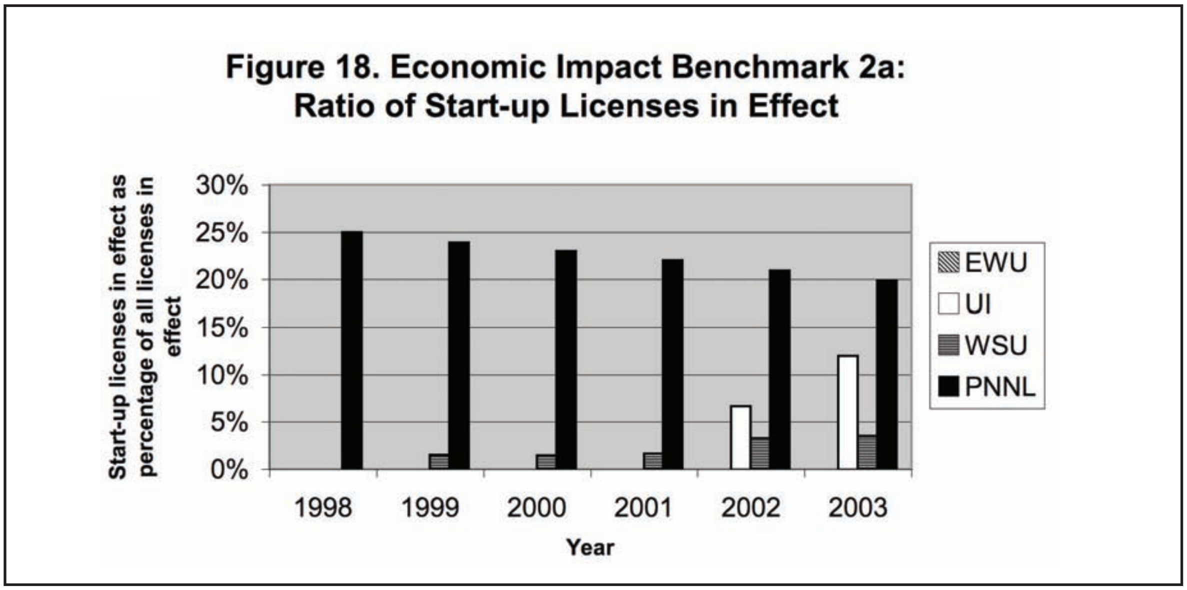


Figure 18. Economic Impact Benchmark 2a:
Ratio of Start-up Licenses in Effect
Start-up licenses in effect as percentage of all licenses in effect
30%
25%
20%
15%
10%
5%
0%
1998
1999
2000
2001
2002
2003
Year
EWU
UI
WSU
PNNL

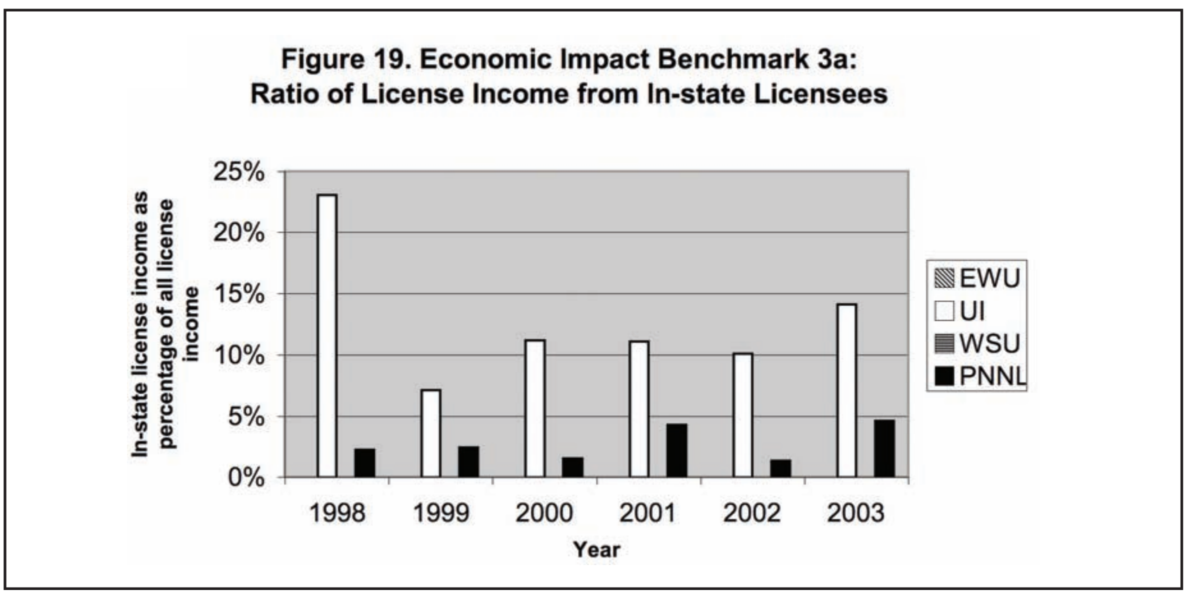
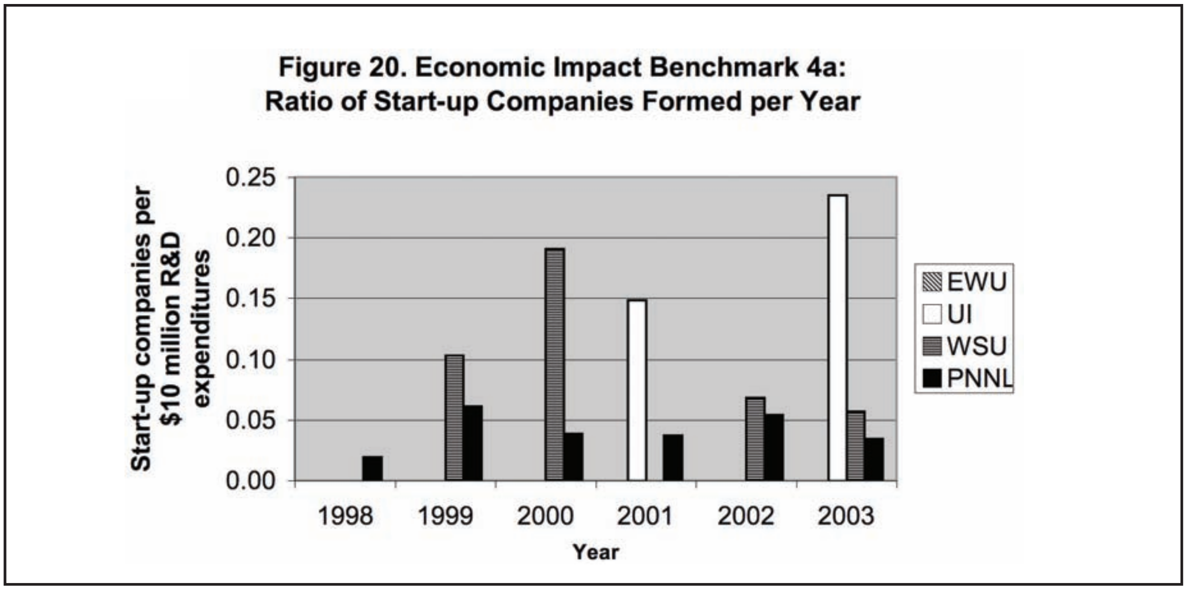
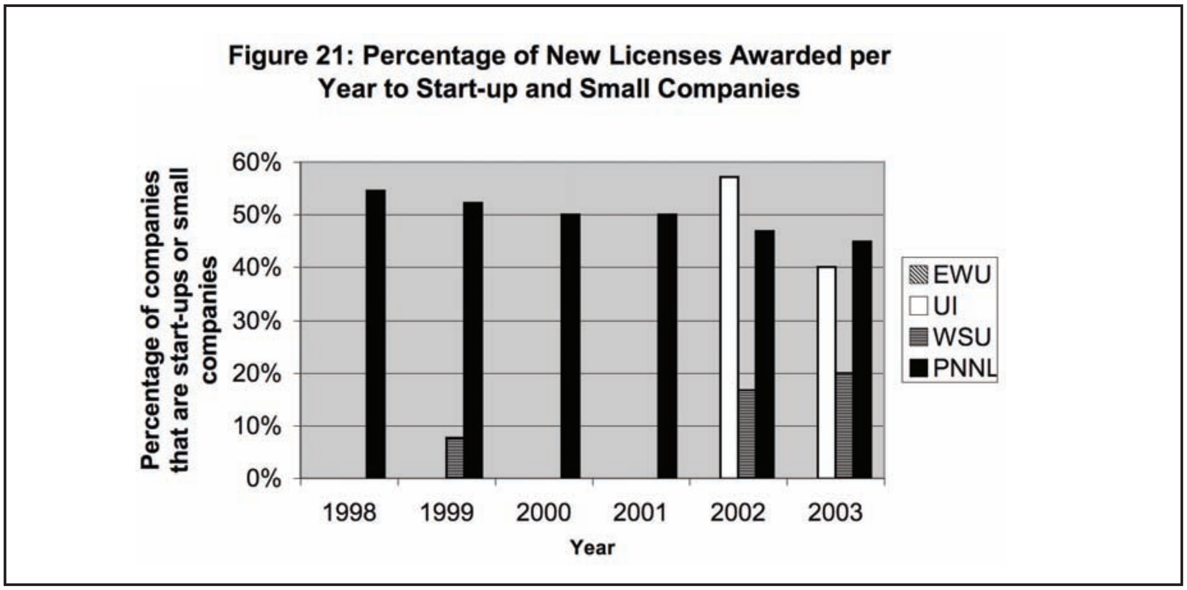


Figure 19. Economic Impact Benchmark 3a:
Ratio of License Income from In-state Licensees
In-state license income as percentage of all license income
25%
20%
15%
10%
5%
0%
1998
1999
2000
2001
2002
2003
Year
EWU
UI
WSU
PNNL





For figures 11–21, the following remarks should be taken into consideration

EWU

- o EWU essentially had no patent applications, no patents awarded, no license income, etc., for all years with the exception of FY2002, when it had one patent application. Therefore, most of the EWU values in the figures are "0" except for figure 13, FY2002.
- o Since there is no licensing income, no in-state or start-up proportion can be calculated. Consequently, EWU values for figures 17, 18, 19 and 21 are indicated as "0".

UI

- o The number of start-up licenses in force for FY1998-2001 were not available for UI. Therefore UI values for these years are not included in figure 18.
- o The number of new start-up companies for FY's 1998, 1999 and 2002 was not available for UI. Therefore values for these years are not included in figure 20. The value for FY2000 is "0".

- o The number of new licenses awarded to large companies for FY's 1998, 1999 and 2001 were not available for UI. Therefore UI values for these years are not included in figure 21. The value for FY2000 is "0".

WSU

- o License revenue from licensees within the state is "0" for each of the years, hence in figure 19 the values are "0".
- o Although the trend in figure 21 indicates that the percentages to start-up and small companies is increasing at WSU, this is largely due to a lower number of new licenses and options awarded in the last couple of years.

PNNL

- o For economic impact figures, PNNL did not keep track of licensees' location or size. However, it was possible for technology transfer office employees to estimate the percentage of in-state licensees and to estimate the percentage of licenses to start-up companies. Therefore PNNL data in figures 17, 18 and 21 are based on these estimates.

6.3 Technology areas

Aside from the more quantitative approach, each of the Inland Northwest institutes was also asked to qualitatively estimate where they have been making most of their technology transfer contributions. An overview of the results for the top three areas is given in table 7. Table 8 indicates which disciplines three of the four institutes expect to contribute to their future research agendas.

UI

UI expects technology transfer to grow approximately linearly over the next couple of years. Its goal is to have 14 new licenses per year in the next four years. There is a perceived opportunity to increase technology transfer because:

1. Currently much of the faculty is unaware of technology transfer opportunities. Making more faculty aware of technology transfer opportunities should increase the number of disclosures and patents.
2. It is possible to increase the number of licenses, that is, work towards commercialization. This requires resources in the technology transfer office. Currently, the number of FTEs in technology transfer is perceived as a constraint. Achieving licenses is related to the quantity and quality of networks. More FTEs in technology transfer allow more focus on building networks with potential licensees. For example, the regional business community needs to be made aware of the potential at UI. However, the regional impact is limited. Plant licenses are more regional or local. In general, it is not easy to do start-ups and the local community is perceived as not very entrepreneurial. So, the potential for licensing lies with well-established, small companies.

WSU

Due to a change in the administration at WSU, the interest in technology transfer has been higher over the last two years than in the past. There is a push for more industry sponsored R&D, more faculty involvement and a higher number of licensees within the state. Similar to UI, WSU pointed out that the direct impact of WSU on the region through licensing is very small. In particular, the economic impact on the state of Washington depends on the technology and networks. Some developed technologies can more easily be transferred to other states, while, for example, agriculture may be more regionally connected. If a university has more sponsored research where in-state companies work with universities, then networks are built and results are more likely to stay within the state.

Table 7: Three Top Areas of Contribution to Regional Technology Transfer – by Fiscal Year

	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003
EWU					- Chemistry	
UI	- Agriculture - Nat. Resources - Bio Sci/Chem	- Agriculture - Nat. Resources - Bio Sci/Chem	- Agriculture - Nat. Resources - Bio Sci/Chem	- Agriculture - Nat. Resources - Bio Sci/Chem	- Agriculture - Nat. Resources - Bio Sci/Chem	- Agriculture - Nat. Resources - Bio Sci/Chem
WSU	- Biotechnology	- Biotechnology	- Biotechnology	- Biotechnology	- Biotechnology	- Biotechnology
PNNL	- Materials - Sensors/Optics - Chemical	- Materials - Sensors/Optics - Biotechnology	- Materials - Sensors/Optics - Information Technology	- Materials - Sensors/Optics - Information Technology	- Information Technology - Materials - Sensors/Optics	- Information Technology - Energy - Materials

For WSU, approximately 85% of technology transfer is within the College of Agriculture and within that, half is focused on traditional agriculture and half on biotechnology. WSU has very few devices and limited software.

Table 8: Expected Areas for Future Success of Regional Technology Transfer

Institute	Expected areas
EWU	N.A.
UI	Electronics and communication security has received more attention, this is due to a group of faculty who have become aware of technology transfer opportunities.
WSU	Biotechnology is, in broad terms, likely to grow. The agricultural industry is becoming molecular agriculture. But, there are very few biotechnology agricultural companies in-state. Therefore, the regional impact will be limited.
PNNL	It is likely that Materials, Energy and Information Technology will be the most prolific areas in the near future. PNNL is making significant investments in Biotechnology areas but it may be several years before technology transfers occur in this area.

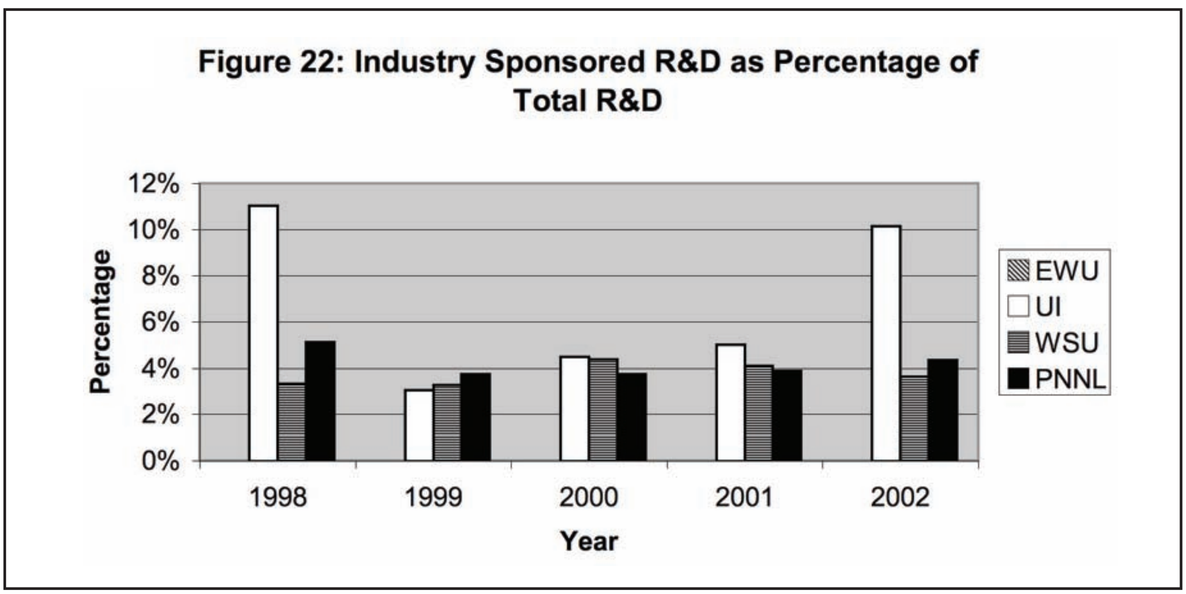
6.4 Industry supported R&D

In the U.S., a notable development of the past decade has been the growth in industrial support of academic research.[78] The average share of industry-funded university R&D at U.S. universities has been estimated at approximately 7% in the last decade [79] [80] [81]. In this section, industry sponsored R&D for the Inland Northwest institutes is briefly analyzed. A special note should be made for EWU. EWU has some industry-sponsored work but this is funding for non-research programs, that is, the industry support is not part of the total R&D reported to NSF. In the case of EWU, this money is often spent on consulting that does not lead to intellectual property nor technology transfer. Table 9 shows the industries that provide the most funding support for research. Figure 22 provides an overview of the percentage of total R&D at the institutes provided by industry sources.

Table 9: Industry Sponsored R&D at Regional Research Institutes by Area

	Highest ranked	Second highest	Third highest
EWU	-	-	-
IU	Food technologies	Forest products	Materials/Microcomputer
WSU	Wood materials	-	-
PNNL	Not available	Not available	Not available

Figure 22 shows that UI is doing exceptionally well in attracting industry-funding for research. UI's numbers are well above the national average 7% for some of the years. The other Inland Northwest institutes are well below the average 7%.



7. Conclusion

7.1 Conclusions & Recommendations

This study included four institutes of different size charters. It included one small university without a research emphasis (EWU), two universities with significant research emphasis (UI and WSU) and one national laboratory. All of these institutes have essentially improved their performance over the last five years for most of the benchmark measures.

The small university's performance on technology transfer is minimal compared to the other Inland Northwest institutes and compared to the STC study. This can easily be explained by its limited emphasis on research and its limited resources in technology transfer FTEs. For FY1998, UI was comparable to the median values of the STC study and WSU often scored above the median value. Both institutes have improved over the last five years. Interestingly, both institutes pointed to problems with in-state or regional licensing. One of the reasons indicated was that their research is primarily agriculturally oriented, allowing only a certain amount of licensing in the region.

In addition, the viewpoint was expressed that both UI and WSU are at a locational disadvantage compared to EWU. Although both UI and WSU have many more research funds available than EWU, when it comes to commercializing the outcomes of research, EWU may be much better situated due to its proximity to a metropolitan area. Simultaneously, EWU may reconsider its emphasis on teaching. Due to its location, there is an opportunity for EWU to have a much larger role in regional development.

7.2 Reflections on Methodology

For the benchmarking part of the study, the survey instrument designed by the Southern Technology Council was used. However, instead of sending out the surveys to the Inland Northwest institutes, the author held interviews at each of these institutes to gain additional insight. One of the consequences of this approach was the ability to ask questions about the survey instrument. During each of the interviews, respondents had questions about the exact definitions used in the study. This indicates that, even though the definitions are provided in the survey instrument, the institutes use different definitions, and it is not always easy for the respondents to "translate" their measures and definitions into the measures and definitions used in the survey. In other words, the institutes may not administer the items in the same defined "boxes" as questioned in the survey. This led to the following insights about the applicability of the questions:

- The survey asks about patents. One of the institutes was involved in joint patent development, raising the question whether joint patents should be included. Also, if there is a joint patent with a company that subsequently commercializes the technology, but without a license, how should income be counted?
- Another issue is what exactly constitutes a patent. For example in WSU's administration, there is a category labeled "Plant Variety Protection Applications." Should this be included as a patent?
- The survey asks about license revenue. One of the institutes received royalty payments but without a license agreement. This case is not included in the questionnaire but income is still generated.
- EWU, because of its small size and limited experience, contracts out some of its technology transfer activities. The outsourced activities are not included in the estimate on technology transfer FTEs because they are irregular and not part of EWU's technology transfer office.
- There are certain dynamic elements that create confusion. For example, if a company moved out-of-state, how should this company be included in the data?
- In several instances, some information was not available. In particular, these gaps were related to the distinction between in-state and out-of-state licensing and the distinction between start-up companies, small companies and large companies. This indicates that while there is interest in regional and economic impact from a policy perspective, the institutes are not (yet) tracking this type of data. For example, PNNL has not kept track of company size and in-state or out-of-state licensees. Instead, it keeps track of a number of indicators that allow comparison of PNNL

with other national labs, but this does not necessarily show regional economic performance.

- The survey asks about the number of start-up companies. An issue here is the involvement of faculty in the establishment of start-up companies. For example, there may be companies that are established by former faculty members of an institute who quit their university job to pursue the new start-up company. But there may also be start-up companies that are established by faculty members that remain faculty members and simultaneously work for the start-up company.

  The institutes involved in the research held different views on this issue. In one instance, an institute had reservations about people quitting their job to start a new company because this may indicate use of knowledge generated during university activities without payment to the university. Another institute had reservations toward faculty members who start a company but remain employed by the university, due to conflicts of interest. For example, will this new company benefit from student research for the faculty member? In both cases, the start-up company may create jobs, and both categories are therefore, from an economic development perspective, relevant.

- Although not included in the analysis, one of the questions asked on the survey was whether the institutes keep track of information about "industry-sponsored research". Most of the included institutes did not track elements such as firm size, location of principal place of business, primary business, etc.

- The survey calculates ratios based on a fiscal year where technology transfer accomplishments are compared with research expenditures in that year. However, it has been shown that the mean time interval between the relevant academic research result and the first commercial introduction of the product or process is about seven years[82 83]. Therefore, it would be better to introduce a time factor in the ratio measures.

The above-mentioned issues all raise questions about surveys of technology transfer. More importantly, they reveal that social scientific interest (fueled by political interest) emphasizes and measures different variables than the institutes involved in technology transfer. This is an important finding, because it indicates that priorities of policy makers may not match those of practitioners. In order to improve technology transfer, this issue will have to be addressed. This could mean that technology transfer analysts start measuring different things. Or institutes might be made aware of another role that they perform in the region, leading to their adoption of a different or expanded set of indicators.

7.3 Recommendations and Future Research

Based on the study the following three recommendations and insights for further research emerge:

- There is a lack of comparability among the various institutes because of the differences in how they collect information on technology transfer. For future studies to have more comparable data, the institutes need to come up with a standard, comprehensible set of items that they address in their databases. This will also make it easier to track performance over time.

- The survey instrument used has several limitations, primarily because it is based on "counting" certain items, although institutions may use different types of "counting". Therefore, the approach used in future research should be more open to the different ways in which universities keep track of technology transfer data to allow for nuances to show through.

- This research study has only covered a small portion of technology transfer, as figure 2 demonstrates. Future research should focus on some of the other technology transfer issues. For example, it is quite possible that informal technology transfer has a much greater impact than formal technology transfer in the Inland Northwest. It is recommended that future research focus on these transfers and develop instruments that will capture this type of transfer.

Appendix A:
Southern Technology Council Benchmarking Study Findings and Analysis

Table A.1: Best-in-Class Institutions, in Order, for Input Benchmarks[84]

Patent applications per $10 million R&D	U.S. patents awarded per $10 million R&D
Oklahoma Medical Research Foundation	University of North Carolina, Charlotte
East Carolina University	Oklahoma Medical Research Foundation
Idaho State University	Institute of Paper Science and Technology
University of North Carolina, Chapel Hill	University of Oklahoma Health Science Center
Institute of Paper Science and Technology	University of Maryland, Baltimore County
University of Southern Mississippi	East Carolina University
University of South Florida	Florida Atlantic University
Number of patent applications	**Number of patents awarded**
Johns Hopkins University	Johns Hopkins University
University of Maryland, College Park	University of Florida
University of Florida	Louisiana State University
Georgia Institute of Technology	University of North Carolina, Chapel Hill
Washington University	Duke University
Duke University	Washington University
University of North Carolina, Chapel Hill	North Carolina State University

Table A.2: Best-in-Class Institutions, in Order, for Output Benchmarks[85]

Licenses and options in effect per $10 million research expenditure	License income as a percent of research expenditure (royalty ROI)
North Carolina State University	Florida State University
University of Georgia	Tulane University
Oklahoma Medical Research Foundation	University of Florida
St. Jude Children's Research Hospital	Clemson University
University of North Carolina, Chapel Hill	South Dakota State University
North Dakota State University	University of Virginia
Vanderbilt University	Emory University
Number of licenses and options in effect	**License income**
North Carolina State University	Florida State University
Johns Hopkins University	University of Florida
University of Georgia	Tulane University
University of North Carolina, Chapel Hill	Johns Hopkins University
Duke University	Emory University
Washington University	Washington University
University of Alabama, Birmingham	Clemson University

In the STC study, performance information on economic impact measures were measured by in-state licensing, start-up licensing and license income from in-state licensees. The benchmark institutions are shown in table A.3.

Table A.3: Best-in-Class Institutions, in Order, for Economic Impact Benchmarks[86]

Percentage of licenses and options to in-state licensees	**Number of licenses and options to in-state licensees**
Idaho State University	University of Georgia
University of Arkansas, Medical Sciences	North Carolina State University
Virginia Commonwealth University	University of Alabama, Birmingham
University of North Carolina, Charlotte	Georgia Institute of Technology
South Dakota State University	University of South Florida
Percentage of licenses and options to start-up licensees	**Number of licenses and options to start-up licensees**
Idaho State University	University of Alabama, Birmingham
University of North Carolina, Charlotte	University of Georgia
South Dakota State University	University of South Florida
University of South Florida	North Carolina State University
University of Wyoming	Georgia Institute of Technology
Percentage of license income from in-state licenses	**License income from in-state licenses**
Florida Atlantic University	North Carolina State University
University of Maryland, Baltimore County	University of Georgia
University of Memphis	Virginia Tech
University of North Carolina, Charlotte	University of Florida
University of Alabama, Huntsville	Florida Atlantic University
Number of start-up companies formed per $10 million in R&D spending	**Number of start-up companies formed**
University of Southern Mississippi	University of Georgia
University of North Carolina, Charlotte	Virginia Commonwealth University
Idaho State University	University of Alabama, Birmingham
Virginia Commonwealth University	Georgia Institute of Technology
East Carolina University	Emory University
Florida Atlantic University	Johns Hopkins University
Oklahoma Medical Research Foundation	University of South Florida

Table A.4 gives a more detailed distribution of the institutes that classified as best performers on ratio measures and the number of times it appeared at a particular position in the benchmark list. This shows that when examined in a little more detail, the research-extensive universities are still performing extremely well, even on ratio measures. There are, in total, 16 research-extensive universities on the benchmark list versus only 12 non-research-intensive universities. Note that there is only one master's college I institute on the list.

Table A.4: Benchmark Institutes for Ratio Measures

Frequency of Occurrence in Top Seven								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
Research –extensive universities								
Clemson University				1				1
Emory University							1	1
Florida State University	1							1
North Carolina State University	1							1
Tulane University		1						1
University of Florida			1					1
University of Georgia		1						1
University of Maryland, Baltimore County		1			1			2
University of Memphis			1					1
University of North Carolina, Chapel Hill					1			1
University of Southern Mississippi	1					1		2
University of South Florida				1			1	2
University of Virginia						1		1
University of Wyoming					1			1
Vanderbilt University							1	1
Virginia Commonwealth University			1	1				2
Research – intensive universities								
East Carolina University		1			1	1		3
Florida Atlantic University	1					1	1	3
Idaho State University	2		2					4
North Dakota State University						1		1
South Dakota State University			1		2			3
University of Alabama, Huntsville					1			1
University of Arkansas, Medical Sciences		1						1
Master's colleges I								
University of North Carolina, Charlotte	1	2		3				6
Specialized institutes								
Institute of Paper Science and Technology			1		1			2
University of Oklahoma Health Science Center				1				1
Not classified								
Oklahoma Medical Research Foundation	1	1	1				1	4
St. Jude Children's Research Hospital				1				1

Table A.5 shows the overwhelming performance of research-extensive universities on absolute measures. There is in fact only one research-intensive institute in this benchmark list.

Table A.5: Benchmark Institutes for Absolute Measures

Frequency of Occurrence in Top Seven								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Total**
Research-extensive universities								
Clemson University							1	1
Duke University					2	1		3
Emory University					2			2
Florida State University	1							1
Georgia Institute of Technology				3	1			4
Johns Hopkins University	2	1		1		1		5
Louisiana State University			1					1
North Carolina State University	2	1		1			1	5
Tulane University			1					1
University of Alabama, Birmingham	1		2				1	4
University of Florida		2	1	1				4
University of Georgia	2	2	1					5
University of Maryland, College Park		1						1
University of North Carolina, Chapel Hill				2			1	3
University of South Florida			1		1		1	3
Virginia Commonwealth University		1						1
Virginia Tech			1					1
Washington University					1	3		4
Research-intensive universities								
Florida Atlantic University					1			1

Appendix B: Fiscal Year 1998 Benchmark Comparisons

Figure B1. Input Benchmark 1b:
U.S. Patent Applications Filed in 1998

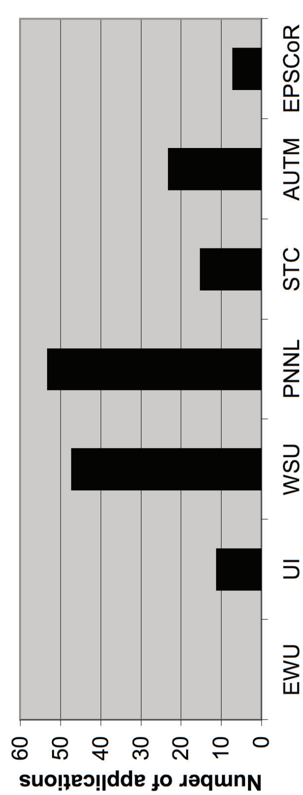


Figure B2. Input Benchmark 2b:
U.S. Patents Awarded in 1998

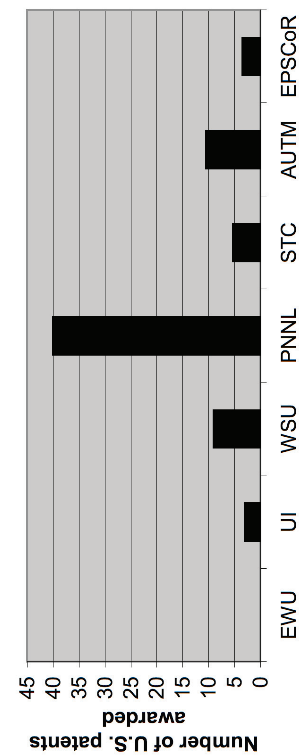


Figure B3. Output Benchmark 1b:
Licenses in Effect for 1998

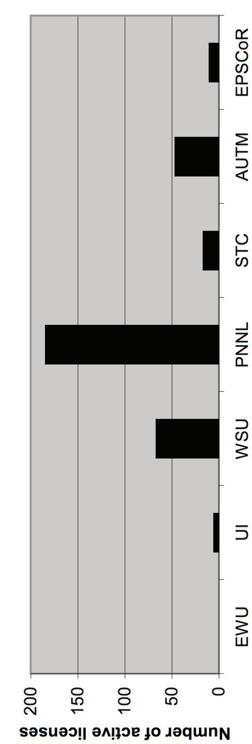


Figure B4. Output Benchmark 2b:
License Income for 1998

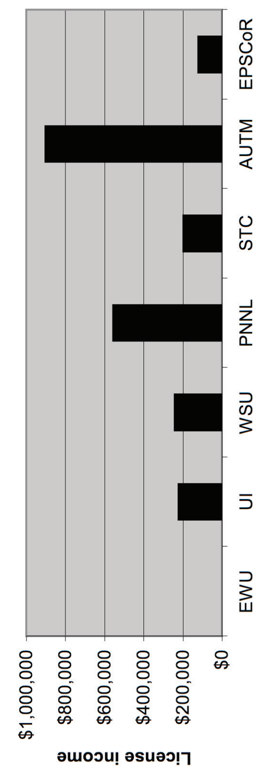


Figure B5. Economic Impact Benchmark 1b: In-state Licenses in Effect for 1998

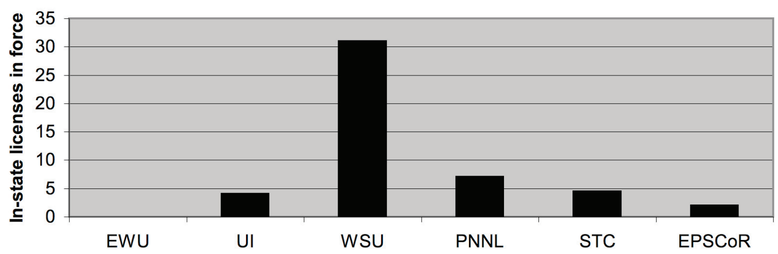


Figure B6. Economic Impact Benchmark 2b: Licenses in Effect to Start-up Companies for 1998

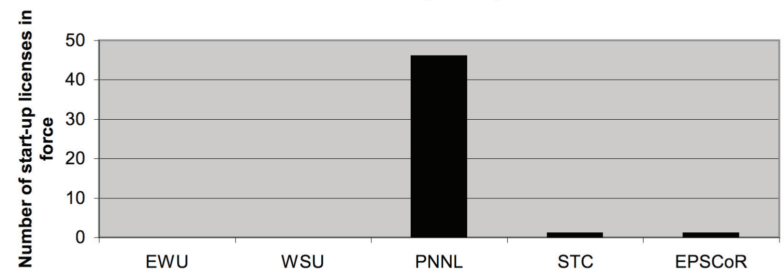


Figure B7. Economic Impact Benchmark 3b: License Income from In-state Licenses for 1998

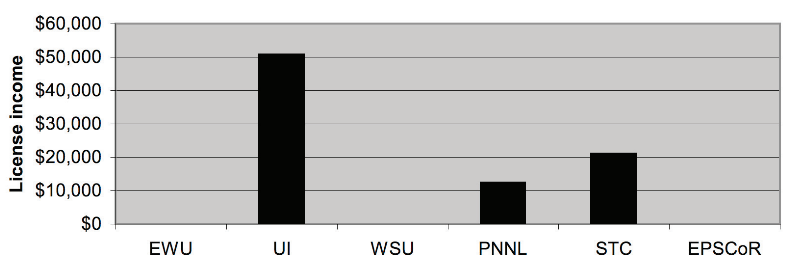
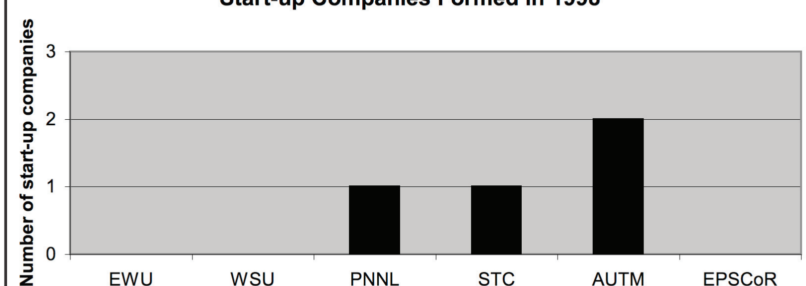


Figure B8. Economic Benchmark 4b: Start-up Companies Formed in 1998



Appendix C: 1998 – 2002 Inland Northwest Benchmark Comparisons

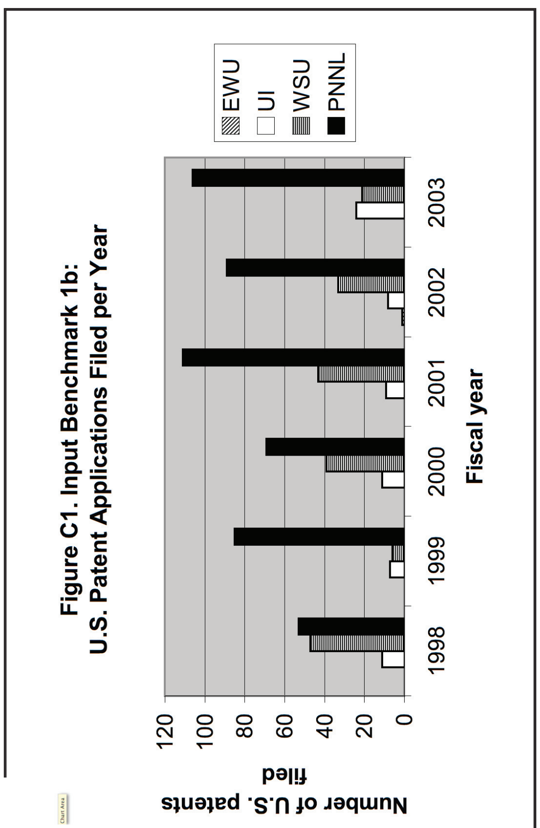


Figure C1. Input Benchmark 1b: U.S. Patent Applications Filed per Year

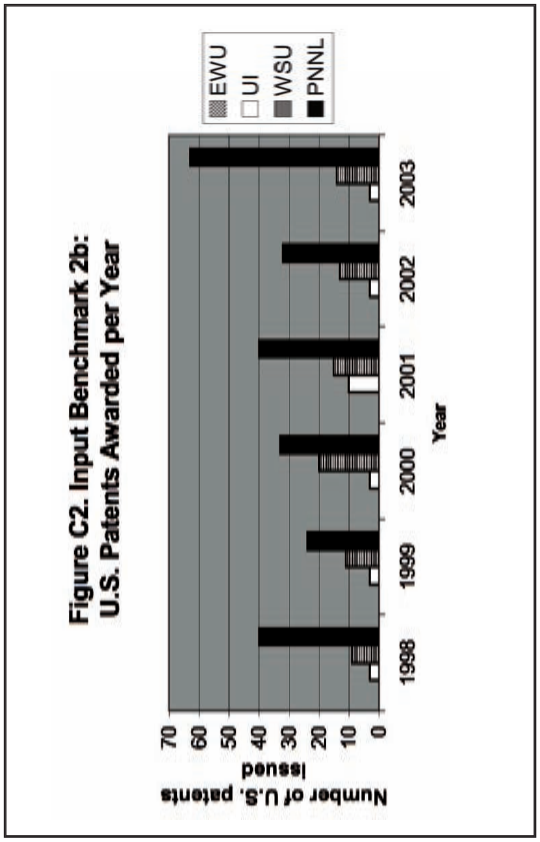


Figure C2. Input Benchmark 2b: U.S. Patents Awarded per Year

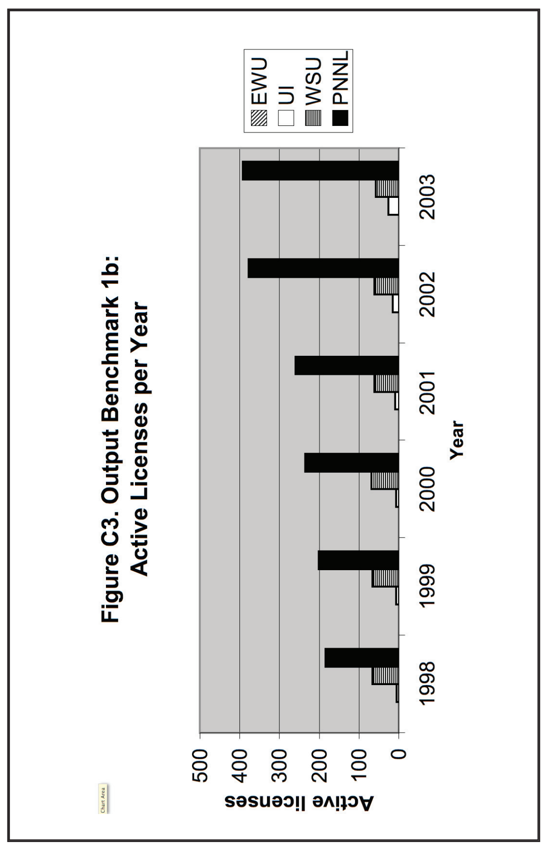


Figure C3. Output Benchmark 1b: Active Licenses per Year

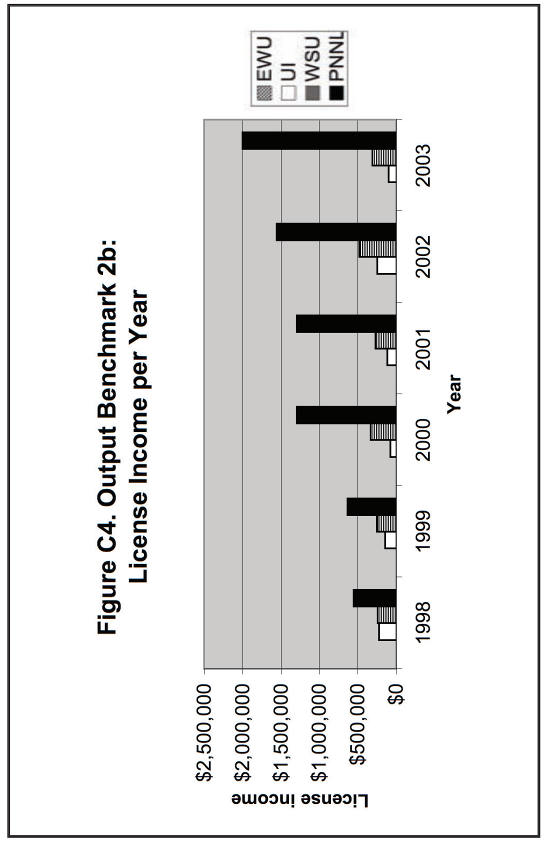


Figure C4. Output Benchmark 2b: License Income per Year

Figure C5. Economic Impact Benchmark 1b: Number of In-state Licenses in Effect

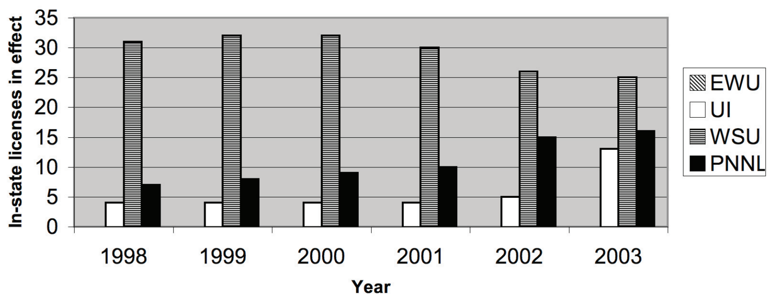


Figure C6. Economic Impact Benchmark 2b: Number of Start-up Licenses in Effect

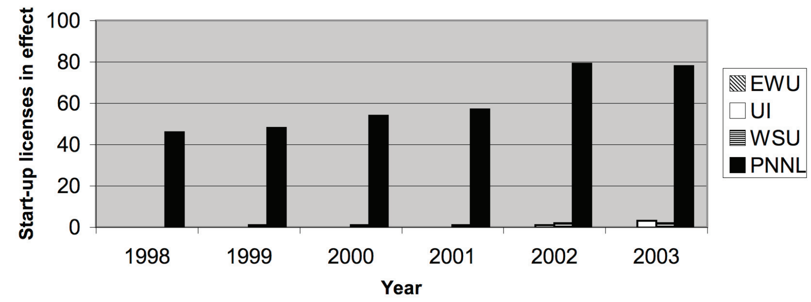


Figure C7. Economic Impact Benchmark 3b: License Income from In-state Licensees

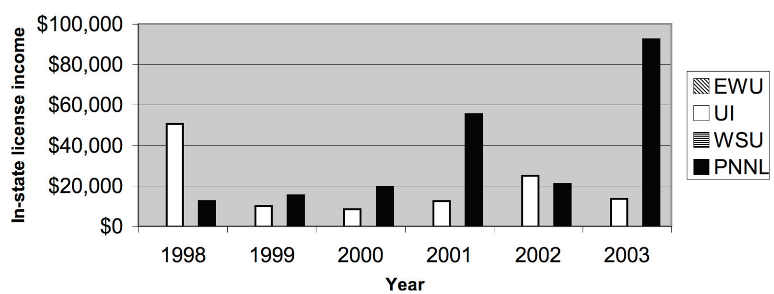
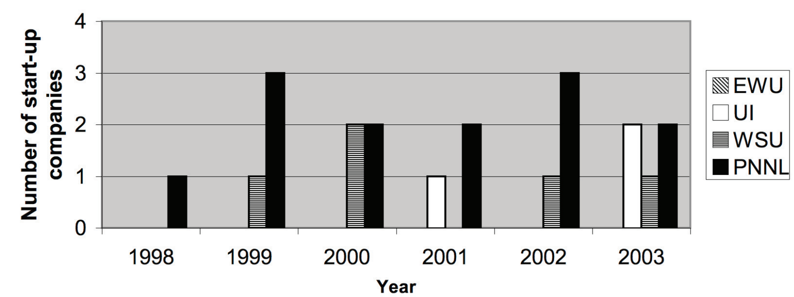


Figure C8. Economic Impact Benchmark 4b: Start-up Companies Formed per Year



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E a s t e r n W a s h i n g t o n U n i v e r s i t y


"From One to Z" artist Ms Gloria Bornstein

Our Mission

Eastern Washington University's mission is to prepare broadly educated, technologically proficient and highly productive citizens to obtain meaningful careers, to enjoy enriched lives and to make contributions to a culturally diverse society. The University's foundation is based on career preparation, underpinned by a strong liberal arts education.

Our Students

Eastern is emerging with fresh, dynamic leadership and campus-wide enthusiasm for its future. As of fall quarter 2004, Eastern's enrollment numbers were 9,775 students.

Accreditations

The university is accredited by the Northwest Association of Schools and Colleges and many discipline-specific associations, such as the American Assembly of Collegiate Schools of Business, the National Association of Schools of Music, the Computing Sciences Accreditation Board, the National Council of Accreditation of Teacher Education, the Planning Accreditation Board and many more.

Exceptional Faculty and Academic Programs

Eastern provides a student-centered learning environment. Students have access to more than 130 undergraduate majors, nine master's degrees, four graduate certificates, 76 graduate programs of study and a doctor of physical therapy. The University consists of six colleges – Business and Public Administration; Education and Human Development; Arts and Letters; Social and Behavioral Sciences; Science, Mathematics and Technology; and School of Social Work and Human Services.

Eastern enhances its strong commitment to teaching and learning by vigorously pursuing grants, extramural funding and student-faculty research collaborations. For the most recent fiscal year, the university secured a total of $12.2 million in grants and extramural funding.

Several Institutes or Centers of Excellence add focus to faculty research and performance. They are: creative writing, music and honors. Student-faculty research projects are a priority of the institution. Every spring, the Research and Creative Works Symposium showcases undergraduate and graduate students' collaborative efforts with their professors.