Evaluation of Maine's Public Investments in Research & Development

Interim Report 2003

Prepared for the Department of Community and Economic Development
as part of an ongoing evaluation of Maine's Public Investments
in Research and Development

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Executive Summary

Despite improvements in the U.S. economy in the past year, states continue to struggle with tight budgets. The situation is Maine may be worse than for other states. In light of these continuing challenges, it is incumbent upon Maine's and other states' legislatures to scrutinize every direct and tax expenditure program, and to seek alternative sources of revenue. This year's interim *Evaluation of Maine's Public Investments in Research &Development* is presented within that context. The Governor and legislature have maintained their commitment to grow the state's science and technology capacity. This commitment, in light of Maine's sustained fiscal pressures, recognizes the promise of technology-led economic development in the new economy of the 21st century.

This report is the third annual assessment of Maine's investments in R&D. It is part of a six-year effort to collect relevant information, put it in the context of economic developments in Maine, New England, the EPSCoR states, and the nation, and provide advice to the Governor and legislature on policies to help create a more competitive Maine. The project is unique in its meaningful inclusion of stakeholders around Maine, in its continuity over time, and in the periodic interplay between the evaluation team and policymakers in Augusta.

The report addresses three questions posed by the legislature in 2001:

1. *How competitive is Maine's publicly funded R&D and has the state's competitiveness improved over time?*
2. *What is the impact of Maine's R&D investment on the development of Maine's R&D industry?*
3. *What is the impact of Maine's R&D investment on the level of innovation and innovation-based economic development?*

We use three types of evidence to answer these questions: surveys of recipients of state R&D assistance that is channeled to them through stakeholder organizations, and of research institutions in Maine; economic and technology indicators constructed with data for Maine, New England, all EPSCoR states, the EPSCoR states that entered the program with Maine in 1980, and the U.S. as a whole; and case studies of the Maine Agricultural and Forestry Research Station (MAFES) and the Maine Revenue Service's (MRS) administration of three R&D tax credit programs.

Answers to the three questions

1. How competitive is Maine's sponsored R&D and has it improved over time?

We define competitiveness in terms of the character and quantity of state support of R&D relative to other states and in terms of the effectiveness of the state's programs as measured by the outputs and outcomes arising from state initiatives.

We noted in the 2001 *Initial Evaluation* the distinctive character of Maine's R&D enterprise. Nationally, industry performs the largest portion of a state's total R&D, and universities and federal government laboratories usually perform the largest portion of publicly funded R&D. Maine's situation is quite different. In Maine, the not-for-profit sector is much more prominent than in the nation as a whole. Therefore, care is in order when using aggregate measure of R&D performance to assess Maine's competitive performance and position.

This point is driven home again in this year's data: overall, Maine lags behind its benchmarks in the level of R&D funding, but is a leader in the not-for-profit sector. Maine also shows relative R&D strength in the areas of environmental and social sciences.

The evidence also is mixed in terms of external funding (grants and contracts from the federal government). The state has not fared well relative to its competitors in competitive awards, except from the Department of Defense (DoD), most likely for work at the Bath Iron Works. Businesses have done well in set-asides and earmarked funds. EPSCoR, SBIR phase I and II, and STTR funds all increased significantly in 2003. The increased reliance on earmarks and set-asides is a matter of concern, in part because those funds are under scrutiny in Washington and are likely to be cut back.

As noted in previous reports, Maine started from a lagging position and continues to lag behind comparable states. Maine has been improving its absolute position and relative standing on several, but not all indicators, a trend that is now several years old. While the state's current level of investment is large by historical standards, it is still not as substantial as in some other states (for example, Michigan, New York, North Carolina, and Massachusetts). As a result, it is difficult for Maine to progress far in relative terms; it is shooting at a moving target.

We observed that Maine increased its number of science and engineering degree programs in 2003, but enrolled fewer students in them. Other states — especially Maine's EPSCoR cohort — have invested even more heavily in science and engineering, and have been producing more graduates. Other states also have invested more in R&D, including the construction of more research space and purchase of more equipment. Not surprisingly, then, they have outpaced Maine in the generation of intellectual property. It is also not surprising that gross indicators, like per capita personal income and output, have not improved relative to other places.

Last year we observed it was likely that published (secondary) data did not yet reflect the positive impacts of the state's most recent initiatives. We make the same observation this year. The very current survey and interview results paint a more dynamic picture of the Maine economy than do the indicator data. For example, the University of Maine used state R&D funds to add research space and equipment last year. UM also increased its number of post-docs (one-third of whom were paid for with state R&D support dollars) and individual programs — like MAFES — have added faculty and generated external funds.

2. What is the impact of Maine's R&D investment on the development of Maine's R&D industry?

Maine's R&D investments are intended to increase the level of research being conducted by the state's businesses and within its research institutions. That has happened in absolute dollars, more so than in a relative sense.

We noted above some very recent additions to the research capacity of the University of Maine. Consequently, in 2003 the number and value of research proposals submitted increased from 2002. However, the success rate for those proposals fell. That is troubling in the short-run, but may improve over time as researchers gain experience in writing proposals. In that sense, a good predictor of future success is today's level of activity. The anemic results on research awards received may also reflect the type of expertise resident in the Maine research community. The large pots of research dollars today are at NIH, National Cancer Institute, Defense, and Homeland Security. The universities are not strong in those areas; the absence of a research-oriented medial school is a handicap in Maine. The bright spots are Jackson Labs and the Maine Medical Center Research Institute, which each receive NIH and NSF funding for biotech and medical-related projects, and Bath Iron Works, which receives DoD funds.

A strengthening university research sector also is suggested by a jump in peer-reviewed articles and other scholarly output. Eighty percent of that increase is attributed to state R&D investments. There was also a modest increase in disclosures by university researchers and in spin-offs. This still has not translated into much of an increase in research institution-based intellectual property (IP) production, largely reflecting culture (in the case of Jackson Labs), resource constraints, and a rudimentary technology transfer apparatus in place. The weak performance in IP generation also might indicate that the type of research being conducted at the institutions does not lend itself to patenting, because it is either too basic or not sufficiently innovative to patent. Alternatively, research that is too applied, such as extension work with companies, typically is not patentable.

Maine does not have a large private sector R&D presence. Most recipients of state R&D money in the business community — including grants and tax incentives — are producers of goods and services, not R&D operations. A positive finding is that many of the grant recipients are young firms that tend to be more dynamic, and can use the state's assistance to enhance their growth prospects.

Because of the lack of a critical mass of private R&D companies, links between industry and the university are particularly important in Maine. Sixty percent of businesses that received state assistance interacted with the university in 2003. That interaction was judged by respondents to be important to success, but less critical than assistance from Maine Technology Institute and the Applied Technology Development Center.

In some places, there are good linkages with industry. MAFES demonstrated a good feedback loop with end-users of research. However, the difficulty of balancing academic rigor (and subsequently more basic research) with responsiveness to industry (and subsequent desire for more rapid answers to immediate questions) is evident.

3. What is the impact of Maine's R&D investment on the level of innovation and innovation-based economic development?

The survey results from business recipients of state R&D assistance suggest that Maine's level of innovation and innovation-based economic development is quite promising, if not robust. The reported IP activity includes patenting, licensing, copyrighting, and trademarking. Recipient firms account for most, if not all, of the private sector IP production in Maine.

The R&D investments seem to be reaching the kinds of companies they are supposed to reach: newer and dynamic businesses who can use the investments to enhance their growth. Even though the recipient companies represent a fraction of Maine's industrial base, they appear to have a disproportionate impact on the state's economic development. Almost all are headquartered in Maine, and most earn a large proportion of their revenue from outside the state. These revenues pay for salaries and benefits for workers in the state and profit distributions to Maine-based owners. Average wages paid in these companies was $31,369, approximately 12 percent higher than the Maine average wage in 2003. In addition to the wages and profits paid within the state, the recipient businesses help economic development in Maine by buying most of their inputs from suppliers in Maine.

The survey responses suggest that most of the venture capital deals in Maine are being done by recipient firms. Very few of the surveyed recipient businesses took advantage of the R&D tax credits discussed in the case study. That supports the finding that the tax credits are not being used by the small R&D companies, mainly because they do not have tax liability.

Either as a result of the selection process, as a consequence of the receipt of assistance, or because of the guidance provided the grant recipient by the pass-through (stakeholder) agency, the recipient businesses performed considerably better than the average Maine company in 2003. Their employment and revenues both grew by faster than the state average.

Companies got the most assistance in prototyping and market research, followed by business planning, and product design. That is logical given the early stage of the companies in this group. Over 66 percent of respondents indicated that the assistance they received was critically important or very important to them. (The response was 2.6 percentage points higher for MTI and multiple stakeholder clients.) It appears that more assistance leads to higher perceived importance. Nearly 78 of respondents were satisfied or very satisfied with the assistance they received (again, somewhat higher for MTI and multiple stakeholder clients).

CHAPTER 1

R&D and State Economic Development

Despite improvements in the U.S. economy in the past year, states continue to struggle with tight budgets. Modest increases in revenues are being offset by deferred commitments from even worse budget years and higher mandatory spending on programs such as Medicaid. Summarizing recent studies by the National Conference of State Legislatures and the National Governors Association, the National Federation of Independent Businesses reports that only 12 states are predicting surpluses for fiscal 2005. Thirty-three states are trying to resolve budget gaps as they negotiate their FY 2005 budgets. Moreover, governors expect expenditures for fiscal 2005 to rise only 2.8 percent from 2004, lower than the 26-year average of 6.2 percent.[1]

The situation is Maine may be worse than for other states. One report claims that Congressional action in 2004 would result in a loss of $119 million in federal funds for key programs, over 10 years.[2] For that and other reasons, the state Treasurer predicts a structural budget gap of $785 million for the next biennium, or almost 17 percent of general fund revenues on an annual basis. In light of that prediction, Standard & Poor's recently downgraded Maine's bond rating, which will cost the state a projected $130 million more in interest over 10 years.[3]

In light of these continuing challenges, it is incumbent upon Maine's and other states' legislatures to scrutinize every direct and tax expenditure program, and to seek alternative sources of revenue. This year's interim *Evaluation of Maine's Public Investments in Research &Development* is presented within that context. The Governor and legislature have maintained their commitment to grow the state's science and technology capacity, through

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[1] NFIB Newsletter, May 5, 2004. Electronic version at http://www.nfib.com/cgi-bin/NFIB.dll/jsp/issues/newsReleaseDisplay.jsp?contentId=4287595

[2] Institute for America's Future, *Maine Impact Analysis: Effect of 2004 Congressional Budget Resolution* (Washington, DC: Economic Policy Institute, April 2003).

[3] In *boston.com News*, May 27, 2004, http://www.boston.com/news/local/maine/articles/2004/05/27/ standard_poors_drops_maine_rating_in_advance_of_bond_sale/. In a DECD communication to the authors in June 2004, the estimated deficit was in excess of $900 million. Both of these projections exceed the $173 million gap projected for FY 2005 alone by the Washington, D.C.-based Center for Budget and Policy Priorities in February 2004. Nicholas Johnson and John Zahradnik, "State Budget Deficits Projected for Fiscal year 2005," *Center on Budget and Policy Priorities Newsletter*, February 6, 2004.

the programs that are shown in table 1.1 below. This commitment, in light of Maine's sustained fiscal pressures, recognizes the promise of technology-led economic development in the new economy of the 21st century.

This report is divided into three main chapters and five appendices. The remainder of this chapter restates the importance of sustained investments in R&D as a basis for prosperity today and tomorrow and presents the three questions posed by the legislature, around which this multi-year project is organized. Chapter 2 presents an overview of the survey results, indicator data, and case studies. In the final chapter we move from description to interpretation, and draw some lessons-to-date from what we have observed. Appendix 1 describes the methodology used by the study team in 2003. Our approach included another year of surveying the recipients of state R&D funding, including research institutions, and two additional case studies. Appendix 2 contains the full case study reports. Appendix 3 presents our indicators. Appendix 4 focuses on the research institutions' survey results, and appendix 5 contains the survey instruments that we used. We use appendices liberally in this report to allow the reader to get through the substantive results contained in the three main chapters relatively quickly.

Innovation/technology-based economic development for the "new economy"

Recent innovations in economic development focus on the "new economy," trying to increase the competitiveness of communities faced with increasingly fierce global competition. Competitiveness strategies include programs to assist existing companies, especially manufacturers, acquire and use new processes and technologies. A parallel strategy is to increase technology development, including an emphasis on a particular industry sector or region. Other strategies focus on supporting entrepreneurship, through business assistance and access to capital. These strategies, taken together, are often called innovation- or technology-based economic development.

Maine's programs

In their overview of state innovation-based economic development programs compiled in 1994, Battelle researchers[4] categorized state programs into the five groups we used to organize table 1.1.

- Technology development
- Industrial problem solving
- Technology financing
- Start-up assistance
- Teaming

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[4] Berglund, Dan, and Chris Coburn. 1994. Partnerships: A Compendium of State and Federal Cooperative Technology Programs. Columbus, OH: Battelle Press.

Table 1.1 Maine's Research and Development Programs

	Basic Research	Applied Research	Commercialization	Improved Competitiveness
Technology Development	• Biomedical Research Fund • Gulf of Maine Aquarium • Marine Connectivity • EPSCoR • Marine Technology Fund • Research Challenge Grants • R&D Bonds			
Industry Problem-solving		• MAFES • Sea Grant • Strategic Research Initiative		• *Manufacturing Extension Partnership* • *MAFES Cooperative Extension* • *Sea Grant Cooperative Extension*
Technology Financing		• Maine Technology Institute Seed Grants • SBIR assistance • Seed capital tax credit • Expensing of R&D expenditures tax credit • Research expenditures tax credit	• Maine Technology Institute Development Awards • VC Revolving Investment Program • Small Enterprise Growth Fund • High tech tax credit • Super credit	• *High tech tax credit* • *Agricultural Development Grant* • *Potato Marketing Improvement Fund*
Start-up Assistance			• Applied Technology Development Centers	
Teaming	• Mainescience.org	• Mainescience.org	• Mainescience.org	• Mainescience.org
Workforce	• Governor's Marine Fellowship			
Clusters	• Maine Aquaculture Innovation Center • Maine Space Grant Consortium • Maine Technology Institute Cluster Enhancement Awards	• Maine Aquaculture Innovation Center • Maine Space Grant Consortium • Maine Technology Institute Cluster Enhancement Awards	• Maine Aquaculture Innovation Center • Maine Space Grant Consortium • Maine Technology Institute Cluster Enhancement Awards	• Center for Innovation in Biotechnology • Maine Aquaculture Innovation Center • Maine Technology Institute Cluster Enhancement Awards

Programs which are in italics are not included in the R&D evaluation.

These categories are still valid a decade later, though there are new types of programs in each group. In addition, there are two new categories of innovation-based economic development: clusters and workforce development. We described these in last year's interim report.

Maine's programs in innovation-based economic development map well into Battelle's typology (as amended). As shown in table 1.1, Maine has programs in every category, and in some cases, there are multiple programs. The map in table 1.1 shows how programs in each of the seven categories also focus on basic or applied research, commercialization, and/or improved competitiveness. When they apply to more than one of those, they are listed again. Whether Maine's programs follow best practices is another question, however, and one that is beyond the scope of this evaluation.

Three questions about these programs

The three questions posed by the legislature are:

1. *How competitive is Maine's publicly funded R&D and has the state's competitiveness improved over time?*

2. *What is the impact of Maine's R&D investment on the development of Maine's R&D industry?*

3. *What is the impact of Maine's R&D investment on the level of innovation and innovation-based economic development?*

The first question is about Maine's relationship to its competitors. For this evaluation, we define Maine's competitors in different ways. First, Maine competes with its neighbors in New England. Second, in the R&D arena, Maine competes with the other EPSCoR[5] states. Third, Maine competes with the U.S. as a whole. This year, we added a fourth competitive benchmark group: the four states that entered the EPSCoR program with Maine in 1980.

The second question is about the impact of the R&D industry on Maine. The R&D industry consists of those entities whose primary output is research and development. Those include the doctoral universities, non-profit research entities and some companies.

The third question asks how Maine's level of innovation and the innovation-based economy have changed as a result of the R&D investments.

Appendix 1 explains how we undertook to answer these questions. The next chapter presents our findings.

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[5] EPSCoR is the acronym for the Experimental Program to Stimulate Competitive Research and is used to denote the states with low levels of federal research funding. The states are: Alabama, Alaska, Arkansas, Idaho, Kansas, Kentucky, Louisiana, Maine, Mississippi, Montana, Nebraska, Nevada, North Dakota, Oklahoma, Puerto Rico, South Carolina, South Dakota, Vermont, West Virginia and Wyoming.

CHAPTER 2

Findings

Maine's support for R&D investments is intended to help create a high quality of life for its citizens by building a sustainable economy. The specific goals for science and technology as outlined in Maine's Science and Technology Action Plan 2001 are:

- An educated and technically skilled workforce;
- A robust research and development enterprise;
- An environment that fosters entrepreneurial innovation; and
- Statewide access to the latest information technology infrastructure.

This Action Plan was in place for the period of this report, 2003.

To assess progress toward these goals, the legislature has asked three questions:

1. *How competitive is Maine's sponsored R&D and has it improved over time?*
2. *What is the impact of Maine's R&D investment on the development of Maine's R&D industry? and*
3. *What is the impact of Maine's R&D investment on the level of innovation and innovation-based economic development?*

This chapter details the new data assembled in 2003 to help us answer those questions. The implications of these tabulations are presented in chapter 3.

In the following sections we summarize, in turn, responses from the company and research institutions survey, the R&D outcome indicators, and the case studies. Throughout the chapter we use the stakeholders' acronyms. Table 2.1 associates those with their full names.

Table 2.1: Stakeholder names

Acronym	*Stakeholder name*
CIBT	Center for Innovation in Biomedical Technologies
DECD	Department of Economic and Community Development
FAME	Finance Authority of Maine
MAIC	Maine Aquaculture Innovation Center
MSGC	Maine Space Grant Consortium
MSTF	Maine Science and Technology Foundation
MTI	Maine Technology Institute
SEGF	Small Enterprise Growth Fund
TLC	Technology Law Center

Findings from company surveys

First we present characteristics of the respondents relative to the population. Then we summarize responses to key questions that can be used to judge the importance of the R&D investments to recipient companies and the state.

The population of companies that received assistance from the R&D investment programs in 2003 (either new or continuing grants) was 325. One hundred and seventy-six companies completed the survey, a response rate of 54.2 percent. Table 2.2 shows the distribution of the population and responses by stakeholder organization.

Table 2.2: Distribution of respondents and population, by stakeholder

	All Respondents		**All Surveyed**	
Stakeholder	Number	Percent	Number	Percent
CIBT	0	0.0	4	1.2
DECD	6	3.4	19	5.8
FAME	12	6.8	54	16.6
MAIC	2	1.1	26	8.0
MSGC	1	0.6	2	0.6
MSTF	0	0.0	1	0.3
MTI	65	36.9	71	21.8
Multiple	61	34.7	82	25.2
SEGF	6	3.4	11	3.4
TLC	23	13.1	55	16.9
Total	176	100.0	325	100.0

Ideally, we would have had a 100 percent response rate. Short of that, we would have liked the distribution of responses to be the same as the distribution of the population. Then the third and fifth columns in table 2.2 would be the same. Instead, we have an oversampling of MTI clients and an undersampling of FAME and MAIC clients, for example.[6] We need to bear possible response bias in mind when generalizing our findings to the full population.

All 176 companies that responded are headquartered in Maine. One hundred forty-four have just one location for their company, all in Maine. Thirty-two have multiple locations in Maine (12 have two and 20 have three Maine locations). Ten companies have locations in the U.S., outside of Maine, as well as their Maine location. The other states represented are: AZ, CT, MA, NH, NY (2), OH (3), VA, IL, TN, and SC. Three companies have locations outside of the U.S. as well (Chile, England, Thailand, Ireland, Norway).

Table 2.3 compares respondents versus the population by the county and region of central office location. Statistical analysis confirms the visual observation that the numbers in the third and fifth columns are not significantly different.[7]

Table 2.3: Distribution of responses and population, by location

	All Respondents		**All Surveyed**	
Counties	Number	Percent	Number	Percent
No address	2	1.1	7	2.2
Androscoggin	6	3.4	9	2.8
Aroostook	6	3.4	13	4.0
Cumberland	73	41.5	133	40.9
Franklin	1	0.6	6	1.8
Hancock	30	17.0	47	14.5
Kennebec	9	5.1	17	5.2
Knox	6	3.4	12	3.7
Lincoln	14	8.0	22	6.8
Oxford	1	1.7	3	0.9
Penobscot	2	1.1	5	1.5
Piscataquis	1	0.6	1	0.3
Sagadahoc	1	0.6	4	1.2
Somerset	0	0.0	3	0.9
Waldo	2	1.1	4	1.2
Washington	4	2.3	10	3.1
York	16	9.1	29	8.9

Table 2.3 continues next page

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[6] The difference between the numbers in columns 3 and 5 for MTI is statistically significant using a chi-squared test. $\chi 2 = 29.12$; df = 9 at $\alpha = 0.05$.

[7] For the counties, $\chi 2 = 5.66$; df = 18; Same distribution of sample and universe at $\alpha = 0.05$. For the regions, $\chi 2 = 1.27$; df = 5; Distribution of sample and universe are the same at $\alpha = 0.05$.

Table 2.3 continued

Regions[8]	All Respondents Number	Percent	All Surveyed Number	Percent
No address	2	1.1	7	2.2
Central	38	21.6	68	20.9
East	34	19.3	57	17.5
North	6	3.4	13	4.0
South	89	50.6	162	49.8
West	7	4.0	18	5.5
Total	176	100.0	325	100.0

Table 2.4 compares the distribution of respondents and the population, by industry sector. Again, the numbers in the third and fifth columns are not statistically different.[9]

Table 2.4: Distribution of responses and population, by industry sector

Industry sector	All respondents Number	Percent	All surveyed Number	Percent
Advanced materials and composites	9	5.1	11	3.4
Advanced technology for forestry and agriculture	14	8.0	19	5.8
Biotechnology	19	10.8	27	8.3
Environmental technology	20	11.4	26	8.0
Information technology	38	21.6	67	20.6
Marine technology and aquaculture	30	17.0	62	19.1
Precision manufacturing	20	11.4	28	8.6
Other	17	9.7	35	10.8
Not coded	19	10.8	60	18.5
Total	176	100.0	325	100.0

Of the 176 respondents last year, one had been acquired (0.5 percent), four purchased another company (2.2 percent), one had an IPO (0.5 percent), and seven closed or become inactive (4 percent).

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[8] There is no official allocation of counties into regions. Based on common practice in Maine, we made the following groups: Central (Androscoggin, Kennebec, Know, Lincoln, Sagadahoc and Waldo); East (Hancock and Washington); North (Aroostook); South (Cumberland and York); West (Franklin, Oxford, Penobscot, Piscataquis and Somerset).

[9] $\chi 2 = 8.39$; df = 8; Distribution of sample and universe are the same at $\alpha = 0.05$.

Table 2.5 shows the age of respondents; 72 percent are less than 10 years old.

Table 2.5: Distribution of respondent ages

Year organized	Number of respondents	Percent of respondents
Plan to organize in future	2	1.0
2000–2003	69	39.2
1995–1999	56	31.8
1990–1994	13	7.4
1985–1989	11	6.3
1980–1984	11	6.3
pre-1980	13	7.4
no answer	1	0.5
Total	176	100.0

The age distribution in table 2.5 is consistent with the data in table 2.6 with respect to distribution of employees. The skew toward smaller-sized businesses reflects the fact that, if successful, a business grows over time — newer companies typically have fewer employees than older ones.

Table 2.6: Distribution of respondents, by employment size

Employment range	Number of respondents	Percent of respondents
1-10	141	80.1
11-20	16	9.1
21-30	5	2.9
31-40	5	2.9
41-50	4	2.3
51-100	3	1.7
100+	2	1.1
Total	176	100.0

The number of workers in respondent businesses in 2003 was a 2,335, or 2.3 workers per respondent, compared to 1,937 in 2002. Inflating to the population of recipients, there would be 4,213 workers in 2003. Respondents paid a total of $74,365,687 in wages and salaries.[10]

Table 2.7 paints a somewhat different picture than table 3.6. There is a much more even distribution of responses in terms of revenue, compared with employment.

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[10] Min = $0; Max = $22,897,502. Mean: $422,532.31, Std Dev. $1,843,830. Average salary: $31,821.

Table 2.7: Distribution of respondents, by revenue

Revenue	Number of companies	Percent
$0	38	21.6
$1–49,999	40	22.7
$50,000–99,999	13	7.4
$100,000–499,999	36	20.5
$500,000–$999,999	17	9.7
$1 million–4,999,999	21	11.9
$5 million +	9	5.1

Revenue per employee in 2003 was $104,587.

Table 2.8 shows the sources of revenue for the 174 respondents. Most respondents derive the bulk of their revenues from products and services. Relatively few earn income from research grants and contracts.

Table 2.8: Sources of revenue

Number of respondents with indicated percent of revenue attributable to:	Products and services	Research grants and contracts	Other
0 percent	56	110	142
1-10 percent	8	22	19
11-20 percent	3	7	0
21-30 percent	0	4	1
31-40 percent	1	1	1
41-50 percent	1	2	2
51-60 percent	1	3	0
61-70 percent	1	1	2
71-80 percent	8	2	0
81-90 percent	5	2	1
91-100 percent	90	18	8
Total	174	174	174

Table 2.9 shows the areas of the state from which revenues are derived. The table shows that many recipients export outside of Maine.

Table 2.9: Geographic location of revenue generation

Number of respondents with indicated percent of revenue generated from:	Sales in Maine	Sales in NE, outside of ME	Sales in U.S., outside of NE	Sales outside U.S.
0 percent	68	93	87	130
1-10 percent	39	27	10	28
11-20 percent	10	21	6	1
21-30 percent	15	14	8	5
31-40 percent	5	9	8	4
41-50 percent	4	3	9	3
51-60 percent	2	2	7	1
61-70 percent	3	2	7	1
71-80 percent	2	1	12	1
81-90 percent	7	2	9	0
91-100 percent	26	2	13	2
Total	176	176	176	176

Respondents paid 0.2 percent of their revenue, or $576,349, in state taxes. Inflating that to the population yields almost $1.1 million in taxes paid. Only 5 percent (9 companies) of respondents availed themselves of the research expense tax credit, 1.1 percent (2 companies) used the super tax credit, and 0.6 percent (1 company) used the high tech investment tax credit. Nine different companies among the respondents took tax credits (some took two). Eight of those nine companies had revenue greater than $1 million. The tax expenditure (i.e., foregone taxes) resulting from these credits amounted to $256,863, $174,249, and $5,304 in 2003 for the three types of credits, respectively. Inflating the total foregone revenue to the population yields approximately $805,000. (See the case study on these tax credits in the appendix.)

Tables 2.10 and 2.11 show the extent to which recipient companies received debt and/or equity financing in 2003. Over 22 percent of respondents obtained debt capital, mostly from banks, and 17 percent received infusions of equity, mostly from venture capitalists and angel investors.

Table 2.10: Access to debt finance by companies receiving R&D investment assistance

Sources	Number of transactions	Dollars of new debt	Percent of total new debt
Bank	21	$35,504,909	87.1%
SBA loans	3	$300,000	0.7%
Friends and family	10	$1,365,023	3.3%
Other	17	$3,618,187	8.9%
Total	51	$40,788,119	100.0%

Total adds to more than 39 companies, since there were multiple transactions at some companies.

Table 2.11:
Access to equity capital by companies receiving R&D investment assistance

Sources	Number of transactions	Dollars of new debt	Percent of total new debt
Venture capital	7	$35,598,224	59.6%
State seed funds	5	$1,009,224	1.7%
Angel investors	11	$5,765,530	9.7%
Friends and family	9	$2,549,634	4.3%
Other	12	$14,819,019	24.8%
Total	44	$59,741,631	

Total adds to more than 30 companies, since there were multiple transactions at some companies.

Table 2.12 indicates the extent to which recipient firms succeeded in obtaining SBIR, STTR, and other federal awards in 2003. Overall, more than $6.3 million came to respondents, which translates to $11.7 million for all recipients of state R&D assistance in Maine.

Table 2.12: Federal awards

Federal award	Number of awards	Total $ of awards
Advanced Technology Program	0	$0
SBIR Phase I	13	$1,467326
SBIR Phase II	4	$2,365,651
STTR	1	$500,000
Other *	9	$1,985,959
Total	27	$6,318,936

** Other: NOAA Saltonstall Kennedy Awards (4), EPSCOR (1), Office of Naval Research (2), USDA-CREES (2)*

A key question is how R&D investment programs and federal awards translate into new products, patents and licenses, and other intellectual and tangible property. The total product and service count based on R&D assistance is shown in table 2.13. Seventy-eight companies reported bringing one-to-ten new products and services to market and seven reported more than 50. In total, 91 companies reported some activity; the 85 remaining respondents indicated they expected to get to market within two years.

Table 2.13: Total product and services count based on R&D assistance

Number of products and services	Number of companies reporting	Percent
0	85	48.3
1-10	78	44.0
11-20	4	2.3
21-30	1	0.6
31-40	1	0.6
41-50	0	0
> 50	7	4.2
Total	176	100.0

Table 2.14 addresses the generation of new products by recipient firms, using in-house production, a joint venture, and exclusive and non-exclusive licenses. We see that of the companies that have brought products to market, the mode was to produce them in-house, followed by joint ventures, exclusive, and then non-exclusive licenses.

Table 2.14: Mechanisms by which new products are brought to market

Number of products	In-house production	Joint venture	Licensing, exclusive	Licensing, non-exclusive
0	22	66	76	77
1	31	12	5	4
2	7	2	1	0
3	5	2	0	0
4	2	0	0	0
>5	13	0	0	1

Table 2.15 provides two separate, but related insights. The middle panel indicates the propensity of firms that bring new goods to market to buy inputs from within the state of Maine. Thirty of the 82 respondents to this question (37 percent) purchased at least half their raw and intermediate inputs within Maine, and 40 of the 82 purchased their services in Maine (49 percent). That is important because the higher the level of locally produced inputs, the larger the spending multiplier will be. The right-most panel shows the extent to which products and services brought to market have resulted in revenue for the company. To date, that effect has not been significant.

Table 2.15: Inputs from Maine

	Type of inputs		
Percent of inputs from Maine	Raw materials, intermediate goods	Services	Revenue share from these P & S
0 percent	28	21	139
1-10 percent	7	11	11
11-20 percent	6	2	3
21-30 percent	4	4	3
31-40 percent	3	0	1
41-50 percent	4	6	3
51-60 percent	3	1	2
61-70 percent	1	4	2
71-80 percent	7	7	1
81-90 percent	6	4	1
91-100 percent	13	22	9
Total	82	82	176

Sixty respondents (34 percent) filed or planned to file for U.S. patent protection and 50 (28 percent) filed or plan to file for foreign patent protection. Eighteen companies were granted a U.S. patent. In terms of patents (allowing multiple per company), 337 either were filed, or will be filed, in the U.S. and abroad. That is shown in table 2.16. Table 2.17 explains reasons for those not filing or planning to file.

Table 2.16: U.S. and foreign patents, filed, intended, and granted

U.S. patent protection	Number of companies	Percent
Have filed	35	19.9
Intend to file	25	14.2
Granted	18	10.2

U.S. patent protection	Number of patents
Filed	129
Intend to file	88
Granted	57

Foreign patent protection	Number of companies	Percent
Have filed	22	12.5
Intend to file	28	15.9
Granted	0	0
No answer	29	16.5

Foreign patent protection	Number of patents
Filed	57
Intend to file	63
Granted	14

Table 2.17: Reasons for not filing for patent protection

Reason	Percent
Not appropriate	31
Don’t see need	24
Don’t know how	2
Too expensive	16
Other	27

Table 2.18 shows licensing activity. Sixty-one companies (34.7 percent) licensed technologies resulting from their interaction with service providers. Fifty-six of the 62 for which we have data were all or part in Maine.

Table 2.18: Licensing activity

Have you or will you license?	Number of companies	Percent
No	114	64.8
Yes, exclusive	5	2.8
Yes, non-exclusive	14	8.0
Yes — don’t know type	42	23.9

Table 2.18 continued

Location of licensees	Number of companies
All in Maine	6
Some in Maine	25
None in Maine	31

Other intellectual property among survey respondents include the use or intended use of trade secrets by 79 (44.9 percent) of companies, copyrights by 25 companies (14.2 percent), intended copyrights by 30 companies (17 percent), and trademarks filed, registered, or intended to be filed by 75 companies, as shown in table 2.19.

Table 2.19: Trademark activity

	Number of companies	Percent
No trademark	100	56.8
Yes, filed, not registered	10	5.7
Yes, registered	30	17.0
Yes, intend to file within 12 months	35	19.9

The last several tables of this section focus on the role of stakeholder organizations. Table 2.20 shows the extent to which recipient companies used and valued support organizations in 2003.

Table 2.20: The importance of support organizations

	Didn't use	Degree of importance 1= least critical, 5= most critical					Mean score
Support organization:		**1**	**2**	**3**	**4**	**5**	
MTI	47	7	21	15	38	48	4.09
ATDC	130	6	11	9	7	13	3.37
Other firms outside Maine	65	8	36	24	22	21	3.23
Maine Patent	113	10	16	8	15	14	3.17
Other ME firms	81	10	29	19	19	18	3.15
U. Maine system	70	14	31	16	18	21	3.08
Educational/research outside Maine	97	7	31	15	12	14	3.03
Trade assoc outside Maine	90	8	31	16	21	10	2.95
SBDC	110	7	26	9	14	10	2.95
Market Dev Center	127	10	15	10	9	5	2.57
Non-profit research institutes	112	11	25	13	11	4	2.45
MEP	97	16	31	9	13	10	2.45
ME Trade Ass	72	21	39	21	18	5	2.34
Other educational institutions	118	12	24	9	10	3	2.29

Table 2.21 shows the areas in which respondent companies received assistance.

Table 2.21: Frequencies of assistance, by activity

	Number of companies	Percent
Prototype	94	53.4
Market research	85	48.3
Business planning	77	43.8
Product design	70	39.4
Alpha test	60	34.1
Concept	58	33.0
Production for market	48	27.3
Intellectual property	46	26.1
Seeking external financing	45	25.6
Beta	41	23.3
Manufacturing design	38	21.6

Tables 2.22 and 2.23 show how important this assistance was judged to be by respondents. The mean rating in table 2.22 is 3.41, and in table 3.23, it is 4.09. Over 62 percent indicated assistance activities were critically or very important and 74.4 percent indicated they were satisfied or very satisfied with assistance activities.

Table 2.22: Importance of assistance activities

How important?	Number of companies	Percent
Critically important (5)	52	29.5
Very important (4)	58	33.0
Frequently important (3)	11	6.3
Occasionally important (2)	20	11.4
Not important (1)	35	19.9

Table 2.23: Satisfaction with assistance activities

How satisfied?	Number of companies	Percent
Very satisfied (5)	85	48.3
Satisfied (4)	46	26.1
Somewhat satisfied (3)	30	17.0
Unsatisfied (2)	8	4.5
Very Unsatisfied (1)	5	2.8

Findings from institutions' survey

This section provides highlights from the 2003 survey of the 11 institutions indicated in table 2.24. The data from the institutions' survey are included in appendix 3.

Table 2.24: Institutions surveyed in 2003

Name (acronym or short name)
University of Maine at Orono (UM)
Jackson Laboratories (Jackson Labs)
University of Southern Maine (USM)
Maine Maritime Academy (MMA)
Maine Medical Center Research Institute (MMCRI)
Mount Desert Island Biological Laboratory (MDIBL)
Foundation for Blood Research (FBR)
University of New England Osteopathic Medicine (UNE)
Wells National Estuarine Research Reserve at Laudholm Farm (Wells)
University of Maine at Machias (UMM)
Bigelow Laboratory for Ocean Sciences (Bigelow)

Only the first five of these responded for last year's (2002) report.

The survey of institutions essentially asks about R&D inputs and outputs. The former (inputs) includes additions to research space and equipment, new faculty and post-docs who then are available to conduct research and train scientists and engineers, and the preparation of research grants. The latter (outputs) include spin-offs, licenses, and patents, the development of new degree programs and graduates, the production of peer-reviewed articles, and the receipt of research awards from the government and industry.

Inputs

Nearly 35,000 square feet of R&D space attributable to state R&D funding came on line this year, but that is less than in FY 2002. Over $2.5 million in new R&D equipment was purchased this year from state R&D funding. That represents almost 87 percent of new R&D equipment reported. It is an increase of 9 percent in R&D equipment over last year.

The number of faculty has stayed relatively stable while the number of post-docs has jumped 58 percent in total. About one-in-three post-docs were funded by state R&D funding in FY2003.

The number of research proposals increased 17 percent with the dollar value increasing 32 percent. Seventy-eight percent of the proposals were enabled by state R&D funding. The number of proposals that were submitted jointly with other Maine institutions grew 12 percent, with the value jumping 403 percent. Similarly, the proposals submitted jointly with both Maine and non-Maine institutions grew 46 percent with the value up $173 percent.

Outputs

Most of the intellectual property activity in 2003 (as in prior years) was concentrated at the University of Maine at Orono (UM) and Jackson Labs. Between those two institutions there were 38 disclosures in 2003, compared to 16 in 2002. There were six spin-offs from UM, with 16 employees; last year there were none. UM also reported application for 18 patents, up from 12 in 2002. Seven patents were awarded. Institutions other than UM and Jackson Labs reported little or no disclosures, patent applications, or other intellectual property activity.

The number of degree programs appears to have risen in the last year in the universities in table 2.24, but enrollment in S&T has declined. That is true both for total and attributable activity.

The number of peer-reviewed articles published increased 26 percent over FY2002; approximately 80 percent of that is attributable to state R&D funding. The number of book chapters jumped over four hundred percent with 96 percent attributed to state R&D funding. The number of books was down 33 percent while the number of other papers published increased 92 percent and the number of other research reports also increased by 167 percent.

Research awards were down 22 percent with a loss of 13 percent in value. However, the number of EPSCoR grants increased from five to seven with an increase in value from $2.8 million to $16.2 million. Similarly, earmarked awards doubled, from 5 to 10, with dollar value rising from $3.8 million in FY 2002 to $5.9 million in FY2003.

Industrial awards increased sharply from only 34 in FY2002 to 245 in FY2003. However, these awards are relatively small, totaling only $410,000 in FY2002 and $6.0 million in FY2003. Of the 244 awards, only 19 were from Maine companies for a total of only $75,188.

The Innovation Index (indicator data)

The story that emerges from the survey results and case studies is not quite the same as from the indicator data. The survey and case studies include very recent data that are provided by individuals who may not be completely objective. The indicator data are more aggregated and often are several years old. They may not fully account for recent developments. In this section, we summarize the material in appendix 2 in terms of Maine's population and labor force (including composition); receipt of venture capital, federal awards, and grants and contracts; amount of R&D performed and patents; and output and income trends.

All figures and tables compare Maine to the U.S. as a whole, New England, the other EPSCoR states, and a subset of EPSCoR states that entered that program along with Maine in 1980.

Population and labor force

After a period of relatively slow growth in the 1990s, Maine's population growth relative to the U.S. has kept pace with New England and the other EPSCoR states, and has outstripped its cohort states. This reflects in-migration to the southern part of Maine (not shown in the appendix) more than natural growth.

Maine's labor force also showed healthy gains, indicated by the fastest growing employment rate among all areas (labor force divided by population). The employment rate is on par with New England and above the other groups.' The most likely explanation is that Maine has relatively more population in the working age years compared to other regions.

Maine has the smallest percentage of its labor force in high tech businesses and in science and technology occupations, compared to the other areas. Maine also is graduating the smallest percentage of S&T degree recipients into its labor force. Perhaps because of the small base in high tech, Maine's rate of new high tech businesses is higher than the other groups.

Venture capital, federal awards, and grants and contracts

While all areas showed a spike in venture capital availability in the late 1990s and early 2000s, all areas have now returned to their mid-1990s levels. Maine and the other EPSCoR states appear to have very little venture capital flow today. The cohort states are showing improvement in this indicator.

Maine's performance in receipt of federal obligations, including SBIR and STTR awards has been positive. In both cases, Maine's numbers are tracking up, above the EPSCoR and cohort states, but still below New England the U.S. Most of the bump up in federal obligations is in the industrial and not-for-profit sectors, with much of the funds coming from the Departments of Defense and Health and Human Services. That is not surprising given the prominence in Maine of the Bath Iron Works and Jackson Laboratories.

R&D performed and patents

In total and industry R&D performed as a percent of gross state product, Maine spiked above 1 percent in the mid-1990s, then dipped. The figure has returned to approximately 1 percent, slightly below EPSCoR and cohort states. Performance is particularly problematic in the university and college sector, where Maine is the lowest of all groups. Its college-university R&D is half the rate of New England's. There is growth in this indicator, but not faster than the benchmark regions. Most promising, however, is a large concentration of R&D in environmental and social sciences R&D, compared to other regions. R&D by the not-for-profit sector also is good.

To the extent that patents are a consequence of a sizable innovative workforce, availability of seed financing, and R&D, it is not surprising to see that Maine's patent activity continues to be disappointing. It is lower than EPSCoR and losing ground against its cohort states.

Output and income

Given all the other trends, it is not surprising to see that output growth (output per capita over time) has lagged. Maine has fallen further behind the U.S. and New England, has just stayed even with other EPSCoR states, and managed to stay slightly ahead of its cohort states over the past two decades.

Similarly, since 1980 Maine has not managed to close the gap in personal income per capita with the U.S. and New England. Nor has Maine pulled ahead of the other EPSCoR states, though it has outperformed its cohort states.

Future prospects

If growth rates in such indicators as production of science and engineering graduates, R&D spending and new equipment, patents, and venture capital are predictors of future output and income performance, Maine could be eclipsed by its cohort states. In those categories, Maine has lagged behind them.

Case studies

We want to know whether and to what degree this year's case study programs — the Maine Agricultural and Forestry Experiment Station (MAFES) and three tax credits administered by the Maine Revenue Service — contribute to greater competitiveness in sponsored R&D in Maine (question 1), a more competitive R&D industry in Maine (question 3), and a higher level of innovation and innovation-based economic development (question 2). Ideally, we also would like to know whether the costs of these programs to the citizens of Maine could be justified by their benefits.

MAFES received $8,140,796 in state funds in FY 2002. That allocation was matched almost two-to-one by non-state sources (52.7 percent of the budget from Maine, 47.3 percent from outside Maine). Those funds were used for research projects in agriculture, food safety and quality, soil and water quality, pest management, and forestry and wood products. Approximately 100 faculty members are hired with those funds, to provide technical assistance and to conduct research on critical problems of crop yield and robustness, and new crop development. A key application is Maine's potato industry, whose direct and indirect effects include nearly $540 million in annual sales, over 6,100 jobs, and more than $262 million in state and local taxes each year.

While $8.1 million is a large sum of money, it must be viewed within the context of the considerable value represented not just by the potato sector, but also by other agriculture- and forest-related crops in Maine.

The case study illustrates that Maine's investment in MAFES has resulted in more sponsored research. As noted above, MAFES successfully competed for $4.6 million in external grants and contracts in FY 2002. In 2002–03, the potato breeding program, for example, brought in $159,000 in funding, and from 1999 to 2003, the potato ecosystem project brought in almost $3 million in external funds.

The receipt of funding from outside Maine is important because of its multiplier effect. The $4.6 million in external funds would not otherwise have been in circulation in Maine. Those dollars set in motion other purchases and created employment and tax revenues that otherwise would not have been in the state. If that multiplier were just 1.8 (modest by industry standards), the state would have recouped its investment in MAFES.

Presumably, however, the budget of MAFES went to uses that created value in terms of greater competitiveness in the agriculture and forestry sector. That also results in jobs and income. While we make no claim of a cause-and-effect relationship, we observe that during the time MAFES has been funded, potato acreage in Maine has stabilized, new markets for potatoes have been established, and more tolerant and faster growing varieties of potatoes have been developed.

The tax credit case covers three different programs overseen by the Maine Revenue Service (MRS):

- Research Expense Tax Credit
- Super R&D Tax Credit
- High Technology Investment Tax Credits

Tax credits are different from direct grants (as provided to MAFES, for example) in design and effect. The cost to the state is a loss of revenue in foregone taxes, not a direct outlay. The tax credits are targeted to businesses and individuals who increase their levels of R&D activity, but that targeting is imperfect. Taxpayers who behave as desired only receive the benefit if they apply for it. Moreover, of taxpayers who apply, only those with tax liability can actually benefit from the credit in a given year.

The fact that the credits are not refundable or marketable, and cannot be expensed, makes them less valuable to small and new businesses. However, that bias is counteracted by a provision that allows the credits to be used by taxpayers against their individual income tax liability. Indeed, many more credits are given to individual versus corporate taxpayers.

The loss of revenue due to the programs is not large — just under $3 million in 2002. The size of the tax expenditure and the number of beneficiaries are in line with national experience. Economists generally conclude that programs of this size, in Maine and elsewhere, are not likely to have a major effect on behavior. Anecdotal evidence suggests that there may be a marginal effect, at best, inducing some additional R&D, and consequently, helping to bring additional products to market in Maine. Local economic developers find such programs to be important symbolically, giving them a tangible (if small) benefit to wave in front of prospects.

CHAPTER 3

Discussion of Findings

In this chapter we apply the survey results, case studies, and indicator data, summarized in the preceding chapter, to the three questions developed for the *Initial Evaluation,* and explain how our answers may have changed since last year as a consequence of another year's data. Our discussion is organized by the three questions.

Providing answers to the questions with the data we have collected is a bit like telling fortunes from tea leaves. Each bit of information is valid, but there is still a considerable amount of missing data, and professional judgment is needed.

Answers to the three questions

1. How competitive is Maine's sponsored R&D and has it improved over time?

For the purposes of this study, we define competitiveness in terms of the character and quantity of state support of R&D relative to other states and in terms of the effectiveness of the state's programs as measured by the outputs and outcomes arising from state initiatives.

We noted in the 2001 *Initial Evaluation* the distinctive character of Maine's R&D enterprise. Nationally, industry performs the largest portion of a state's total R&D, and universities and federal government laboratories usually perform the largest portion of publicly funded R&D. Maine's situation is quite different. In Maine, the not-for-profit sector is much more prominent than in the nation as a whole. Therefore, care is in order when using aggregate measure of R&D performance to assess Maine's competitive performance and position.

This point is driven home again in this year's data: overall, Maine lags behind its benchmarks in the level of R&D funding, but it is a leader in the not-for-profit sector. Maine also shows relative R&D strength in the areas of environmental and social sciences.

The evidence also is mixed in terms of external funding (grants and contracts from the federal government). The state has not fared well relative to its competitors in competitive awards (down 13 percent from 2002), except from DoD, most likely for work at the Bath Iron Works. Businesses have done well in set-asides and earmarked funds. EPSCoR funds were up dramatically in 2003 (to $22.1 million from $6.6 million in 2002). And, businesses receiving state R&D assistance qualified for approximately $11 million in SBIR phase I and II and STTR awards (but virtually nothing from the Advanced Technology Program).[11]

The increased reliance on earmarks and set-asides is a matter of concern, in part because those funds are under scrutiny in Washington and are likely to be cut back. For example, in the federal budget released in the spring of 2004, the proposed budget for the Cooperative State Research Education and Extension Service (CREES) was reduced by 10 percent.

As noted in 2001, Maine started from a lagging position, and continues to lag behind comparable states. Maine has been improving its absolute position and relative standing on several, but not all indicators, a trend that is now several years old. While the state's current level of investment is large by historical standards, it is still not as substantial as in some other states. As a result, it is difficult for Maine to progress far in relative terms; it is shooting at a moving target.

We observed that Maine increased its number of science and engineering degree programs in 2003, but enrolled fewer students in them. Other states — especially Maine's EPSCoR cohort — have invested even more heavily in science and engineering, and have been producing more graduates. Other states also have invested more in R&D, including the construction of more research space and purchase of more equipment. Not surprisingly, then, they have outpaced Maine in the generation of intellectual property. It is also not surprising, then, that gross indicators, like per capita personal income and output, have not improved relative to other places.

Last year we observed it was likely that published (secondary) data did not yet reflect the positive impacts of the state's most recent initiatives. We make the same observation this year. The very current survey and interview results paint a more dynamic picture of the Maine economy than do the indicator data. For example, the University of Maine just added 35,000 square feet and $2.5 million in R&D space and equipment — largely due to state R&D support. UM also increased its number of post-docs by 58 percent (one-third of whom paid for with state R&D support dollars), and individual programs — like MAFES — have added faculty and generated external funds.

2. What is the impact of Maine's R&D investment on the development of Maine's R&D industry?

Maine's R&D investments are intended to increase the level of research being done by the state's businesses and within its research institutions. That has happened in absolute dollars, more so than in the relative sense.

We noted above some very recent additions to the research capacity of the University of Maine. Consequently, in 2003 the number of research proposals submitted jumped 13 per-

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[11] In 2002, total of SBIR and STTR Phase I and II awards in Maine according to SBA was 19 for $2.7 mil. Compare this to 18 reported by surveyed companies for $4.3 mil. The companies may be reporting on a calendar year, not the government fiscal year, but it is still likely that most of the SBIR/STTR winners are clients of the R&D programs. The direction of this relationship is not clear. However, Maine received far fewer SBIRs and STTRs (Only five in 1997 and eight in 1998) before the MTI SBIR program began in 1999.

cent, with a rise in value from 2002 of 32 percent. At the same time, competitive research awards fell 13 percent in 2002. That is troubling in the short-run, but may improve over time as researchers gain experience in writing proposals. In that sense, a good predictor of future success is today's level of activity.[12] The anemic results on research awards received may also reflect the type of expertise resident in the Maine research community. The large pots of research dollars today are at NIH, National Cancer Institute, Defense, and Homeland Security. The universities are not strong in those areas; the absence of a research-oriented medial school is a handicap in Maine. The bright spots are Jackson Labs and the MMCRI, which each receives NIH and NSF funding for biotech and medial-related projects, and BIW, which receives DoD funds.

Gathering strength in some parts of the university research enterprise is suggested by the jump in peer-reviewed articles (up 26 percent over 2002) and other scholarly output. Eighty percent of that increase is attributed to state R&D investments. There was also an increase in disclosures by university researchers, from 16 in 2002 to 38 in 2003, and in spin-offs, from zero in 2002 to six in 2003. This still has not translated into much of an increase in research institution-based IP production, largely reflecting culture (in the case of Jackson Labs), resource constraints, and a rudimentary technology transfer apparatus in place. The weak performance in IP generation also might indicate that the type of research being conducted at the institutions does not lend itself to patenting, because it is either too basic or not sufficiently innovative to patent. Alternatively, research that is too applied, such as extension work with companies, typically is not patentable.

Maine does not have a large private sector R&D presence. Most recipients of state R&D money in the business community — including grants and tax incentives — are producers of goods and services, not R&D operations. (Compare that, for example, to the businesses on Route 128 or in the Research Triangle Park, which are the R&D operations of their companies.) A positive finding is that many of the grant recipients are young firms: 40 percent are three years old or younger and 70 percent are less than 10 years old. Young firms tend to be more dynamic, and can use the state's assistance to enhance their growth prospects.

Because of the prominence of the private sector in the state's R&D, links between industry and the university are particularly important in Maine. Sixty percent of businesses that received state assistance interacted with the university in 2003. That interaction was judged by respondents to be important to success, but less critical than assistance from MTI and ATDC. (The mean assessment of importance was 3.0 on a 5-point scale for the University of Maine, and 3.79 for MTI and 3.26 for ATDC).

In some places, there are good linkages with industry. MAFES demonstrated a good feedback loop with end-users of research. However, the difficulty of balancing academic rigor (and subsequently more basic research) with responsiveness to industry (and subsequent desire for more rapid answers to immediate questions) is evident.

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[12] This is the logic of the EPSCoR program: to set-aside funds for states whose researchers are still learning how to be competitive in the scholarly community.

3. What is the impact of Maine's R&D investment on the level of innovation and innovation-based economic development?

The survey of business recipients of state R&D assistance would lead us to conclude that Maine's level of innovation and innovation-based economic development is quite promising, if not robust. Thirty-four percent of respondents filed or planned to file for a U.S. patent, and 10.2 percent were granted a U.S. patent. Inflating the sample results to the population yields a 2003 patent count of 105. The numbers are even larger if we take foreign patent applications and awards. (We do not include foreign patent applications here because there is likely to be considerable double counting.)

The activity in IP production extends to licensing: 35 percent of respondents (61 companies) licensed technology last year (113 businesses when inflated to full population of recipients). Nearly 25 percent of respondents filed copyright or trademark protection.

The R&D investments seem to be reaching the kinds of companies they are supposed to reach: newer and dynamic businesses who can use the investments to enhance their growth. Forty-four percent of recipient businesses used the investments to bring one-to-ten new products to market. Just over 4 percent of recipients brought more than 50 products to market.

Even though the recipient companies represent a fraction of Maine's industrial base, they appear to have a disproportionate impact on the state's economic development. Almost all are headquartered in Maine, and most earn a large proportion of their revenue from outside the state. Forty-nine percent have revenue in New England, outside of Maine; 51 percent have revenue in the U.S., outside of New England; and 25 percent have revenue from customers outside the U.S. These revenues pay for salaries and benefits for workers in the state and profit distributions to Maine-based owners. The average wage paid in these companies was $31,369, approximately 12 percent higher than the Maine average wage in 2003. In addition to wages and profits paid within the state, recipient businesses help economic development in Maine by buying most of their inputs from suppliers in Maine. Thirty-seven percent of respondents purchased at least half of their raw and intermediate inputs within Maine, and 49 percent purchased their services in Maine.

Recipient firms accounts for most, if not all, of the private sector IP production in Maine. In 2003, there were 230 patents awarded where at least one inventor resided in Maine. Of those, 171 were assigned to companies outside the state. Fifty-two are claimed by recipient companies and seven by the research institutions. This means of the patents that stayed in state, 59/59 or 100 percent are from the state-supported R&D realm.

Indicators show eight venture capital deals within Maine in 2003, totaling $26.8 million.[13] We know that some Maine investments are from overseas (based on previous case studies). Compare this to six deals for $34.6 million reported in the survey. It seems reasonable to conclude that most of the venture capital deals in Maine are being done by recipient firms.

Only 5.2 percent of surveyed companies took advantage of the R&D tax credits discussed in the case study. That supports the finding that the tax credits are not being used by the small R&D companies, mainly because they do not have tax liability. Note the low total

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[13] This is from MoneyTree Price Waterhouse Coopers and is based on reports from U.S.-based investors.

amount of corporate tax paid (only 0.2 percent of revenue). Seven of eight companies that took the tax credits had revenue greater than $1 million and received more than 55 percent of their revenues from products and services and less than 5 percent of revenues from R&D.

Either as a result of the selection process, or as a consequence of the receipt of assistance, or because of the guidance provided the grant recipient by the pass-through (stakeholder) agency, the recipient businesses performed considerably better than the average Maine company in 2003. Their employment grew by 23.3 percent; and their revenues increased by 10.6 percent, both far faster than the state average.[14]

Companies got the most assistance in prototyping and market research, followed by business planning, and product design. That is logical given the early stage of the companies in this group. Over 65 percent of the respondents indicated that the assistance they received was critically important or very important to them. (The response was 2.6 percentage points higher for MTI and multiple stakeholder clients. It appears that more assistance leads to higher perceived importance. Nearly 78 of the respondents were satisfied or very satisfied with the assistance they received (again, somewhat higher for MTI and multiple stakeholder clients).

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[14] The full year of data for 2003 were not available at the time this report was drafted, but based on partial figures, overall employment dropped slightly in Maine between 2002–03.

APPENDIX 1

Methodology for 2003

The evaluation of public investments has benefits for all participants — legislators, stakeholders and recipients alike. Evaluations not only shed light on the outcomes of public investments for comparison with legislative intent, but they also can provide valuable data for program managers seeking to improve their delivery of services. Recipients get a clear indication of what outcomes are desired up front, and can decide whether a program is appropriate for their needs.

In a case like Maine's, where many programs are involved, the process itself, especially if it is highly participatory and collaborative, can build bridges between stakeholder organizations and among recipients. Since evaluation requires discussion of and agreement about clear outcomes, organizations that may previously have been working at cross-purposes have a tool for proceeding together.

This document outlines the highly collaborative process being used to build the evaluation system for the public investment in R&D in Maine. The process maintains the rigor necessary to make informed analyses of the relationship between inputs (Maine's R&D investment) and outcomes such as innovation-based economic development.

In this appendix we elaborate the nature of stakeholder involvement; discuss what it is we seek to measure, using language from legislation and insights from program and impact theory; explain how we proceed to measure outcomes — via global indicators, annual surveys, and case studies; and, summarize our approach to data analysis.

The nature of stakeholder involvement

The key to the success of the evaluation project is stakeholder involvement and commitment. We define stakeholders as all organizations that operate one of the programs included in the evaluation. With the stakeholders' partnership, the evaluation process can be relatively simple and provide important information for all involved. Without the stakeholders' support, the process can be laborious and perhaps, impossible.

The following steps have been followed to gain stakeholder commitment and partnership, and will continue throughout the project.

1. MSTF engaged all stakeholders in informational meetings and general discussions. MSTF invited all stakeholders to attend general meetings held in May 2001, November 2001 and January 2003. DECD assumed MSTF's role in 2003.
2. MSTF invited all stakeholders to participate in an advisory panel of key stakeholders and recipients to work with the evaluation team at a more detailed level. In 2003, the advisory panel met in April to refine the research capacity survey.
3. In 2001, the advisory group agreed that each stakeholder should be provided with an individual report of their impacts, as well as access to their individual data after each year's survey and analysis. The detail of these reports will depend in part upon the response rate. If, for instance, a program only has three of its recipients respond to the survey, it will be difficult to provide anything other than aggregate results without compromising the confidentiality of the individual company/researcher's data.
4. At the advisory committee meetings, it was agreed that annual meetings would be held with stakeholders after the results have been disseminated to discuss how to improve the process in the next year. Potential areas for improvement include the data management system, exact wording of the survey and the addition of new indicators. Three meetings have been held: November 2001 after the initial evaluation, January 2003 to discuss the 2002 interim report, and March 2004 to discuss the 2003 interim report.
5. MSTF, UNC and Maine Technology Institute (MTI) held a number of separate conversations to coordinate this evaluation with the evaluation required by MTI's statute. MTI hired Charles Colgan, University of Southern Maine, to conduct their evaluation. Jointly, UNC and USM created the survey for companies and individuals, including a set of questions for all companies and a set of questions only for MTI companies.

Evaluating Maine's R&D investments: what we include

LD 2243, enacted in 1999, directed MSTF to develop a plan for a comprehensive evaluation of state investments in research and development. In 2000, MSTF developed "A Comprehensive Guide to Evaluating Maine's Public Investments in Research and Development." In late 2000, MSTF held a nationwide competition to choose nationally recognized independent reviewers to conduct the initial evaluation and to develop a strategy to assess these investments in the future.

The "Comprehensive Guide" included the following definition of Maine's publicly funded enterprise:

> "Those activities, expenditures and facilities whose purpose is to discover new scientific knowledge that can be developed into commercially viable products or processes."[15]

This definition does not encompass all science and technology activities in the state, but it does include a broad range of R&D programs. The legislature stipulated that the investments fall into two categories: capital investment programs and research and development programs.

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[15] Maine Science and Technology Foundation, "A Comprehensive Guide to Evaluating Maine's Public Investments in Research and Development," 2000.

Capital investment programs involve funds used exclusively for equipment and capital improvements intended to support R&D activities. R&D programs include funds for a range of expenses including personnel costs and other operating expenses. As mentioned in the "Comprehensive Guide," educational programs and programs designed to increase productivity were not included, although they are related to the broader science and technology enterprise.[16]

Therefore, the three criteria for including a program in this evaluation are:

- The program's objectives should be to fund or support research and development in Maine, or the commercialization of research.
- The program should be publicly funded in the form of an appropriation or bond.
- The program should support the development of new science, technology, products or processes as opposed to the application of existing science, technology, products or processes.

Guidance from program and impact theory

While it has been widely accepted since at least World War II that R&D is important to economic development, various theories exist to demonstrate exactly how that is accomplished. Regardless of the model used, research and development appears to yield two types of outcomes. The end outcome, economic development, is often measured in terms of jobs, companies, and quality of life, while intermediate outcomes are those stops along the way that lead to these outcomes. For researchers, whether in educational or non-profit research institutions, these intermediate outcomes are publications, patents, graduate students etc. For companies, patents are also one important measurable intermediate step as is getting financing.

As new programs are added to the evaluation, a program and impact theory analysis such as the one included in the Initial Evaluation, Part III, Appendix 3, should be conducted to ensure that all relevant outcomes are being considered. No new programs were added in 2002 or 2003.

The evaluation team chose the following indicators to be used in this evaluation. While other indicators may also be of interest, such as new products and processes, national and state data on these indicators are not generally available for comparison purposes.

Intermediate outcomes for researchers:

- S&E graduate students
- Recent S&E PhDs and Masters in the workforce
- Federal R&D obligations by agency
- University-performed R&D expenditures
- Patents
- Patent citations
- Publications
- New sponsored research programs with Maine companies

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[16] We planned to include programs that provide graduate student stipends, since they are a vital component of the R&D environment. To date, however, such programs have not been funded in Maine.

Intermediate outcomes for companies:

- Patents
- Patent citations
- New capital raised including venture capital, SBIRs and other federal grants, mergers and acquisition, initial public offerings (IPOs)

End outcomes, by industry sector:

- Average annual earnings
- Employment
- Number of company births
- Number of establishments
- Revenue per employee
- Percent of revenue from outside of Maine

Monitoring the outcomes

Having decided upon the outcomes and indicators of interest, how should they be used to answer the three questions? We employ a three-level analysis: global indicators, recipients' survey, and case studies. This approach is richer than a recipient survey-based evaluation on its own which tends to understate the social benefits of these types of programs.[17] In this section, we summarize each approach. In the discussion of the surveys we address instrument design, the definition of recipients, sample frame, and attribution challenges.

Global indicators

At the global level, we collected statistics for the indicators listed above for the state of Maine from secondary sources. Then, we compared those statistics with the same indicators for the aggregate (average) of the other New England states, the EPSCoR states, and the nation. In addition, we included comparisons to the four EPSCoR states that started the program with Maine in 1980: Arkansas, Montana, South Carolina and West Virginia. To the maximum extent possible, we developed time series of data to allow analysis of trends as well as absolute values. Data including 1990 and 1995 have established a baseline of performance prior to Maine's increased investment.

In addition, we included in the comparison the statistics defined by "30 and 1000,"[18] specifically the R&D expenditures by employed worker and per capital income as defined by the State Planning Office.

Specific sources for each indicator are listed in appendix 3.

Survey of recipients

To answer the impact questions posed by MSTF and the legislature, the evaluation team conducts an annual survey of all final recipients of Maine's R&D investments. Final recipients

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[17] Feller, Irwin and Nelson, Jon P., "The microeconomics of manufacturing modernization programs," Research Policy, 1999, 28:807-818.

[18] State Planning Office, "30 and 1000," November 1999.

are companies, institutions or individuals who use the funding to perform R&D, or build or operate R&D facilities.[19] The data collected from the survey paint a clearer picture of the impacts of those investments. As discussed later, a comparison between the recipient's results and Maine as a whole provides a greater understanding of the marginal effect of Maine's R&D investments.

Many economic development evaluation projects have been challenged by the question of the appropriate unit of analysis. Some evaluators choose to assess the specific project that has been funded by taxpayer funds. One issue with that approach is that many recipients, especially companies, do not maintain records on a project basis. Research work, specifically, may support a particular product line, but it may also support all the company's products. Companies, especially smaller ones, often do not keep records at the product line level. Larger companies, which may have the sophisticated accounting systems to track results at the product line level, are often reluctant to reveal this information.

In the case of the evaluation of all Maine's publicly supported R&D, another challenge arises because many companies participate in more than one state R&D program. How will a recipient track the difference in impact between a Maine Technology Institute grant, for instance, and the assistance received from being a tenant in an Applied Technology Development Center incubator? And how can the effects of a new laboratory and an additional post-doc be separated?

Because the impact assessment requested by the legislature is for the overall R&D investment, and for the reasons outlined above, the appropriate unit of analysis for this evaluation is the company and the researcher, not the project.

Definition of a recipient

As discussed above, the evaluation team undertakes two types of surveys, one for companies and individuals and one for research institutions. For companies, the recipient is the corporate entity at the location where the funded work occurred. In some cases, individuals who have not yet formed companies are also recipients. For research institutions, the recipient is the parent organization of the individuals and/or laboratories that received the funding or matching funds. For each program, the mix of recipients is somewhat different.

Sample frame

Given the relatively small number of R&D investment recipients, and the lower cost associated with web-based vs. mail surveying, it is feasible for us to conduct a census. Therefore, we are not required to select a representative sample. However, not all recipients respond to surveys. If the characteristics of respondents are identical to non-respondents (in terms of their use of resources, for example), it is a straightforward matter to inflate the quantities of outcomes aggregated from respondents to the full population, and to apply to the full population without adjustment any averages or other ratio outcomes. Our analysis includes a com-

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[19] Most Maine R&D funds flow through intermediate recipients, usually stakeholders, who allocate the funds to companies and/or individuals. For instance, although R&D funds flow to MTI, they in turn grant funds to companies and individual researchers. Final recipients who are companies or individuals not at research institutions will be surveyed. Data for individual researchers at not-for-profit research and educational institutions will be collected by the institution and reported to the evaluation team.

parison of respondents and non-respondents, and the development of appropriate adjustments to ensure we are accurately measuring the impact of the population of recipients, not just that of respondents.

Once a recipient is added to the survey list, it is surveyed each year it is on the active list and for five years thereafter. For instance if a company is in an incubator for three years, it will be on the active list for three years, and the follow-up list for five years thereafter, for a total of eight years. This procedure is designed to capture the out-year impacts that accrue from R&D investments. Note that although some of the programs in the evaluation have completed their grant-making duties and/or or no longer operational, their recipients will be included until a total of five years has passed since receipt of the grant.

Attribution to specific programs, multiple attribution

In spring, 2002, MSTF asked all stakeholders to submit the list of their recipients that fit the definitions above. All stakeholders were asked to review their records for the past five years to identify recipients. The resulting list was the active list for 2002. MSTF then consolidated the lists. That involved identifying duplicates of companies submitted by different stakeholders. MSTF then attributed companies to their stakeholders and eliminated duplicates of researchers and companies submitted by different stakeholders. This process was repeated by DECD in summer, 2003, resulting in a master list of 351 companies and individuals.

Survey instruments

With input from the stakeholder advisory group, the evaluation team developed a survey instrument for both the research institutions and the companies. These surveys are included in appendix 5. The research institution survey was administered by email in October 2003. An email explanation and attached Adobe Acrobat (.pdf) file were sent to all 10 research institutions that received state R&D funds over the past five years.

The company survey was administered via the worldwide web in December 2003. Each company or individual was sent an email verifying that they were the appropriate recipient. Then, they were sent a link to the web survey and a password. A printed version of the web survey is included in appendix 5. Weekly reminders were sent by email asking recipients to complete the web survey. In January 2004, those who had not yet responded were called to request that they complete the survey.

Case studies

Multiple case studies are conducted each year to augment the global indicator and recipient impact analyses. The case studies are intended to illustrate the process of commercialization in Maine and help identify what is working and what needs improvement. Interviewees for the case studies are chosen to cover a broad range of circumstances in Maine. Case studies are defined as a pair consisting of a stakeholder/program and one or more recipients. The complete case study protocol is included in the *Initial Evaluation*, Part III: Appendix 6.

Table A1.1: Case study schedule

Initial Evaluation 2001	▪ Advanced Engineered Wood Composites ▪ Aquaculture Research and Development ▪ FAME and Small Enterprise Growth Fund ▪ Maine Biomedical Research Program ▪ Maine Technology Institute	Complete
2002	▪ Maine Aquaculture Innovation Center ▪ Center for Innovation in Biomedical Technology ▪ Maine Space Grant Consortium	Complete
2003	▪ MAFES ▪ Maine Revenue Service	Complete
2004	▪ Patent Program ▪ UMaine Orono non-EPSCoR	Planned
2005	▪ USM Biomedical ▪ Applied Tech Dev Centers ▪ Gulf of Maine Aquarium	Planned
2006	Update all	Planned

Our case studies do not conform to the strictest definition of case studies found in the social science methods literature.20 We interview a relatively small number of individuals and collect a modicum of background material in order to get a general picture. This part of the evaluation might better be referred to as case vignettes.

We plan to do case studies/vignettes with all the stakeholders. Table A1.1 shows progress toward that goal.

Data analysis

We compare the trajectories over time of the macro-level indicators for Maine with the average results of neighboring states, other EPSCoR states, and the nation. That requires us to adjust (normalize) the data by population or other appropriate base to account for scale differences. We are most interested in trends in the data over time. For example, is Maine's share of total federal R&D increasing or decreasing compared to the other EPSCoR states? To what extent do the results of the recipient researchers lead this trend? This helps answer the question: *How competitive is Maine's publicly funded R&D and has the state's competitiveness improved over time?*

Second, we use the case studies to demonstrate the trends at a micro-level, as well as to highlight any particular barriers to progress in Maine. Third, we consider separately the results from the research institutions survey. By comparing both the totals for the institutions in

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[20] See, for example, Robert Yin, *Case Study Research: Design and Methods*, 2nd ed. (Thousand Oaks, Calif.: Sage Publications, 1994).

each category and the amounts attributable to the state's R&D investment for 2003 and 2002, we are able to detect some trends. We also compare totals in each category with FY1996, the baseline. That is the year before state R&D funds were markedly increased.

The surveys of companies and individuals form the basis for our most extensive analysis. We use the survey responses to characterize the recipients of state R&D investments and to understand how those recipients use the services associated with the R&D investments. We also compare outcomes associated with the sum of the R&D investments to statewide and national outcome data. The findings from these analyses are presented in chapter 2 and discussed in chapter 3.

APPENDIX 2

Case Studies

Two case studies were conducted in 2003: the Maine Agriculture and Forest Experiment Station (MAFES) and the Maine Revenue Service's tax credit programs. The objectives of the case studies were to collect primary data on a subset of the programs and to gain a detailed understanding of the dynamics of innovation-based economic development in Maine.

These case studies, however, are limited in scope. They do not represent a program evaluation of the case in particular and have limited applicability to other programs. They are useful for the insights provided, but are not representative of Maine's R&D programs.

Case studies, when used in this way, should be interpreted as a collection of facts about a certain circumstance, and are not evaluations. A description of the methodology used is included in *Initial Evaluation*, Appendix 6, Case Study Protocol, 2001.

Maine Agricultural and Forest Experiment Station (MAFES)

The University of Maine is a land-grant university, designated to receive the benefits of the Morrill Act of 1862 for Maine. As such, the University of Maine is the home of the state's agricultural experiment station established by the Hatch Act of 1887. Experiment stations are funded by federal funds matched at least one to one by each state. The amount of the federal funds allocated to each state is based on a formula that takes into account the state's rural and farm populations as a percent of the total U.S. rural and farm populations. State funds generally account for more than 80 percent of experiment station funding, but in some states they exceed 95 percent of revenues.[21] As shown below, the Maine Experiment Station has almost four times as much state funding as federal formula funding.

Another component of what has become known as the land-grant university system of federally funded agricultural research and dissemination is the Cooperative Extension Service, created by the Smith-Lever Act of 1914. The Extension Service is charged with disseminating information that results from the experiment station's research. The Extension

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[21] Holt, Donald A., and Bullock, J. Bruce. 1999. "Are Research Alliances between Private Firms and Land Grant Universities Compatible with the Original Purpose?" AgBioForum 2 (1): 11-16.

Service is funded by a formula similar to what is described above for the experiment station., with a federal allocation and state match. In some states, local government contributions are also an important source of extension funding.

The Hatch Act was amended by the Agricultural Research, Extension, and Education Reform Act of 1998. That Act focused on several areas of reform. Among other provisions, it explicitly required that federally supported and conducted agricultural research be more fully integrated with extension and education functions to "better link research to technology transfer and information dissemination activities."

The United States Department of Agriculture, Cooperative State Research, Education, and Extension Service (CREES), administers and coordinates the land-grant extension and experiment station programs at the national level. Their mission is to advance knowledge for agriculture, the environment, human health and well being and communities.[22] For the most part, however, with the exception of national research initiatives funded directly by USDA, most research and extension priorities are set at the state level.

The private sector has also started to play a more significant role in the funding of agricultural research. Private sector funding for food and agricultural research now exceeds public sector spending, having increased from $2.9 billion in 1978 to almost $4.6 billion in 1998. During the same period, public sector expenditures have stayed constant at around $4.2 billion.[23] The state agricultural experiment stations conduct about $2.3 billion of the research, comprising the largest share of the public sector.

Over the last twenty years, the levels of federal funding (adjusted for inflation) for experiment stations allocated through the formula funds has declined and the amounts of competitive grant funding have increased.

There is an ongoing discussion about whether agricultural research should be funded with formula funds or competitive grants. This issue is based on concerns that geographically allocated funding may not result in the biotechnology breakthroughs deemed necessary to maintain historical rates of agricultural productivity growth.[24] However, proponents of formula funding worry that certain types of research would be abandoned under competitive funding, and that local institutions would lose their flexibility to meet critical goals. In addition, opponents of competitive funding express the concern that the resulting agricultural research funds would be highly concentrated geographically.[25]

For 119 years, the Maine Agricultural and Forest Experiment Station (MAFES) has been the center in Maine for research in agriculture; its reach now extends to forestry, aquaculture, and rural economic development. Maine has the largest experiment station in New England

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[22] www.reeusda.gov.

[23] USDA, Economic Research Service, "Agricultural Resources and Environmental Indicators: Agricultural Research and Development." No. AH722. February 2002. www.ers.usda.gov.

[24] Ibid.

[25] National Association of State Universities and Land Grant Colleges, Experiment Station Committee on Policy and Organization. 2001. "Formula Funding: Making the Case." www.escop.msstate.edu/infobook.htm.

in terms of total research funding from all sources. For the federal fiscal year October 1, 2001 to September 30, 2002, the research activities of the Station were funded as follows:[26]

Table A2.1: Revenue sources for MAFES

Source	Dollars	Percent
State funds	8,140,796	52.7
Federal formula funds	2,335,951	15.1
Federal grants and contracts	3,451,205	22.3
Industry funds	502,276	3.3
Other grants and contracts	1,155,933	6.7
Total	15,454,098	100.0

In addition, the Experiment Station performed $271,812 worth of public service activities in 2002, including soil testing, food and pesticide analyses and seed potato testing.

These funds support approximately 100 professors, most of whom are on split appointments at the University of Maine, Orono, spending approximately half of their time teaching in the College of Natural Sciences, Forestry and Agriculture and half doing research on MAFES projects. (Some other professors in the College teach as well as provide extension services. The Cooperative Extension Service for Maine is also at the University of Maine, but separate from the College.)

The research projects undertaken by MAFES cover five broad areas:

1. Agriculture
    a. Plant-based production systems such as potatoes, blueberries, fruit and vegetables
    b. Animal-based production systems such as beef, dairy, aquaculture
2. Food safety and quality
3. Human nutrition
4. Environment
    a. Soil and water quality
    b. Pest management
5. Forestry and wood products

These areas have been chosen, with the concurrence of the University of Maine System Board of Trustees, to reflect the economic composition of Maine. Maine's economy has historically been heavily dependent upon natural resources, including the agriculture, forestry and aquaculture, and marine industries. These traditional sectors face many challenges. To

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[26] MAFES 117th Annual Report, www.umaine.edu/mafes/elec_pubs/annualrepts/annrept117.pdf

sustain the forestry industry in Maine, for instance, requires improving the productivity of the current forest base. Acreage in potatoes was in decline for many years, although it has recently stabilized at between 63,000 and 66,000 acres; the number of dairy farms continues to drop. The aquaculture and marine industry is in transition. The ground fishery is under pressure; some aquaculture operations are expanding while others, notably salmon, are facing new threats to their viability. New techniques, such as integrated pest management and environmentally sustainable practices, are in high demand by farmers in Maine. All of these sectors provide many opportunities for research that will sustain these industries in Maine.

MAFES works with several groups to plan its research, involving key stakeholders in identifying research priorities. The MAFES Research Council, consisting of six senior faculty with Experiment Station appointments, provides oversight for reviewing projects and soliciting external peer reviews. The University of Maine Board of Agriculture, created by the Maine Legislature in 1998, provides advice to both the Experiment Station and Cooperative Extension. Most of the members of this organization are representatives of farm organizations and commodity groups. The Maine Agricultural Center was formed in 1999 to increase the level of cooperation between MAFES and Cooperative Extension. The Center also plays a role in collecting input from agricultural stakeholders. In addition, specific requests for proposals, such as those issued by the Maine Potato Board for research projects, are the result of input by growers and other members of the industry.

Several important new initiatives are underway or planned at MAFES. A tissue culture facility, formerly operated by Monsanto, has been offered to the University as a gift. That facility, which would be operated with state R&D funds, would enable more sophisticated plant breeding. MAFES is also expanding its faculty and research in genomics, an effort specifically enabled by the state's R&D investments, to increase the university's competitiveness in this rapidly growing field.

MAFES maintains several research facilities near or at the University of Maine at Orono. These include the J. Franklin Witter Teaching & Research Center (360 acres), Rogers Farm (225 acres), the greenhouses and gardens on campus, as well as several forests including the Dwight B. Demeritt Forest (1750 acres), and the Penobscot Experimental Forest (4200 acres). Other facilities include:

- Aroostook Farm, Presque Isle, 425 acres;
- Blueberry Hill, Jonesboro, 52 acres;
- Darling Marine Center, Walpole;
- Highmoor Farm, Monmouth, 325 acres;
- Holt Forest, Arrowsic, 300 acres.

Research performed for the Maine Potato Board and for the benefit of the Maine potato industry at MAFES is the focus of the remainder of this case. While not the largest research project at MAFES, this work is critical to sustaining the largest segment of the agricultural economy in Aroostook County.

Research and extension activities at Aroostook Farm, the University of Maine's potato research facility, Presque Isle, Maine

Aroostook Farm sits on 425 acres of land just south of Presque Isle, Maine. The office/laboratory building, the home of the farm superintendent, the barn and various sheds sit close together near the main road; a new potato storage facility is being constructed close by. The remainder of the land is devoted to growing potatoes as part of research on the development and testing of new potato varieties and the effects of various cultural practices.

The County Cooperative Extension office is at the Farm. Cooperative Extension publishes a newsletter and puts on the annual potato conference to help transfer the results of MAFES research to growers. The USDA Agricultural Research Service, New England Plant, Soil and Water Laboratory, is also located at the Farm.

The recipient: Maine Potato Board

The Maine Potato Board was established by the Maine Legislature in the early 1980s to replace the Maine Potato Commission, the Potato Dealers Association and the Potato Sales Association. The Board is partially funded by a mandatory five-cent tax on every hundredweight of potatoes that are sold in Maine. This tax yields an annual income of approximately $700,000, part of an annual budget of $1.0 million. The budget is spent on education, research and advocacy for the industry. The Maine Potato Board has a staff of four.

The Maine Potato Board represents the approximately 400 potato growers, thirty-five licensed dealers and five potato processors that make up the potato industry in the state of Maine. Approximately 90 percent of Maine's total potato production is in Aroostook County, the northernmost county in Maine. According to a recent study of the economic impact of the industry, these businesses generate nearly $300 million in annual sales, employ over 2,600 people and provide over $112 million in income to Maine residents. With indirect and induced effects taken into account, the total impact of the potato industry on Maine's economy is $540 million in sales, 6,100 jobs, over $230 million in personal income and over $32 million in state and local taxes.[27] The potato industry contributes 41 percent of Maine's Gross State Product in agriculture, forestry and fishing, but only 1.4 percent of total Gross State Product. Personal income from the potato industry represents less than 1 percent of Total Personal Income in Maine.[28]

The Maine potato industry has seen its market share decline over the past thirty years and is now a small player nationally. According to the USDA, Maine's share of U.S. potato production has declined from 8.4 percent in 1977 to 3.7 percent in 2002. In that same period, Maine potato production fell from 28 to 17 million hundredweight, a 40 percent decline.[29] According to the Maine Potato Board, the major reason for the decline is the large increase in production in Washington, Idaho, and Colorado resulting from new federally funded irriga-

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[27] Planning Decisions, Inc. 2003. A Study of the Maine Potato Industry Economic Impact. Presque Isle, ME: Maine Potato Board.

[28] Calculated from 2001 Total Personal Income and Gross State Product. www.bea.doc.gov/regional.

[29] USDA, National Agricultural Statistics Service, Table 102, www.nass.usda.gov:81/ipedb/, quoted in Planning Decisions, 2003.

tion projects. However, potato acreage in Maine appears to be stabilizing; it has been around 63,000 acres and 4 percent of U.S. production since the late 1990s.[30]

Another important change for Maine potato growers has been the distribution of the potatoes. Ten years ago, Maine allocated 43 percent of its potato sales to the fresh market and 46 percent to the processing market. At the same time, U.S. consumption of potatoes was stable for fresh potatoes, but growing for processed potatoes. By 2001, Maine sent 25 percent of its potatoes to the seed market, and 65 percent to the processing market. The remaining 10 percent were sold as fresh potatoes.[31]

This increasing reliance on the processing market has brought its share of challenges. First, processors demand a level of quality and consistency of product. Secondly, processors want product year-round, not just at harvest time. Maine's potato farmers, with the support of the Maine Department of Agriculture, have been investing in new potato storage facilities. These facilities enable growers to store their potatoes for delivery to buyers throughout the year. New technology in the facilities maintains the quality of stored potatoes for a longer period. The Maine Potato Board recently was granted a $644,000 grant from the Economic Development Administration, $100,000 from the Maine Technology Institute, $150,000 from the Department of Agriculture and matched these funds with $200,000 of their own to build a new Research Storage Facility at Aroostook Farm. This facility will enable researchers to better understand the impact of various storage regimes on different varieties of potatoes.

Annually, a research committee from the Maine Potato Board looks at its priorities and, in consultation with Maine researchers, puts together a request for proposal for research. Most of the research is done at MAFES, although some is done by USDA-ARS and Cornell University, but in Maine. The MAFES share was approximately $110,000 for 2002–03.

The research

On behalf of the Maine potato industry, the Maine Potato Board supports two main research initiatives at MAFES: the potato breeding program and the potato ecosystem project.

Potato Breeding: In 1969, the University of Maine hired its first potato breeder, Robert Akeley, to initiate a potato breeding program for Maine. He was replaced in 1975 by Alvin Reeves, who served until his death in 2001. Dr. Zenaida Ganga is the current plant breeder. Throughout the past twenty-four years, the goal has been to develop new potato varieties that are earlier maturing, higher yielding, better quality and more disease-resistant than existing commercial varieties.

Early funding for the program came from the Maine Department of Agriculture, MAFES and industry organizations. From 1972–1982, the program was funded entirely by the Maine Potato Board and its predecessor organizations. Starting in 1996, federal funds from CREES were obtained and the Maine Potato Board continued to participate. In 2002–03 cropping season, the funding comes from two federal sources and the Maine Potato Board:

▪ USDA Special Potato Grant	$125,702
▪ Maine Potato Board	23,750

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[30] Planning Decisions, op cit.

[31] Ibid.

- USDA-ARS (PMTV Project) 33,132.

The PMTV project is to research which varieties are most susceptible to or have relative tolerance to powdery scab and potato mop-top virus infection. The latter virus appeared at Aroostook Farm during the summer of 2002.

The plant breeding process is extensive and time consuming. First, prospective parent plants, chosen for specific characteristics, are cross pollinated. True seeds are harvested from the parent plants and planted in the greenhouse in June of the following year. Seedlings are grown throughout the summer and in the fall a single tuber is harvested from each pot. The tubers are planted in the field the second spring, each in its own "single-hill." Enough seed-tubers are harvested from each selected single-hill to plant a 12-hill plot the third year. These potatoes are harvested in the fall and subjected to several tests; only the selected clones continue onto the fifth year. In the fifth year, these chosen clones are grown in 60-hill seed plots and 20-hill observational production plots.

At this stage, seed tubers of selected clones are shared with out-of-state collaborators, which include North Carolina, New York, Pennsylvania, Virginia, New Jersey, and Florida. Each state conducts its own trial and results are discussed during the Northeast 1014 annual meeting in January. This collaboration enables the breeding program to select potential varieties that are widely adapted and acceptable in the northeast region, where most of the Maine potatoes, especially seeds are marketed. NE 1014 is also a multi-state program that conducts on-farm evaluation of promising potato selections from the different breeding programs in the region.

Approximately one-third or less of the total selections are advanced to year six, and tests of their quality, disease resistance and processing characteristics continue. The total number of selections is further reduced for testing in year seven and each selection is increase in seed plots of 200 and 800 hills. The most advanced selections are then testing in a semi-commercial scale production at the Aroostook Research Farm and other interested growers; and finally promising closes that survive this process will be sent to the Maine Seed Potato Board for cleaning-up and seed increase.

Despite this rigorous process, none of the fifteen officially released and named varieties of potatoes identified by the Maine Potato Breeding Program from 1975–1997 have had much commercial success. A few have been planted by growers but the adoption was short-lived. Recently, a joint university/Maine Potato Board group met to determine why. The group acknowledged that new varieties were tried by various growers, but were not broadly adopted. They also noted that since a large portion of Maine potatoes are grown under contract to processors, individual growers had no economic incentives to try new varieties.

Therefore, the University of Maine took a different tack in 2002 with a new processing clone numbered "AF175316" which was suitable for french fry production. The university applied for and was granted plant breeding rights for this clone. Plant breeding rights are similar to a patent, but granted by the USDA. Then, the clone was offered for licensure. McCain Foods Limited, a processor with a plant in Easton, Maine, was granted a license for seed demand with a royalty on seed sale. The university believes that McCain will contract with growers for this particular type of potato.

The current plant breeder, Dr. Ganga, considers what the growers have to say in deciding what varieties to develop. She attends meetings with growers such as the Maine Potato Board and Maine Potato Seed Board, as well as the potato breeders' demonstration day sponsored by the Maine Potato Growers Board and the Maine Potato Growers School put on annually by the University Cooperative Extension. In addition, the breeding program considers the needs and variety preferences of the major potato processing companies in Maine in the development and selection of new varieties. Details about promising clones and new varieties are presented at the Growers School, as well as through progress reports to the Maine Potato Board, fact sheets and press releases.

Maine Potato Ecosystem Project: Through extensive discussions between MAFES scientists and the Maine Potato Board in the late 1980s, a long-term project to test the principles of sustainable agriculture as applied to potato cropping systems was developed and begun in 1991. A second phase, started in 1998, continues to test the interactions among a variety of production techniques, potato varieties, and rotation crops over several years. Outcomes such as yield, profitability, pesticide use, and environmental impacts are measured and compared.

From 1991 to 1998, funding for the project came from a USDA Special Grant for Potato Research with additional funds provided by the University and the Maine Potato Board. Since 1999, the university and the Maine Potato Board have provided a total of between \$7,000 and \$10,000 a year. This funding allowed the team to change the experimental design (adding phase two), and provided some preliminary data. As a result of the preliminary data, the research team successfully participated in a new grant from USDA IFAFS for a total of \$2,000,402 for Maine, Michigan, and Iowa called "Re-integrating Crop and Livestock Enterprises." This was a competitive grant proposal that will provide \$212,892 for a three-year period to support the potato ecosystem project through the 2004 growing season.

External grant dollars awarded to MAFES faculty for other work associated with the potato ecosystem project for the last five years totals \$2,982,714, as shown below.[32]

▪ FY99	\$209,143
▪ FY00	540,254
▪ FY01	312,090
▪ FY02	1,207,786
▪ FY03	713,441.

In collaboration with the Maine Potato Board Research Subcommittee, MAFES scientists have determined that potato production practices that generate high yields and quality, but also minimize costs, are essential to the long-term sustainability of the potato industry in Maine. Phase two of this project relates to two of the research areas described by the Maine Potato Board in its 1997 visioning conference:

- Finding and developing profitable crop rotations for potatoes
- Soil management practices to increase yield and reduce plant stress, including disease and water stress.

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[32] University of Maine, NSFA office, personal communication.

The initial project was started to understand how to sustain the soil, whether by soil amendments or by different rotation crops and rotation periods, as well as how to manage pests since potatoes are second only to cotton in terms of pesticide inputs. The second phase has added two tasks: understanding the impact of crop rotation length on potato yields, quality, pests and soils and understanding the impact of the use of soybeans and forages as rotation crops as compared to traditional rotation crops such as barley. These new tasks are particularly important because the rotation crop also needs to generate cash and mesh well with the activities, equipment, and resources required by potato production.

By growing potatoes in 96 0.3-acre plots, with each plot receiving one of the possible combinations of rotation crops, rotation lengths, soil amendments, and pesticide use, MAFES scientists can assess the impact of these practices alone and in combination, and over time, through various environmental scenarios, such as drought, and disease.

Results from are published in annual reports to the Maine Potato Board Research Subcommittee, academic journals,[33] and Maine Experiment Station bulletins,[34] and the Maine Potato News, a newsletter published by the Maine Potato Board. In addition, results are presented to growers through the Extension Services' Potato School and included on the Maine Potato Board website. Tours of the fields involved in the project at Aroostook Farm are common.

Interviews

Donald Flannery, Executive Director, Maine Potato Board, August 4, 2003.

Eric Gallandt, Assistant Professor, University of Maine. August 11, 2003.

Timothy Hobbs, Director of Development/Grower Relations, Maine Potato Board, August 12, 2003.

Steven Reiling, Assistant Director, MAFES, University of Maine, August 11, 2003.

Randy Smith, Aroostook Farm Manager, University of Maine, August 12, 2003.

Mike Vayda, Assistant Director for Biotechnology, University of Maine, August 11, 2003.

Additional information provided by Drs. Greg A. Porter and Zenaida N. Ganga, University of Maine.

Maine Revenue Service and R&D Tax Credits

This case study covers the three research and development (R&D) tax credits overseen by the Maine Revenue Service (MRS):

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[33] Gallandt, E.R., Mallory, E.B., Alford, A.R., Drummond, F.A., Groden, E., Liebman, M., Marra, M.C., McBurnie, J.C., Porter, GA. 1998. Comparison of Alternative Pest and Soil Management Strategies for Maine Potato Production Systems. American Journal of Alternative Agriculture. 13(4):146-161. and Gallandt, ER. 1998. Effects of Pest and Soil Management Systems on Weed Dynamics in Potato. Weed Science. 46 (2): 238-248.

[34] See, for example, The Ecology, Economics, and Management of Potato Cropping Systems: A Report of the First Four Years of the Maine Potato Ecosystem Project. MAFES Bulletin 843. April 1996.

- Research Expense Tax Credit
- Super R&D Tax Credit
- High Technology Investment Tax Credit.[35]

It was conducted in Portland and Augusta on August 13–14, 2003. Information for the case study came from government documents and interviews with representatives from Maine Revenue Service and three companies who received tax credits.

The study is a description of the program, its salient features, its place within the state's R&D policy framework, and its relationship to R&D programs in a number of other states. It is not an evaluation of the program's effectiveness. Such a study extends beyond the scope of this project; more generally, the program is too new and relevant data too scanty to permit such an evaluation at this time.

The case study has three further sections. First, we describe the contours of the three R&D tax credits. We then note some important features of the program design. Third, we summarize the information obtained from our interviews. Fourth, we offer some observations about the Maine program in the context of other tax incentive programs around the U.S.

The tax credit programs

The Research Expense Tax Credit, enacted in the 1995 session of the Maine legislature, was designed to create high-wage jobs in telecommunications and increase the state's low rankings on R&D performance. Under this program, a taxpayer is allowed a credit against taxes due equal to: (1) 5 percent of the excess of any qualified research expense over the average of the past three years, and (2) 7.5 percent of "basic research expenses" as defined in the federal Tax Code. Those are payments made taxpayers for R&D under contract to universities and scientific research organizations, in excess of the previous three-year average. The credit is limited to 100 percent of a corporation's first $25,000 of tax due plus 75 percent of the tax due over $25,000. The credit may be carried forward for 15 years. The credit allowed may not reduce the tax due to less than zero.

The Super R&D and High Technology Investment Tax Credits were passed in the 1997 legislative session as another way to spur R&D in the state. Companies or individual taxpayers qualify for the credit if they increase their research expenditures in Maine by more than 50 percent above the previous three-year average. However, the Super R&D Tax Credits can only be used to offset up to 50 percent of tax liability, after other tax credits are taken, and they cannot reduce the tax liability below zero. Unused credits may be carried forward five years.

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[35] 36 MSRA c. 882 §5219-K, L, M.

Table A2.2:
Companies receiving more than $10,000 for the Maine Research Expense Tax Credit between 1999 and 2002

Company	City	State	Amount of credit received	Calendar year
Auto Europe	Delray Beach	FL	$14,043	1999
Cambrex Bio Science Rockland Inc.	East Rutherford	NJ	$35,101	2000
Champion International	Memphis	TN	$204,930	1999
Commnav Engineering Inc.	Portland	ME	$14,489	2001
Control Devices	Standish	ME	$193,632	2000
Control Devices	Standish	ME	$235,984	2002
Fairchild Semiconductor Corp.	So. Portland	ME	$88,425	2001
Forum Financial Group LLC	Portland	ME	$84,490	2001
Idexx Lab Inc.	Westbrook	ME	$469,266	2000
Idexx Lab Inc.	Westbrook	ME	$96,772	2001
Idexx Lab Inc.	Westbrook	ME	$309,471	2002
Intelligent Controls Inc.	Saco	ME	$11,163	2000
John Keefer & Mary Jo Walters	Cumberland	ME	$84,490	2002
Kady International	Cape Porpoise	ME	$17,700	2002
Loftware Inc	Cape Neddick	ME	$24,325	2000
Loftware Inc	Cape Neddick	ME	$14,085	2002
Mega Industries	Gorham	Me	$90,935	2001
Mega Industries	Gorham	Me	$63,727	2002
Pfizer Inc	New York	NY	$18,219	2001
Pfizer Inc	New York	NY	$11,226	2002
Province Automation	Sanford	ME	$10,762	1999

Source: Maine Department of Economic and Community Development, compiled from the Annual Economic Development Incentive Report

The High Technology Investment Tax Credit is limited to taxpayers involved in the design, creation and production of computer software, computer equipment, supporting communications components and the provision of Internet or advanced electronic communications access services or support. Those qualifying may take a tax credit equal to their investment in equipment (depreciated basis). The credit may not reduce the tax liability below zero, or to less than the taxes paid in the preceding year net of tax credits received. The credit also is limited to $100,000 per taxpayer in any year. Unused credits generated before 2001 can be carried forward 10 years; other credits can be carried forward five years.

Table A1.2 shows taxpayers who have received more than $10,000 from the Maine Research Expense Tax Credit between 1999 and 2002. There are only 15 different large beneficiaries of the legislation. Table A2.3 shows that the number and amount of tax credits claimed have varied substantially over the years. There appears to be a leveling-off of around 140 claims per year. Since some taxpayers claim more than one credit in a given year, the number of taxpayers participating is even less. The aggregate tax expenditure for these three programs is modest, amounting to about less than $3 million per year, a very small percentage of a $5.5 billion budget.

Table A2.3: Trends in R&D Tax Credits in Maine, 1996-2002 Tax Years

	Research Expense		**Super Credit for R&D**		**High Tech Investment**	
Year	# Claims	Total $	# Claims	Total $	# Claims	Total $
1996	10	$251,390	n/a	n/a	n/a	n/a
1997	15	$937,765	n/a	n/a	n/a	n/a
1998	10	$251,390	3	$57,339	n/a	n/a
1999	8	$808,947	2	$1,176	n/a	n/a
2000*	41	$441,116	22	$1,285,441	53	$2,297,892
2001*	59	$631,926	35	$1,085,747	50	$922,939
2002*	55	$302,662	34	$1,121,904	50	$1,395,906

Source: Maine Revenue Services.

Notes: 1996 was the first year of the Research Expense Tax Credit; 1998 was the first year of the Super Credit for R&D and High-Technology Investment tax Credit

* Tax year 2000 figures and later include individual claims; prior to 2000, individual credits were not separately recorded.

2000 and 2002 data for the super R&D credit represent a maximum; actual data were suppressed for confidentiality reasons.

Some features of Maine's R&D tax credits

Several key features of the Maine R&D program are important to note:

- These credits can be taken against the corporate income tax or by individual business owners on their personal income tax forms (based on income received from partnerships, sole proprietorships, or S-corporations).
- The credits are not refundable. Taxpayers without taxable income cannot benefit in the same tax year, but can carry their tax credits forward.

- The tax credits are paid in the year generated, up to the amount allowed, rather than in installments.
- The credits are "incremental," requiring an increase in R&D spending above some base period amount.
- These tax credits are not the same as "expensing," which allows a full write-off of expenses in the year the expenses were taken.
- The tax credits are not marketable, which would allow companies that generate the credits but are unable to use them to sell them to companies with tax liability.
- Maine State Statute (5 MRSA Sec 13070-J) requires that any business receiving one of several economic development incentives that exceeds $10,000 in one year to report data to the Department of Economic and Community Development annually. The Research Expense Tax Credit is considered an economic development incentive and so companies that use this tax credit have provided the information that is included in tables A2.2 and A2.3.[36]

These features have implications that are pertinent to this study. Many states now allow the credit to be taken against either corporation or personal taxes, recognizing that R&D investments are made by larger C-corporations, as well as by sole proprietors, partnerships, and S-corporations.[37] Moreover, companies seeking R&D funds can go to individual investors whose motivation for supplying funds is the tax write-off that would allow. The ability to use tax credits to offset personal income taxes is important for at least two reasons. First, a business entity may not generate income and pay taxes, but the individual owner(s) is (are) likely to owe personal income taxes. So the availability of credits is a real benefit to them on the personal side. Related to that, individual tax rates are generally higher than corporation tax rates, so the dollar value of the credits is higher.

Table A2.4 shows the split in number of claims and size of expenditures for credits taken on individual and corporation tax forms.

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[36] Individual and corporate tax returns are private. Thus, other than for firms that meet the $10,000 threshold, we cannot access the records of those who took the Super R&D or High Technology Investment tax credits.

[37] We were not able to find data on the distribution of R&D among different types of business ownership in Maine. It is generally true that in absolute dollar terms, most R&D is performed by large, multi-national corporations. But in terms of the number of claimants, the reverse is true: many small businesses do a little R&D.

Table A2.4: Credits taken, by type of taxpayer

		Tax year					
Type of credit:		2000		2001		2002	
		Returns	$	Returns	$	Returns	$
Research Expense Tax Credit	Individual Income Tax	28	$ 147,129	47	$ 149,167	44	$ 140,993
	Corporate Income Tax	13	$ 293,987	12	$ 482,759	11	$ 161,669
	Total	41	$ 441,116	59	$ 631,926	55	$ 302,662
Super R&D Tax Credit	Individual Income Tax	19	$ 1,185,141	32	$ 953,037	31	$ 921,904
	Corporate Income Tax	< 3	< $100,000	3	$ 132,710	< 3	< $200,000
	Total			35	$ 1,085,747		
High-Tech Tax Credit	Individual Income Tax	46	$ 917,702	44	$ 570,188	42	$ 1,132,421
	Corporate Income Tax	7	$ 1,380,190	6	$ 352,751	8	$ 263,485
	Total	53	$ 2,297,892	50	$ 922,939	50	$ 1,395,906

Source: Maine Revenue Services; Individual & Corporate Income Tax Returns

The number and ratio of individual-to-corporate returns grew over the 2000–02 period for the Research Expense Tax Credit and Super R&D Tax Credit, and stayed relatively stable for the High-Tech Tax Credit.

The second bullet above relates to our discussion in the preceding paragraph. Many new and small businesses do not show accounting profits for many years. Indeed, high tech companies often do not show profits because they are investing heavily in R&D to refine their product. Yet, because they do not pay taxes, the R&D tax credit against corporate tax liability is not an inducement to them to engage in more R&D. As previously noted, some get around that by taking the credits against their personal tax liability. But if they are organized as a C-corporation that is not possible, and the best they can do is carry their credits forward. Even if the company generates tax liability in the allotted time (up to 15 years in Maine), the credits have lost value since a dollar today is usually worth more than a dollar tomorrow.[38]

In the debate on this issue nationally, it is generally conceded that tax credits of the size used in Maine for new and small businesses are not likely to affect the viability of those businesses. At most, the generation of unclaimed credits adds to the capital value of the business, which affects its attractiveness as a take-over candidate, assuming the successor firm can cash in on the unused credits.[39]

The point about installments has political implications. Legislators are sensitive to the claim that after they reward companies up front, the companies close, move away, or decide

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[38] That is because of inflation and the time value of money. A dollar given to me today can be invested at rate r, so tomorrow it is worth $1 + r. Yet, the value of the credit tomorrow is still $1.

[39] Michael I. Luger, "North Carolina's Lee Act Incentives Assessed," State Tax Notes 30, 2, October 2003: 129–152.

not to do what they promised, and what triggered the tax credits. Installments provide protection from that, since the annual payment requires certification of continued presence in the state and of specified performance. On the other hand, installments make the tax credit program more complicated and drive up the administrative costs.

Another feature that drives up administrative costs for MRS and firms is the requirement to document that the R&D spending exceeds prior-years' levels. The intent of that is to incite additional R&D, above what otherwise would have occurred. But there is debate nationally whether that is valid: many firms otherwise would have increased their spending, and companies that reduce their spending still could respond to incentives by cutting them back less than they otherwise would. Organizations such as the Electronics Industries Alliance long have advocated against that provision.[40]

For a program as small as Maine's it is particularly important to minimize administrative costs; the smaller the tax expenditure, the less efficient the administration of the program is because there are few economies of scale. For that reason, expensing is a viable alternative. With expensing, businesses get an immediate benefit equal to some percent of their R&D investment. That percentage may or may not be related to their tax rate. Expensing also helps those small and start-up businesses that do not qualify for tax credits. Expensing is used in some federal tax programs, for example, the Jobs and Growth Tax Relief Reconciliation Act of 2003, but not for the federal R&D tax credit.

Another feature not allowed in Maine is for companies that generate credits, but are unable to use them, to be able to sell them to companies doing business in Maine that have tax liability to offset, whether or not the taxpayers purchasing the credits engage themselves in R&D. Pennsylvania amended its R&D tax credit in 2004 to allow this as a way to help cash-strapped technology businesses.[41]

The reporting requirement is important because the availability of data on recipients is critical for an assessment such as this one.

Interviews with recipients

Mega Industries, LLC

Mega Industries is a producer of microwave component parts for high power, low frequency applications. Located in Gorham, Mega has supplied equipment for radar systems, commercial microwave ovens, broadcast equipment, air traffic control systems, medical research, linear accelerators and fusion energy research. Their clients include Argonne National Laboratory and Jefferson Labs. Many of Mega's products are customized for the client's applications. They design products that are part of larger systems use in the R&D industry. Therefore, much "on-the-floor" R&D goes into Mega's products to ensure that they deliver the performance needed by the client.

The company, which is privately held, was incorporated in 1989. In 1991, they acquired the assets of Microwave Techniques and moved into their 70,000 square-foot facility. Mega

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[40] See, for example, http://www.eia.org/resources/2004-02-02.74.phtml.

[41] http://www.pittsburghchamber.com/public/cfm/ advocacy_chamber/index.cfm?FUSEACTION= AdvocacyArchive&NewsletterID=66

has annual revenues of approximately $3 million and 28 full-time employees. They spend about $100,000 per year in research and development. The company has utilized both the R&D Expense Tax Credit and the Super R&D Tax Credit.

Mega is very active with the Maine International Trade Center and reports having benefited greatly from their programs and assistance. In 2002, Mega was awarded the U.S. Department of Commerce's Export Achievement Certificate as recognition for entering new global markets.

Pete Anania, President of Mega, indicates that the tax credits helped them make the decision to develop a new product, a personal safety device that is used as part of larger microwave systems in the R&D industry. "The R&D tax credits definitely have gotten the company thinking more about R&D priorities. The company is now more willing to consider R&D intensive activities," according to Anania. The tax credits get the owners attention because they are taken on their individual income tax returns, and have a noticeable impact on after-tax income.

IDEXX Laboratories

IDEXX is a public biotechnology company founded in Maine in 1984 to develop tests for disease in poultry. At the time of the interview, IDEXX was a $450 million diagnostic company, expanding upon the original products for the veterinary and poultry markets. The firm currently has 900 employees in Westbrook; approximately 200 of them are scientists and engineers.

The company has expanded its operations to other states and overseas through acquisitions that extended its product lines. IDEXX now has operations in Maine, Tennessee, North Carolina, Wisconsin, Georgia, and California. In addition, they do manufacturing in Sweden, R&D in the Netherlands and both in the United Kingdom.

IDEXX has regularly taken advantage of the Research Expense Tax Credit, since they do a substantial amount of their R&D in Maine. However, Geoff Baur, Senior Tax Manager with the company, shared the following concerns about the Maine R&D tax credit.

First, the company is reluctant to base management decisions on the existence of a tax credit, because the Legislature may change their minds about it. They had a bad experience with the property tax credit in Maine. It was changed several times, making planning difficult for the firm. Management concerned about whether the R&D tax credits will remain in place.

On the other hand, Baur noted that other states where they operate, notably North Carolina and Wisconsin, also have R&D tax credits, and the "Maine R&D tax credit is better." This advantage is offset by other Maine taxes that are significantly higher than in other states, especially the 10 percent corporate tax rate.

IDEXX's investment decisions are made primarily on their contribution to the company's focus on growth. The R&D tax credit, while welcomed, is by itself too small in dollar impact to enter significantly into the firm's investment decisions. Put differently, the tax credit would have to offer larger dollar savings for it to become a key investment decision determinant. The size of the credit however does enter into decision about where the firm should locate its R&D activities.

Baur also noted the difficulty with predicting the size of a tax credit in order to factor this into a business decision. While Maine provides the benefit, the definition of R&D that applies is set by the Internal Revenue Service. Baur felt that there was a great deal of complexity in monitoring the IRS' somewhat arbitrary definition of what activities (and thus expenditures) qualify as R&D. Another complexity with the Maine credits is that they require an increase in R&D. It is hard to predict whether certain R&D will qualify as an increase.

IDEXX felt that the most significant benefit of the R&D tax credit is that it helps other technology companies grow in Maine. This benefits IDEXX by enhancing the Maine scientific community and increasing the pool of qualified researchers from which they can recruit. According to Baur, "When the R&D tax credit is discussed [by senior management] at IDEXX, it is this indirect benefit that is mentioned."

First Technology PLC (formerly Control Devices, Inc.)

First Technology is an international, public company headquartered in the United Kingdom. They currently have sales of approximately $200 million with nine operations centers and 1,200 employees.

In 1999, First Technology purchased Control Devices, a public company located in Standish. Control Devices had spun out of GTE in 1994 and went public in 1996. They currently operate as the Automotive and Special Products Division of First Technology. In addition to their Standish location, they have a manufacturing plant in Caribou. This Division's products include circuit breakers, electronic sensors and electronic ceramic components for automobiles, appliances and telecommunications equipment. Their customers include Ford, GM, Mercedes and their subcontractors.

According to Mike Ehman, Director of Engineering for the Automotive and Special Products Division, the Maine R&D tax credits are too small to make any difference to the company's decisions about R&D. The company has taken credits worth approximately $193,000 in both 2000 and 2002.[42]

Ehman notes that other costs are driving their location decisions. They have already moved all manufacturing out of the United States to the Dominican Republic, around 120–130 jobs. Only 40–50 people are left in their Caribou location. He stressed that these decisions were based on the cost of medical insurance that is driving up their U.S. personnel costs. The company is keeping all marketing sales, finance, accounting and R&D in Standish.

Maine's R&D tax credits in context

The tax expenditure from these programs is not large in absolute dollars or relative to the overall budget. For 2002, the tax expenditure per capita for the three programs discussed here was approximately $1.50. That is roughly in line with other states. North Carolina's R&D tax credit, in comparison, averaged just less than a dollar per capita for that same period. Missouri's, however, came to almost $3.00 per capita.

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[42] The Maine unit is one of nine units of the parent corporation; the $193,000 tax credit should be compared against the company's.

The number of taxpayers claiming the credits also is in line with national experience. Approximately 15,000 taxpayers sought the federal R&D tax credit in 2002.[43] Prorating that to Maine translates into an expected take-up rate of approximately 80 taxpayers, which is close to the number of separate claims in 2002.

A key question in Maine's case is whether the benefits of the R&D credit are getting to small and new businesses as much as to larger ones. The answer is a tentative yes, largely as a consequence of the size distribution of tech firms in Maine — which is skewed to smaller companies — and the provision that allows credits to be taken against the individual income tax. Other states have provisions in their R&D credit legislation that are even more favorable to small and new firms — expensing, refundability, and marketability — that might be considered by the legislature.

Are Maine's R&D tax credit programs justified in light of their benefits? As previously noted, an answer to this question, implicitly along benefit-cost lines, extends beyond the scope of this study. It is important to note that the question would be very difficult to answer; in short, the data, experience, and resources required to conduct a rigorous quantitative analysis are not currently available. Even if the ideal data were available, the answer is a matter of individual value preferences. For example, suppose we knew that 100 jobs were created each year because of the tax credits, or $15,000 per job. Some policymakers may find that acceptable, others would not.

The effectiveness of the R&D tax credit using benefit-cost analysis and economic modeling has been addressed in the academic and professional literature, with mixed results. A recent study by economists at the Federal Reserve Bank of Dallas concludes that state R&D tax credits could "tip the balance" for a company deciding where to put its research facilities. However, the value of most state R&D credits is small compared with "the huge investment necessary for most research projects." And just because a company moves its R&D activities to a state doesn't necessarily create many extra jobs, and could subsidize job creation elsewhere, if a firm uses the extra money to produce more jobs in its home state.[44] Two studies of the William S. Lee Tax Act in North Carolina conclude that the tax credits appear to be successful in inducing new jobs, but at a high cost in lost tax revenue. However, the study's author also suggests that additional revenues and therefore additional taxes are created, thereby offsetting the direct cost of the tax credit.[45]

Some economists argue that it does not matter whether the use of the tax credits leads directly to more jobs. The several million dollars returned to businesses each year makes them more competitive, as the legislation intended, since by definition their after-tax profitability is enhanced. They will do something with those proceeds — if not expand the size of their business, then pay their shareholders (or themselves) more, which would stimulate consumer

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[43] From a statement by Congresswoman Nancy Johnson, http://www.house.gov/nancyjohnson/pr_rdstudy.htm

[44] Robert Elder Jr., "R&D Credit Is Popular — But May Be of Little Value," Texas Journal, Wall Street Journal, March 24, 1999.

[45] Luger, Michael I. "2003 Assessment of the William S. Lee Tax Act." Prepared for the N.C. Department of Commerce, July 2003; Luger, Michael I. "North Carolina's Lee Act Incentives Assessed," State Tax Notes 30, 2, October 2003: 129-152; Luger, Michael and Jonathan Perry, "The William S. Lee Act — Assessment II." June 2001.

spending and investment. A key question, however, is whether that would occur in Maine or elsewhere.

Luger argues that small-expenditure tax programs, like Maine's, may have symbolic importance beyond the size of their direct inducement effect.[46] The credits provide economic developers (recruiters and retention agents) with a tangible product to help sell the state of Maine to businesses. It represents a "good business climate," which is particularly important in Maine because of the sentiment expressed by Maine firms about the state's high corporate tax rate.

Economists might argue that it would be more efficient to eliminate the tax credits and enact a revenue-neutral across-the-board tax cut. If the average corporate tax rate is around 6 percent (taking into account brackets ranging from 3.5 to almost 9 percent), and it yields just under $100 million, 1.5 percent of revenues (the tax expenditure) are associated roughly with a tenth of a percent decrease in overall rates. That is not much and arguably would have less symbolic value than the tax credits.

Moreover, the targeting of credits — versus an overall policy — is their very point; they reward a particular activity: R&D. Whether or not a sophisticated analysis would detect any causal link between the policy and outcomes, at least one user we interviewed felt very favorable toward them, and suggested that their behavior changed at the margin.

Another issue was raised by Dan Berglund, Executive Director of the Stare Science and Technology Institute (SSTI): R&D tax credits often fall between jurisdictions at the state level, limiting the impact of the legislation and leading to missed opportunities for economic development.[47] That may be true in Maine. The Maine Revenue Services has the responsibility for administering the programs like all other tax programs, but not for promoting them. The Maine Department of Economic and Community Development, includes the incentives among it listings and publications devoted to business assistance, but does not actively promote to the R&D and business community.

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[46] Ibid.

[47] Presentation to the National Conference of State Legislatures Assembly on State Issues, July 15, 2000.

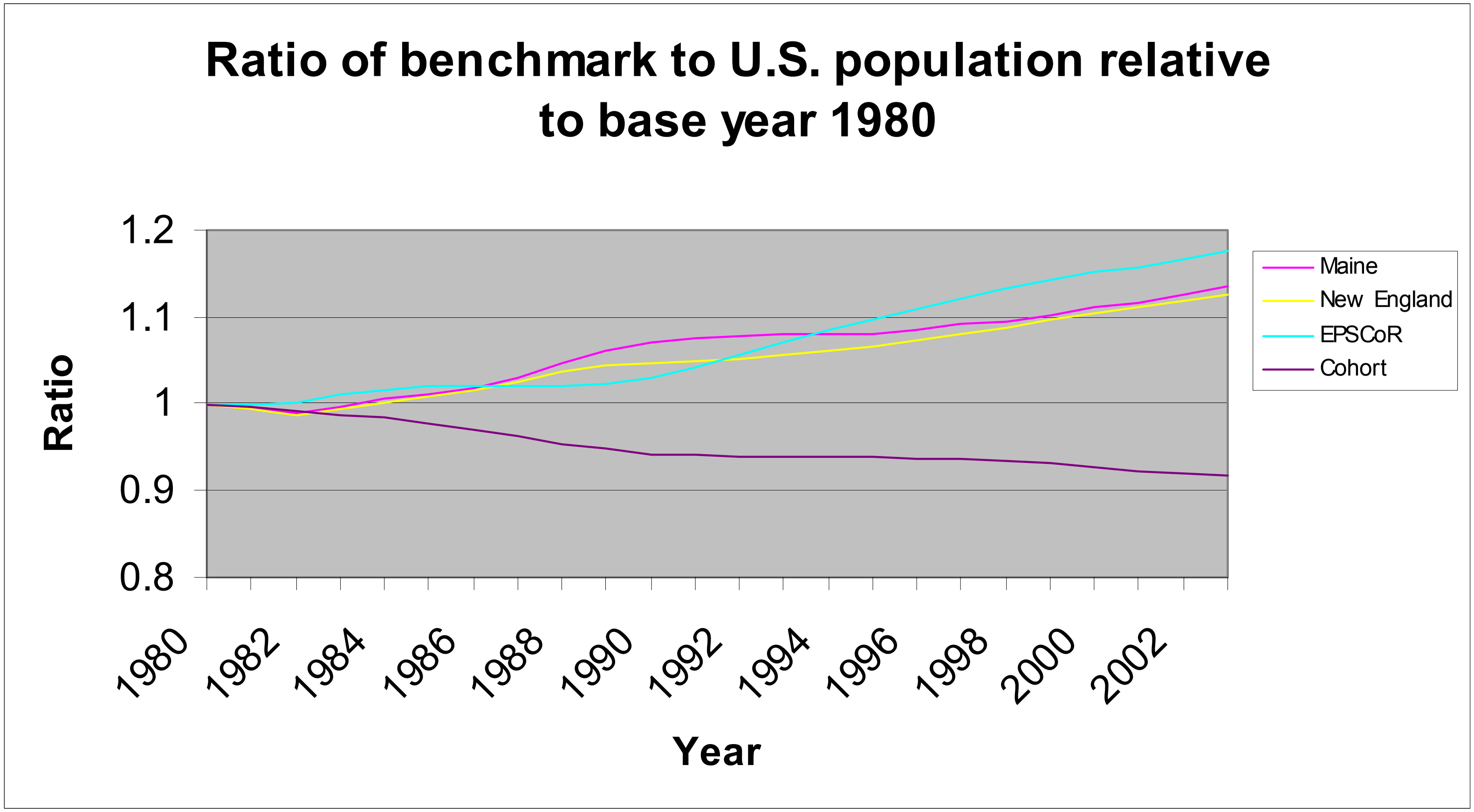
APPENDIX 3

Indicators

This appendix contains graphs and tables constructed from the spreadsheet of indicator data. Most of the figures are numbered to correspond to the associated table. The spreadsheet is available on CD ROM from the authors. The indicators are put into context in chapters 3 and 4 of the text.

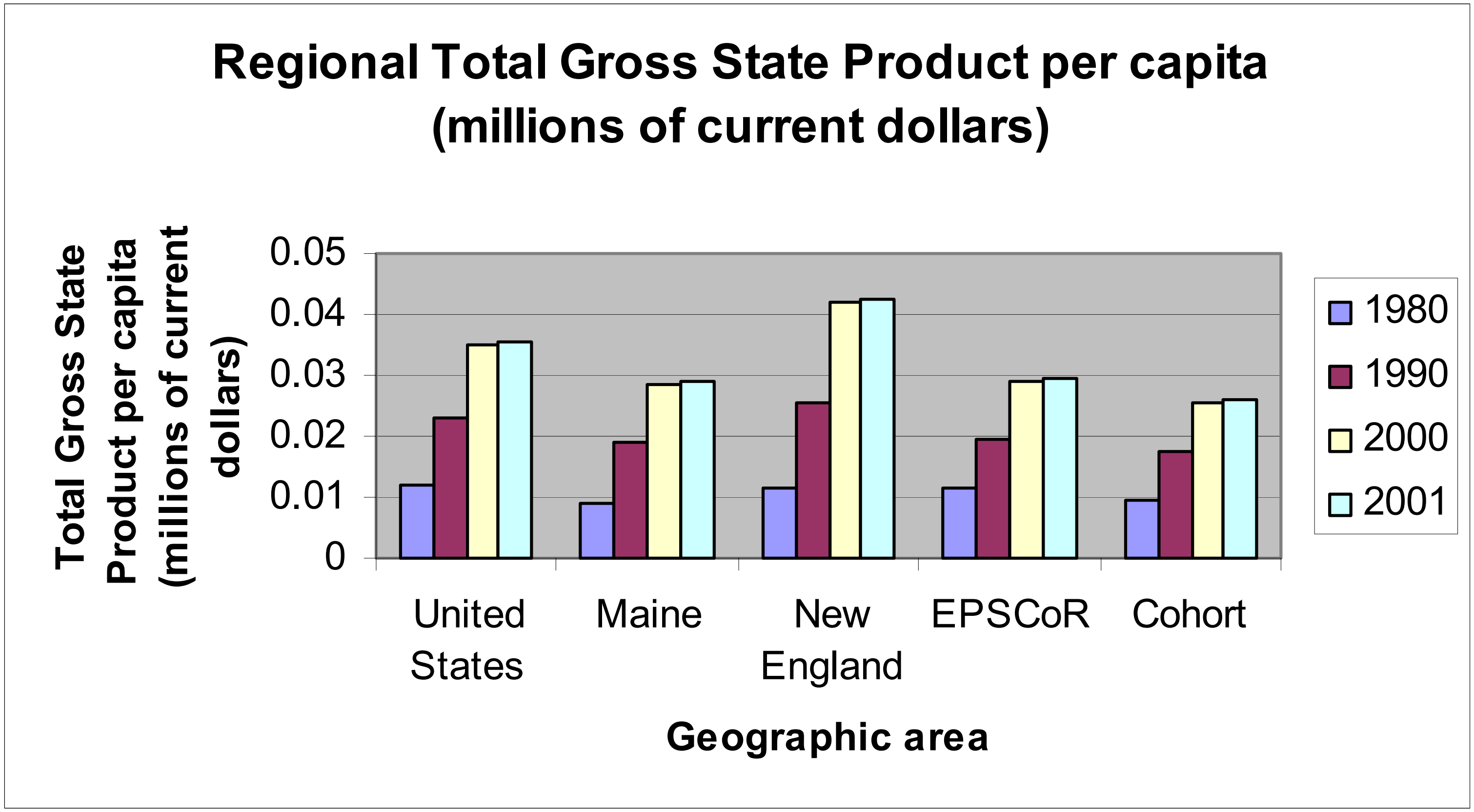
In the exhibits that follow, we compare Maine to New England (the six New England states); the EPSCoR states, excluding Puerto Rico; and a cohort of states (Arkansas, Montana, South Carolina, and West Virginia) that entered the EPSCoR program at the same time as Maine.

Figure A3.1



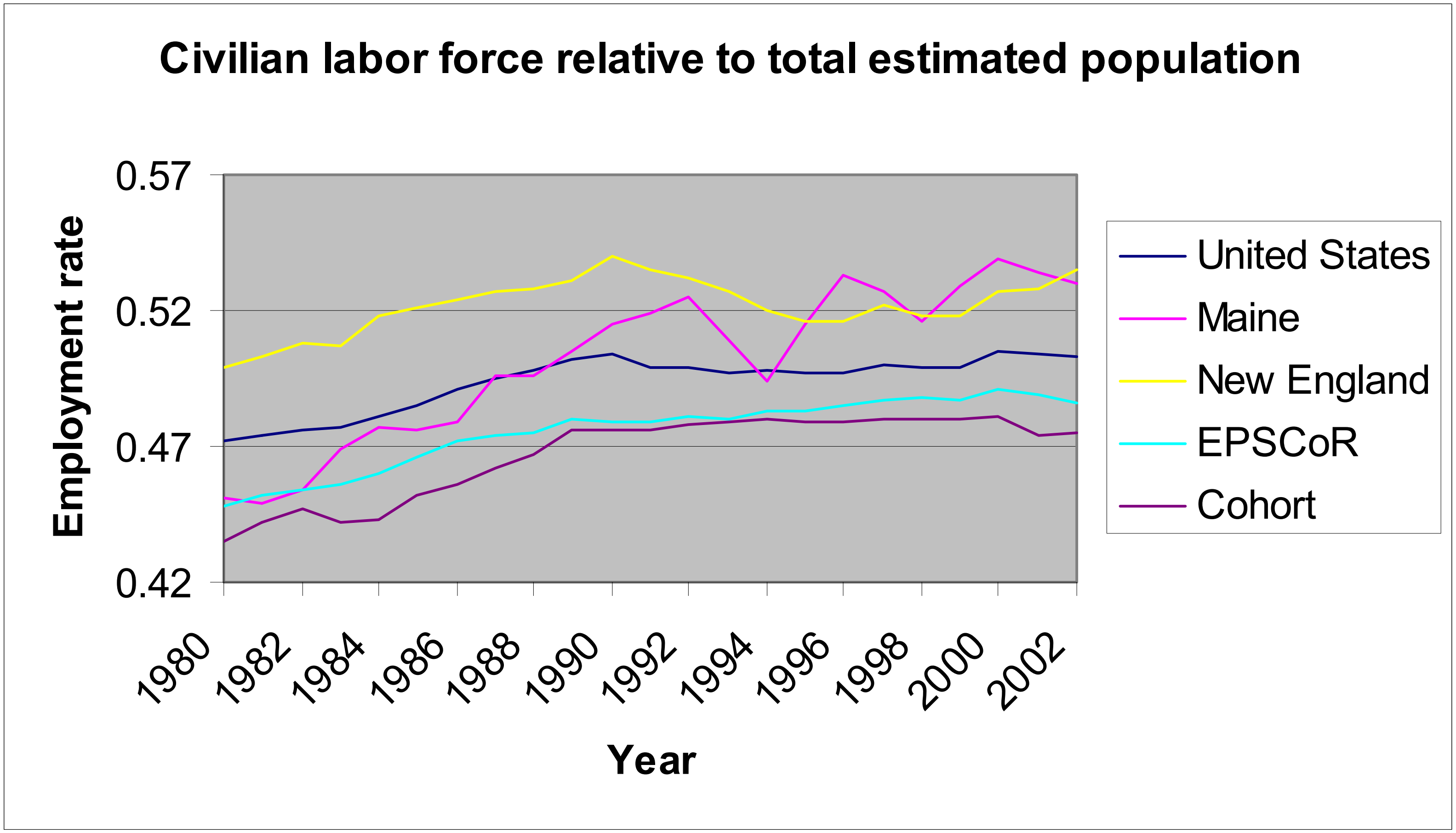
Sources: 1980-1989 - Intercensal Estimates of the Total Resident Population of the States, release date Aug. 1996; 1990-1999 - Table CO-EST2001-12-00 - Time Series of Intercensal State Population Estimates: April 1, 1990 to April 1, 2000; Population Division, U.S. Census Bureau; Release Date: April 11, 2002; July 2000-July 2003 -Table NST-EST2003-01 - Annual Estimates of the Population for the United States and States, and for Puerto Rico: April 1, 2000 to July 1, 2003; Population Division, U.S. Census Bureau; Release Date: December 18, 2003

Figure A3.2



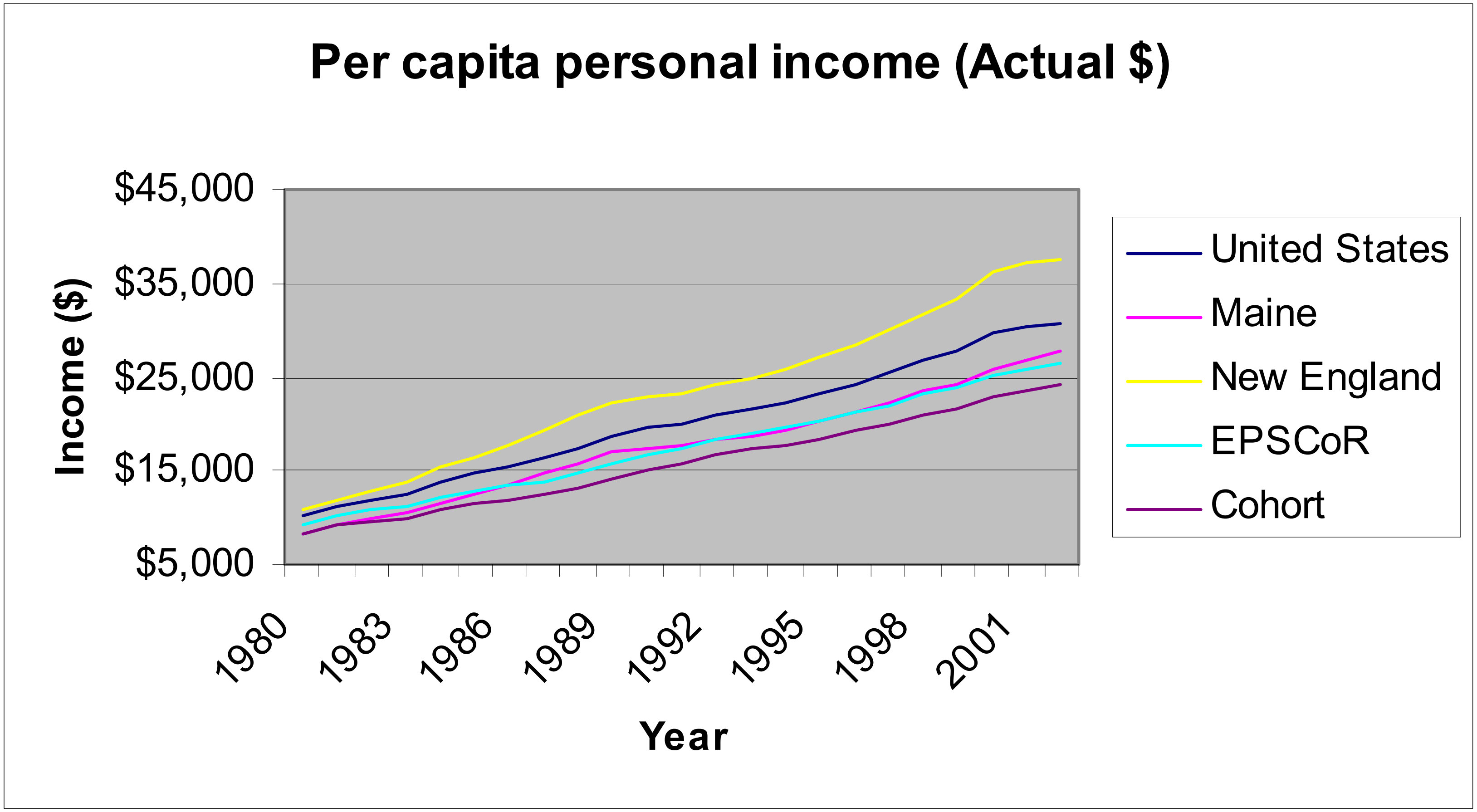
Source: Bureau of Economic Analysis, U.S. Department of Commerce, http://www.bea.doc.gov/bea/regional/gsp/A33; released May 22,2003

Figure A3.3



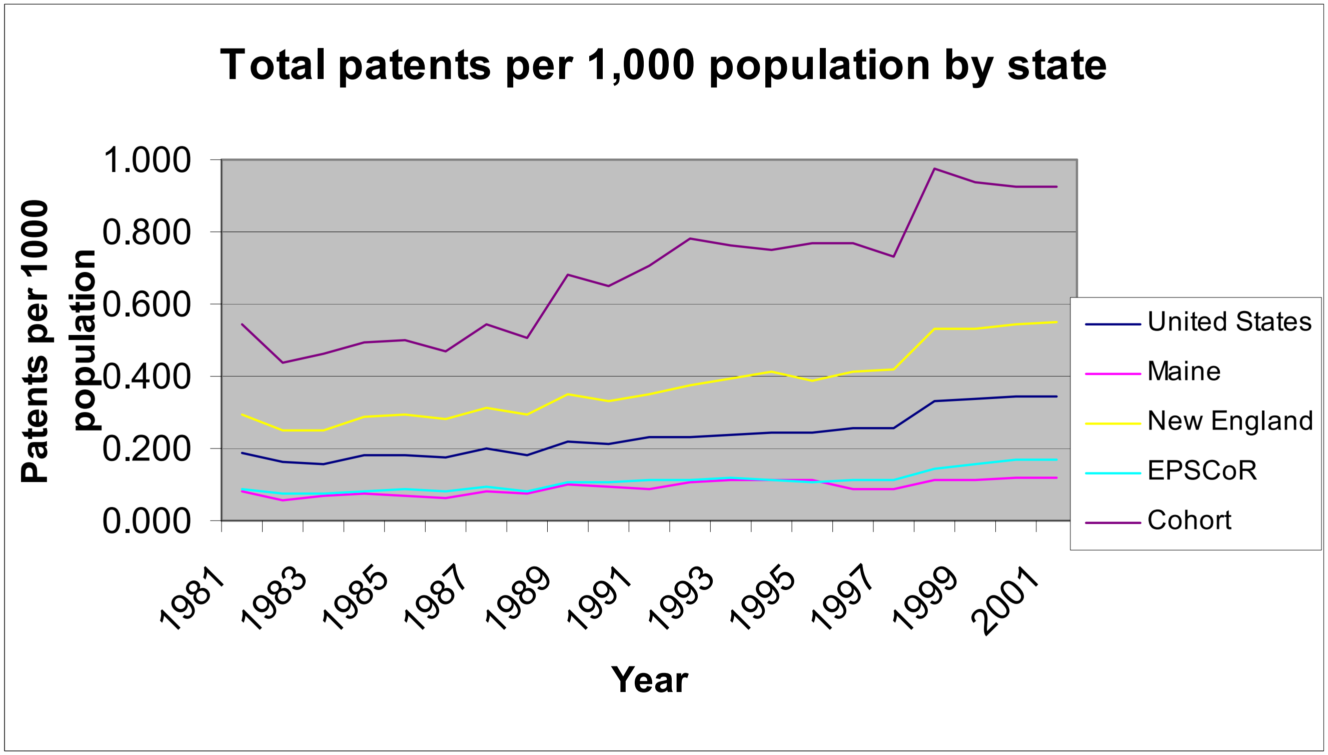
Source: U.S. Department of Labor, Bureau of Labor Statistics, Local Area Unemployment Statistics - http://www.bls.gov/lau/staadoc.htm

Figure A3.4



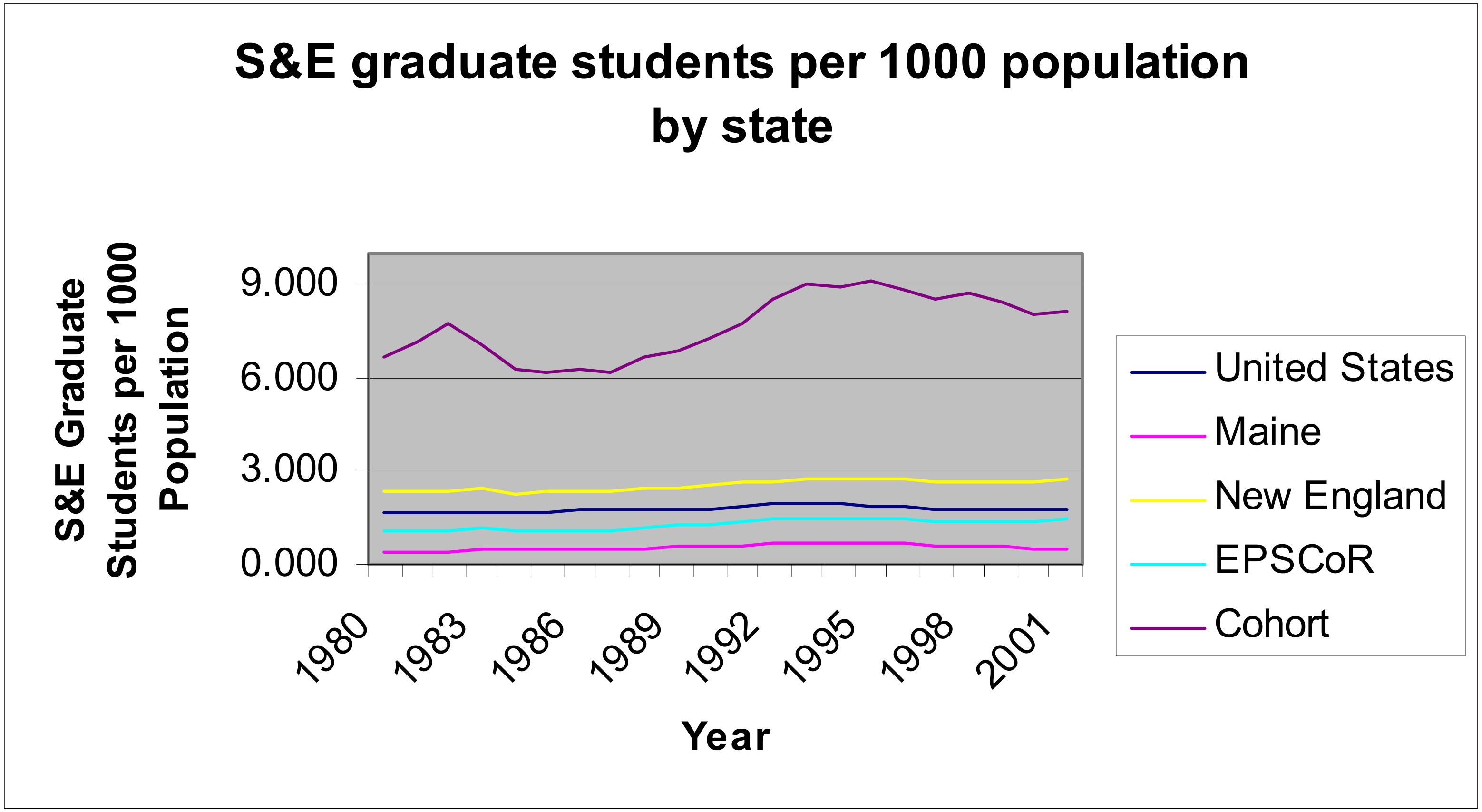
Source: U.S. Department of Labor, Bureau of Labor Statistics, Local Area Unemployment Statistics - http://www.bls.gov/lau/staadoc.htm

Figure A3.5



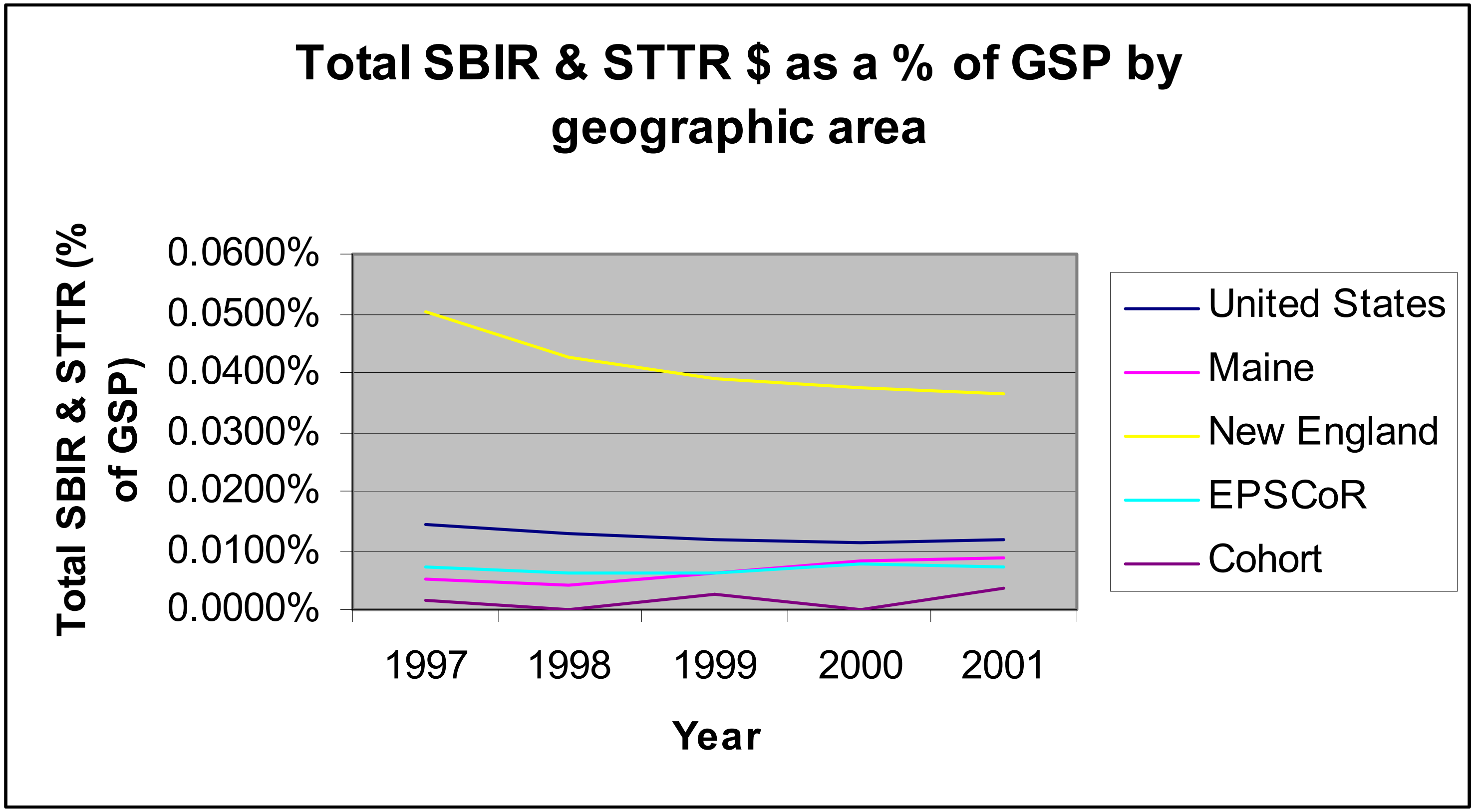
Sources: Patents - Patent Counts by Country/State and Year, All Patents, All Types, January 1, 1977-December 31, 2001; by Calendar Year; U.S. Patent and Trade Mark Office, February 2002; http://www.uspto.gov/.   Population - 1980-1989 - Intercensal Estimates of the Total Resident Population of the States, release date Aug. 1996; 1990-1999 - Table CO-EST2001-12-00 - Time Series of Intercensal State Population Estimates: April 1, 1990 to April 1, 2000; Population Division, U.S. Census Bureau; Release Date: April 11, 2002; July 2000-July 2003 -Table NST-EST2003-01 - Annual Estimates of the Population for the United States and States, and for Puerto Rico: April 1, 2000 to July 1, 2003; Population Division, U.S. Census Bureau; Release Date: December 18, 2003

Figure A3.6



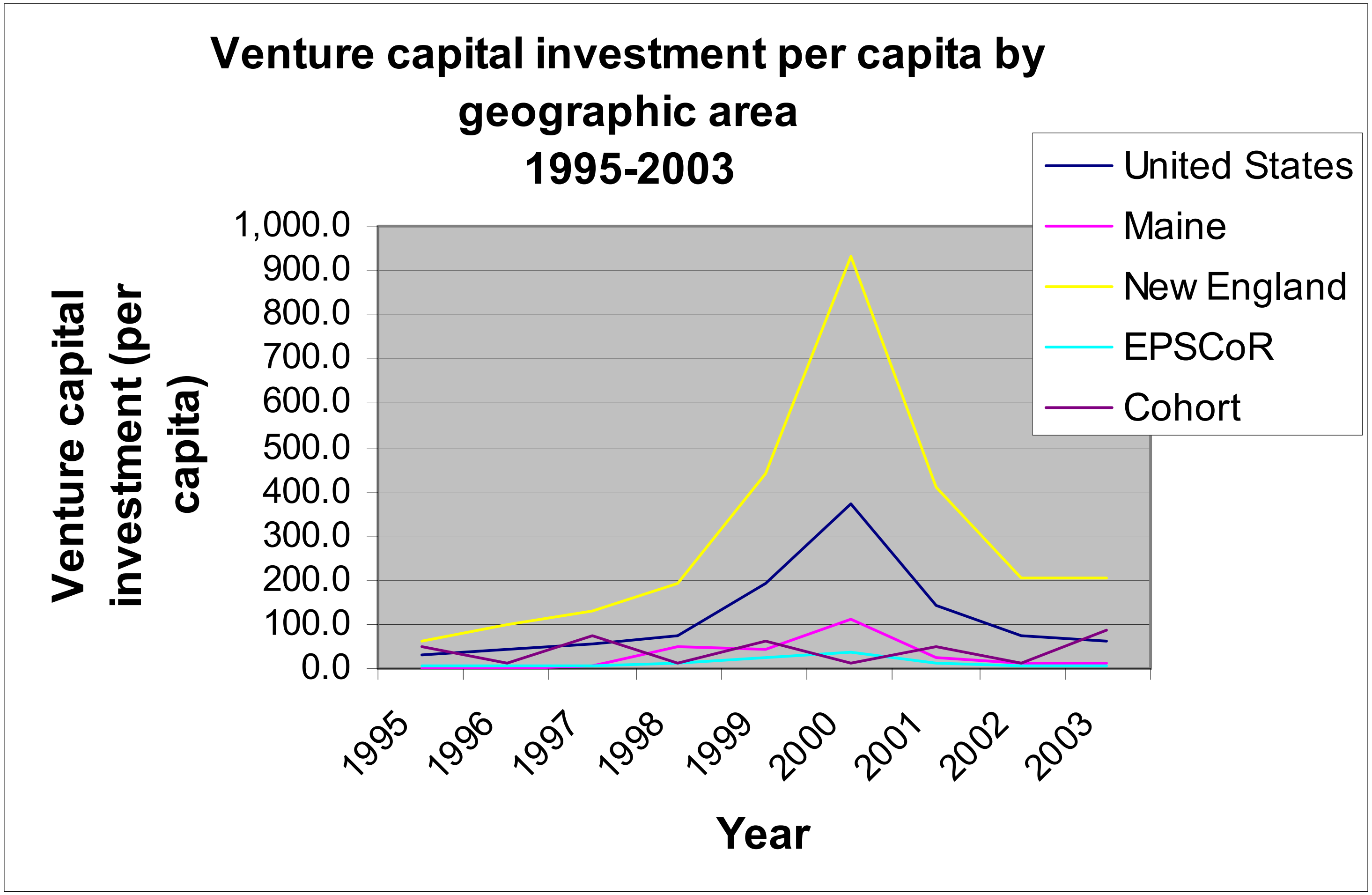
Sources: S&E Graduate Students - NSF WebCASPAR Database System based on "Survey of Graduate Students and Post-doctorates in Science and Engineering", National Science Foundation and National Institutes of Health. Population - 1980-1989 - Intercensal Estimates of the Total Resident Population of the States, release date Aug. 1996; 1990-1999 - Table CO-EST2001-12-00 - Time Series of Intercensal State Population Estimates: April 1, 1990 to April 1, 2000; Population Division, U.S. Census Bureau; Release Date: April 11, 2002; July 2000-July 2003 -Table NST-EST2003-01 - Annual Estimates of the Population for the United States and States, and for Puerto Rico: April 1, 2000 to July 1, 2003; Population Division, U.S. Census Bureau; Release Date: December 18, 2003

Figure A3.7



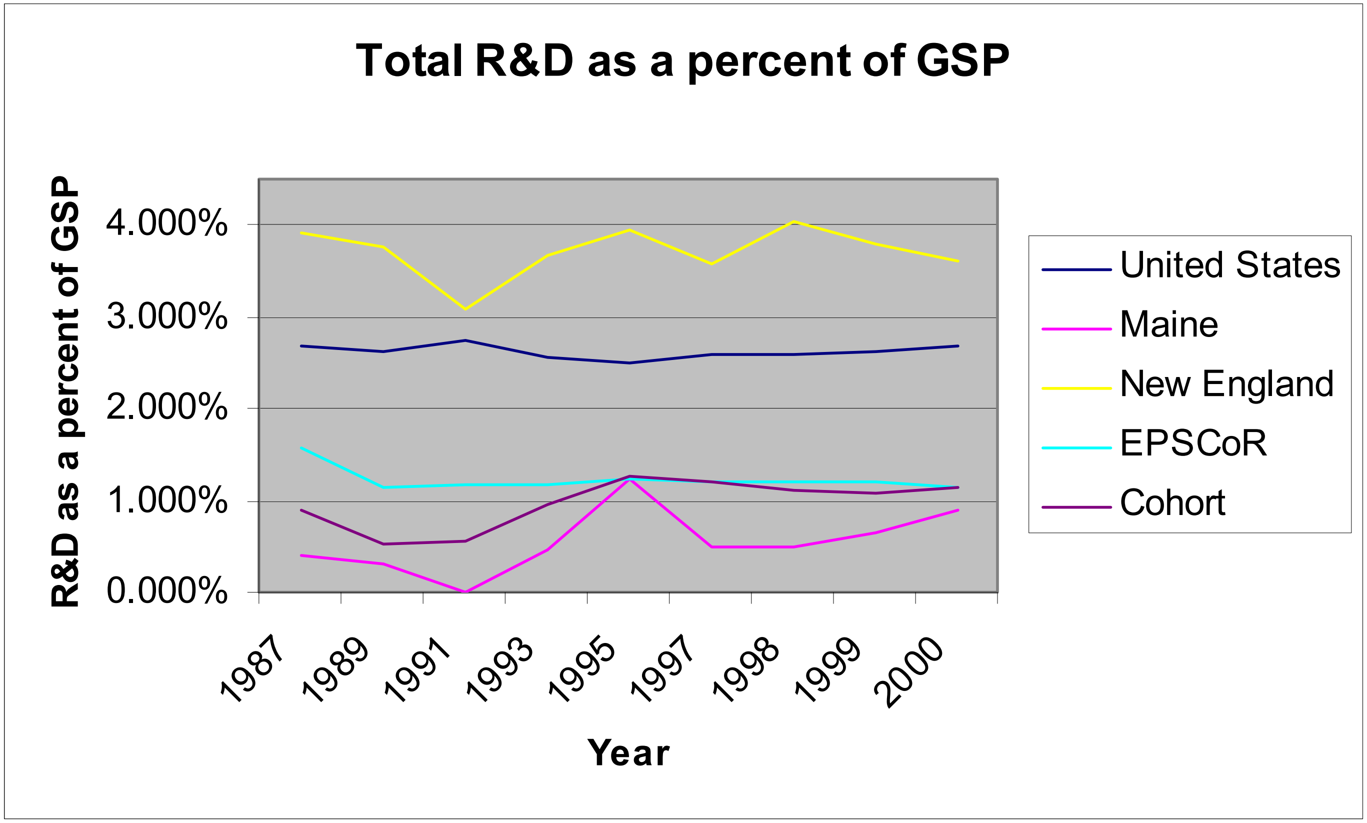
Sources: SBIR and STTR Awards - U.S. Small Business Administration, www.sba.gov/SBIR. Gross State Product - Bureau of Economic Analysis, U.S. Department of Commerce, http://www.bea.doc.gov/bea/regional/gsp/A33; released May 22,2003

Figure A3.8



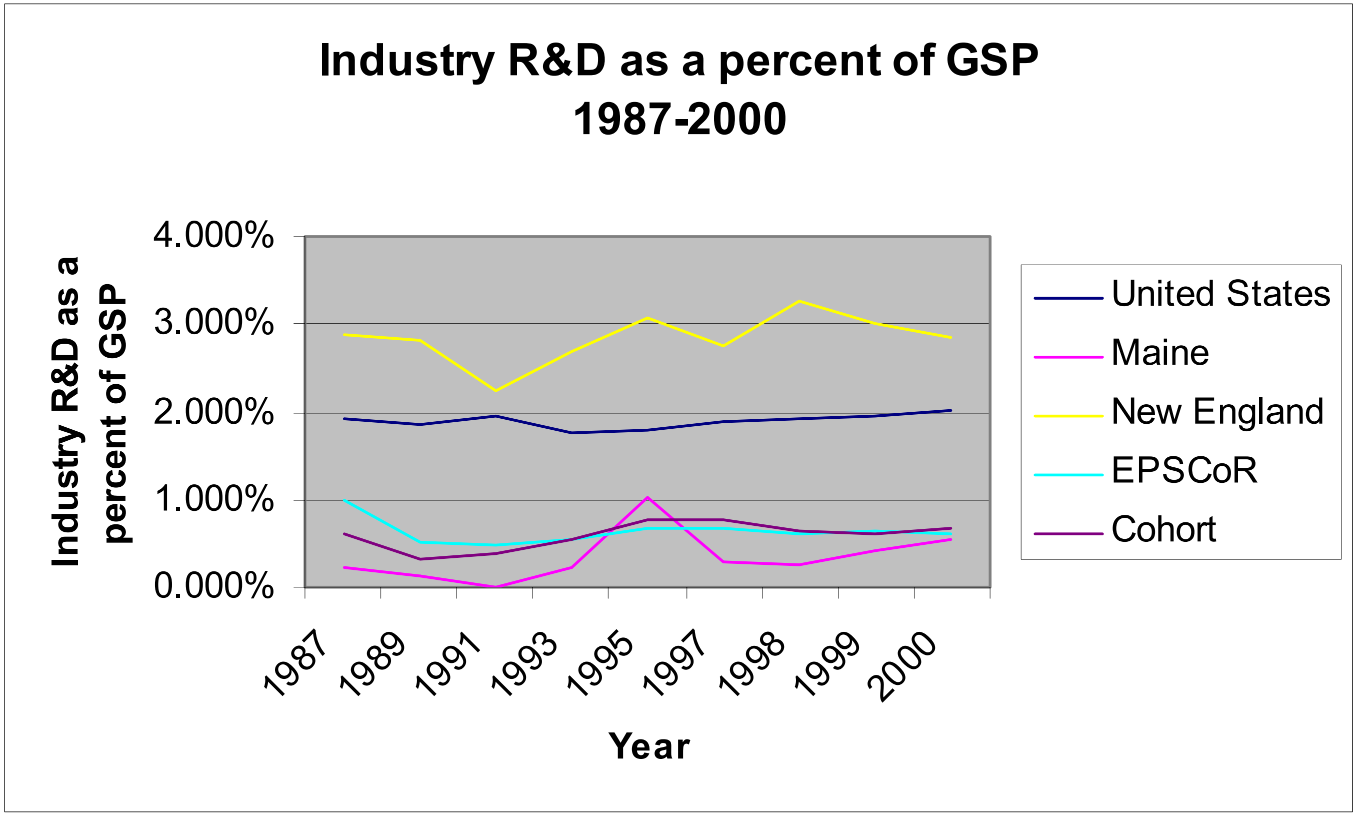
Sources: Venture Capital - MoneyTree Venture Capital Profiles by State; based on PricewaterhouseCooper/Venture Economics/National Venture Capital Association Surveys; http:/www.ventureeconomics.com/vec/stats. Gross State Product - Bureau of Economic Analysis, U.S. Department of Commerce, http://www.bea.doc.gov/bea/regional/gsp/A33; released May 22,2003. Population - 1995-1999 - Table CO-EST2001-12-00 - Time Series of Intercensal State Population Estimates: April 1, 1990 to April 1, 2000; Population Division, U.S. Census Bureau; Release Date: April 11, 2002; July 2000-July 2003 -Table NST-EST2003-01 - Annual Estimates of the Population for the United States and States, and for Puerto Rico: April 1, 2000 to July 1, 2003; Population Division, U.S. Census Bureau; Release Date: December 18, 2003

Figure A3.9



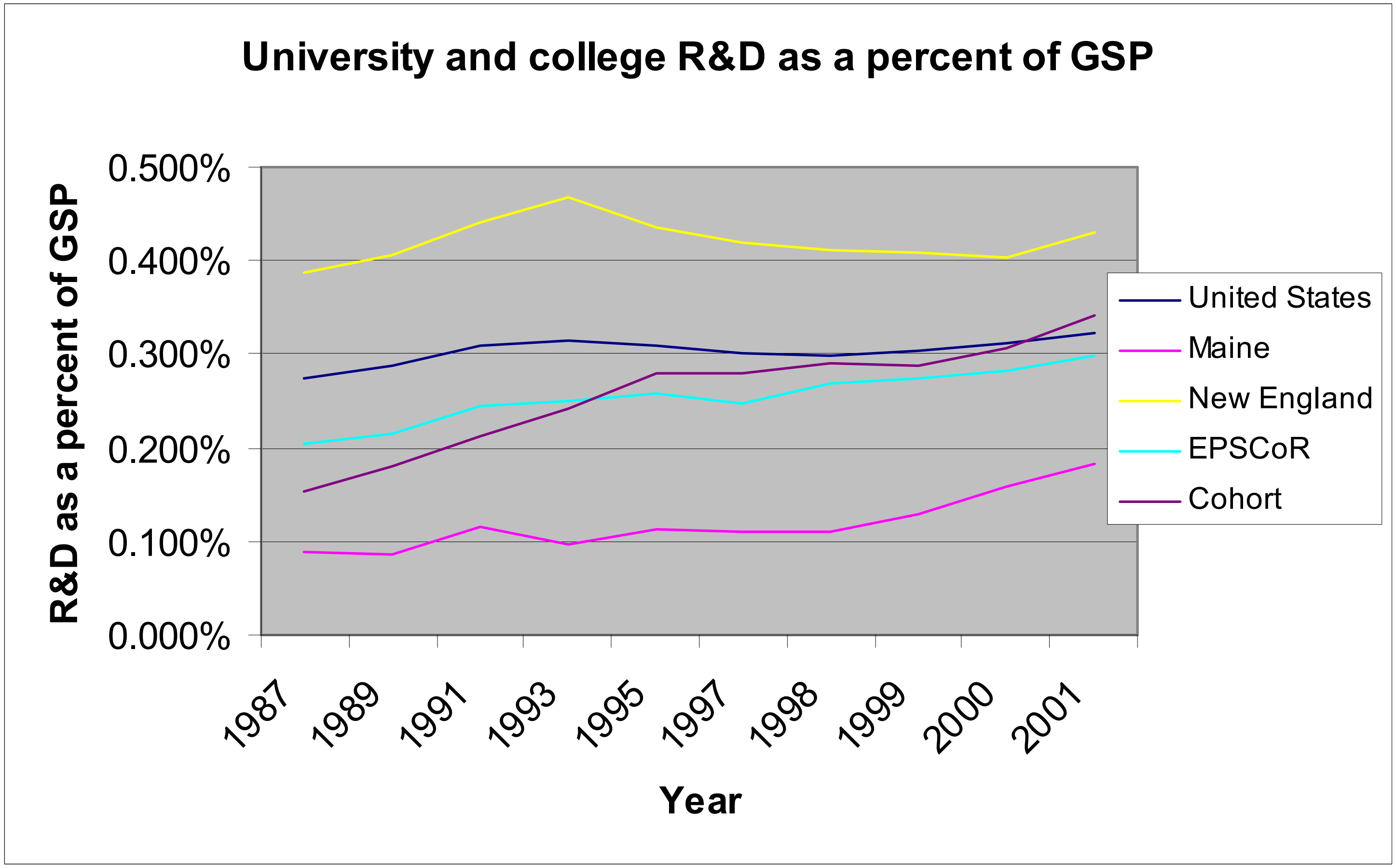
Sources: Total R&D Performed - National Science Foundation/Division of Science Resources Statistics; National Patterns of R&D Resources 2002 Data Update, derived from four NSF surveys: Survey of Industrial R&D; Survey of R&D Expenditures at Universities and Colleges, Survey of Federal Funds for R&D, and Survey of R&D Funding and Performance by Nonprofit Organizations; http://www.nsf.gov/sbe/srs/nsf03313/start.htm. Workers - Civilian Labor Force - U.S. Department of Labor, Bureau of Labor Statistics, Local Area Unemployment Statistics - http://www.bls.gov/lau/staadoc.htm. Gross State Product - Bureau of Economic Analysis, U.S. Department of Commerce, http://www.bea.doc.gov/bea/regional/gsp/A33; released May 22,2003. Blanks = data not available; data for areas with missing data removed from New England and EPSCoR summaries

Figure A3.10



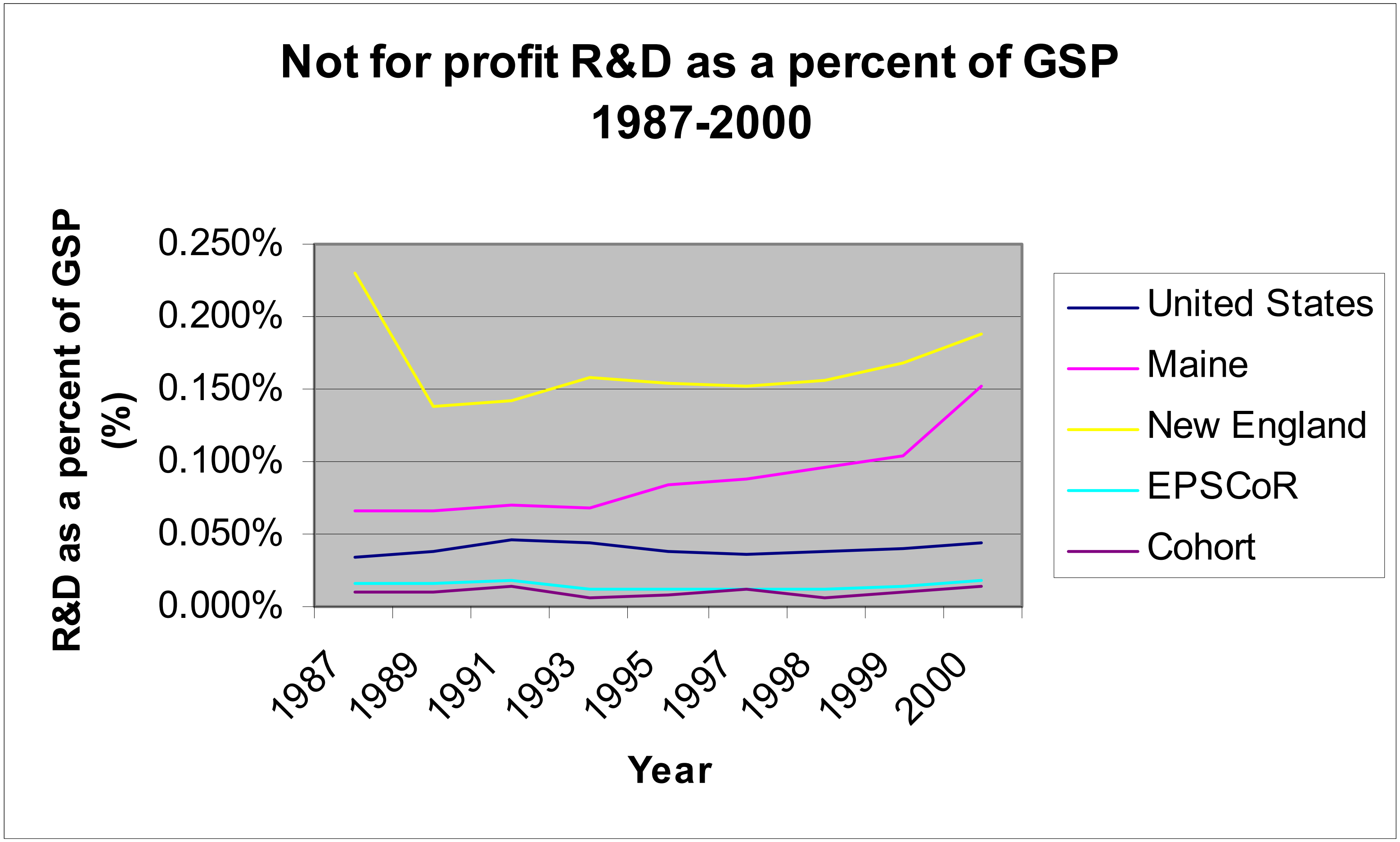
Sources: Industry R&D Performed - National Science Foundation/Division of Science Resources Statistics; National Patterns of R&D Resources 2002 Data Update, derived from NSF Survey of Industrial R&D; http://www.nsf.gov/sbe/srs/nsf03313/start.htm. Workers - Civilian Labor Force - U.S. Department of Labor, Bureau of Labor Statistics, Local Area Unemployment Statistics - http://www.bls.gov/lau/staadoc.htm. Gross State Product - Bureau of Economic Analysis, U.S. Department of Commerce, http://www.bea.doc.gov/bea/regional/gsp/A33; released May 22,2003. Blanks = data not available; data for areas with missing data removed from New England and EPSCoR summaries

Figure A3.11



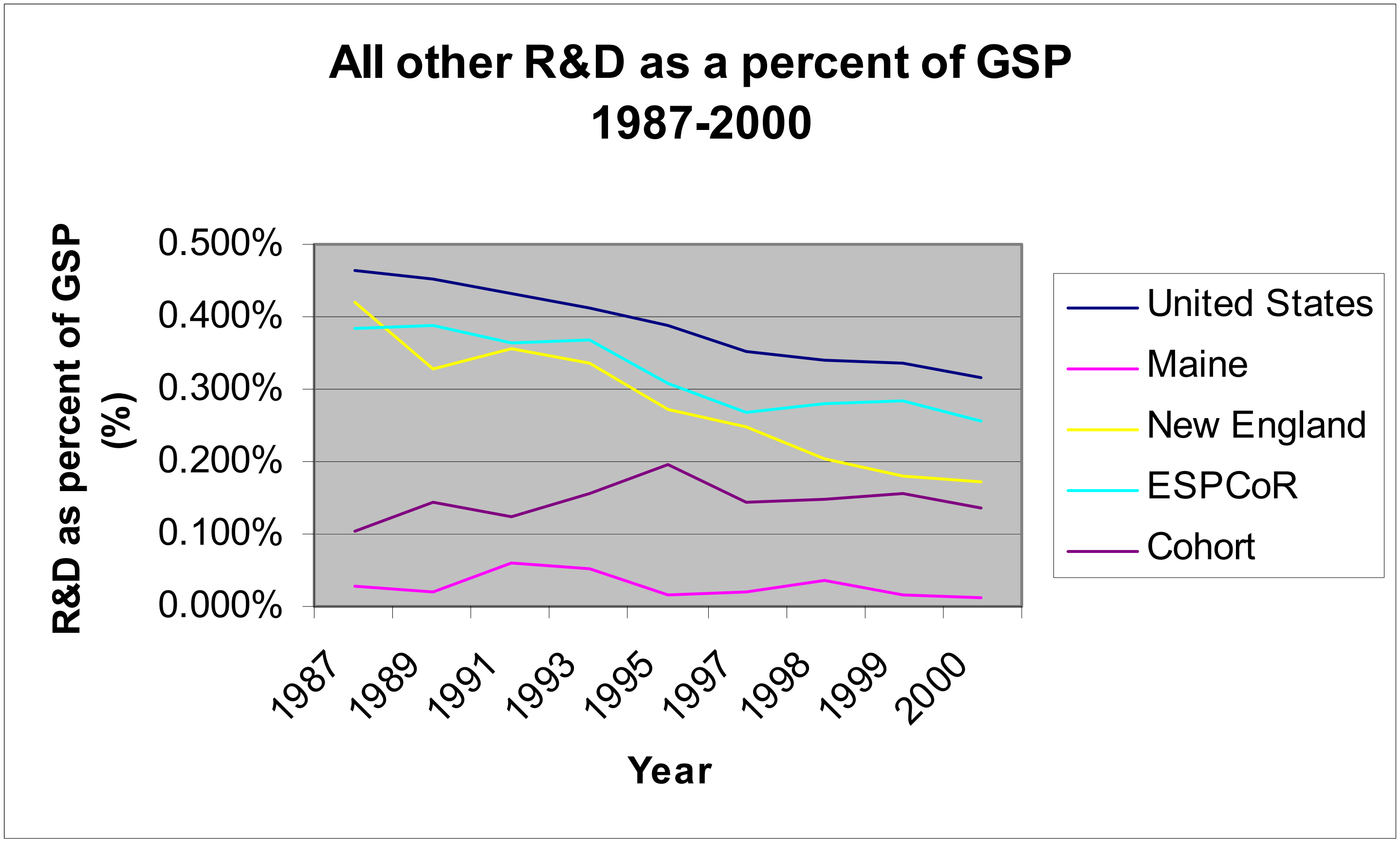
Sources: University & College R&D Performed - National Science Foundation/Division of Science Resources Statistics; National Patterns of R&D Resources 2002 Data Update, derived from Survey of R&D Expenditures at Universities and Colleges; http://www.nsf.gov/sbe/srs/nsf03313/start.htm; 2001 data from Survey of R&D Expenditures at Universities and Colleges 2001; http://www.nsf.gov/sbe/sr. Workers - Civilian Labor Force - U.S. Department of Labor, Bureau of Labor Statistics, Local Area Unemployment Statistics - http://www.bls.gov/lau/staadoc.htm. Gross State Product - Bureau of Economic Analysis, U.S. Department of Commerce, http://www.bea.doc.gov/bea/regional/gsp/A33; released May 22,2003

Figure A3.12



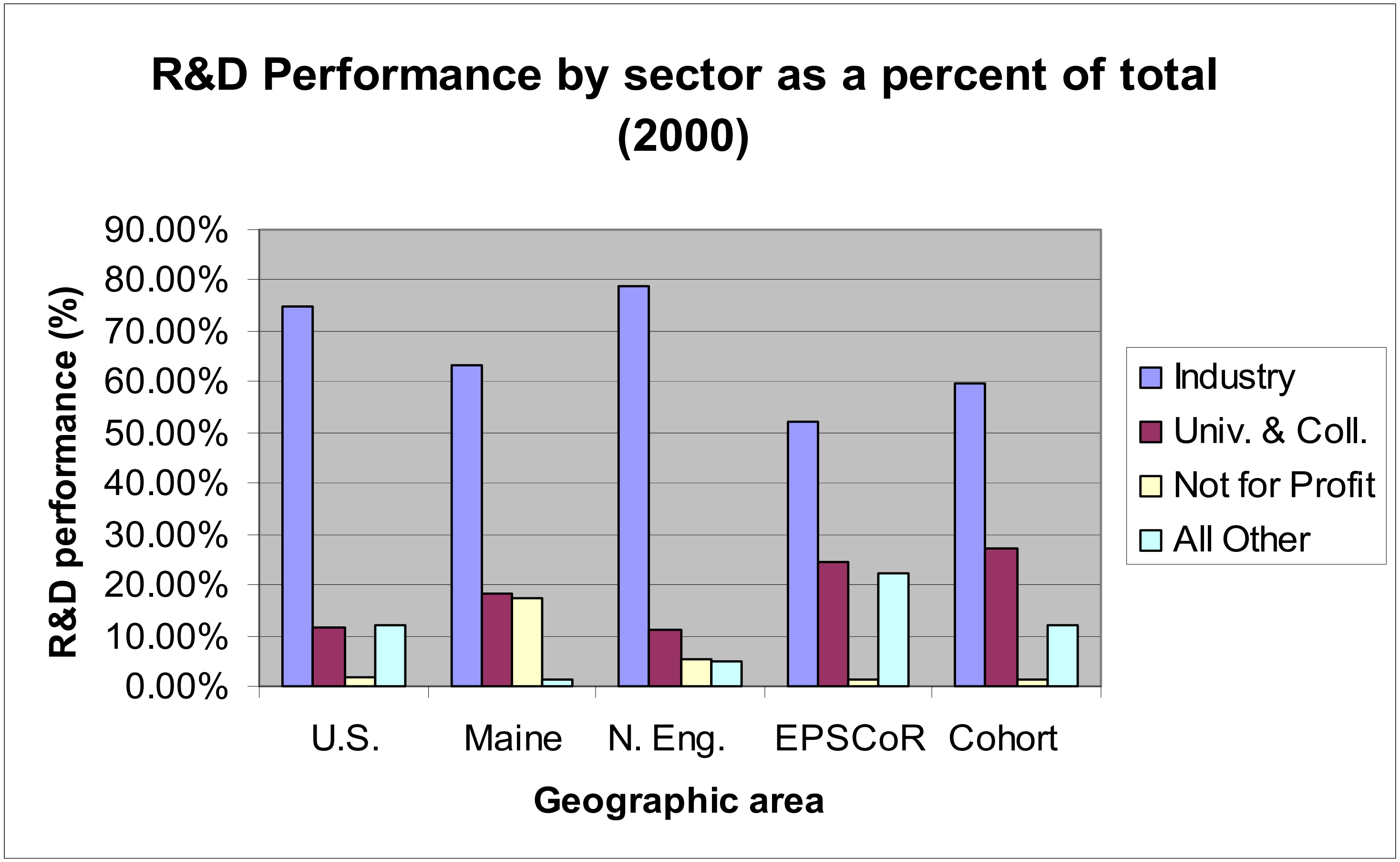
Sources: Not for Profit R&D Performed - National Science Foundation/Division of Science Resources Statistics; National Patterns of R&D Resources 2002 Data Update, derived from Survey of R&D Funding and Performance by Nonprofit Organizations; http://www.nsf.gov/sbe/srs/nsf03313/start.htm. Workers - Civilian Labor Force - U.S. Department of Labor, Bureau of Labor Statistics, Local Area Unemployment Statistics - http://www.bls.gov/lau/staadoc.htm. Gross State Product - Bureau of Economic Analysis, U.S. Department of Commerce, http://www.bea.doc.gov/bea/regional/gsp/A33; released May 22,2003

Figure A3.13



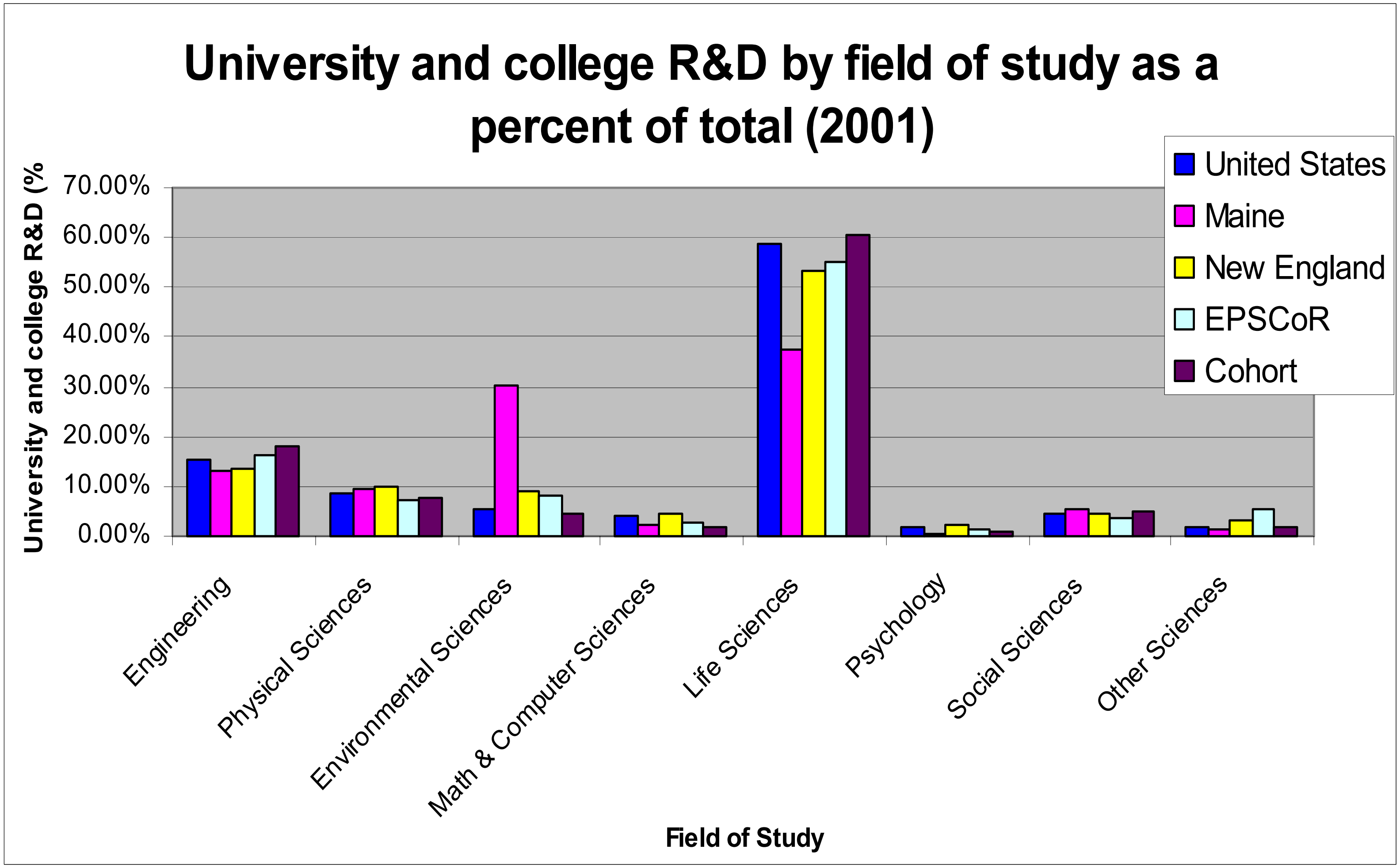
Sources: All Other R&D Performed - National Science Foundation/Division of Science Resources Statistics; National Patterns of R&D Resources 2002 Data Update, derived from NSF Survey of Federal Funds for R&D; http://www.nsf.gov/sbe/srs/nsf03313/start.htm. Workers - Civilian Labor Force - U.S. Department of Labor, Bureau of Labor Statistics, Local Area Unemployment Statistics - http://www.bls.gov/lau/staadoc.htm. Gross State Product - Bureau of Economic Analysis, U.S. Department of Commerce, http://www.bea.doc.gov/bea/regional/gsp/A33; released May 22,2003

Figure A3.14



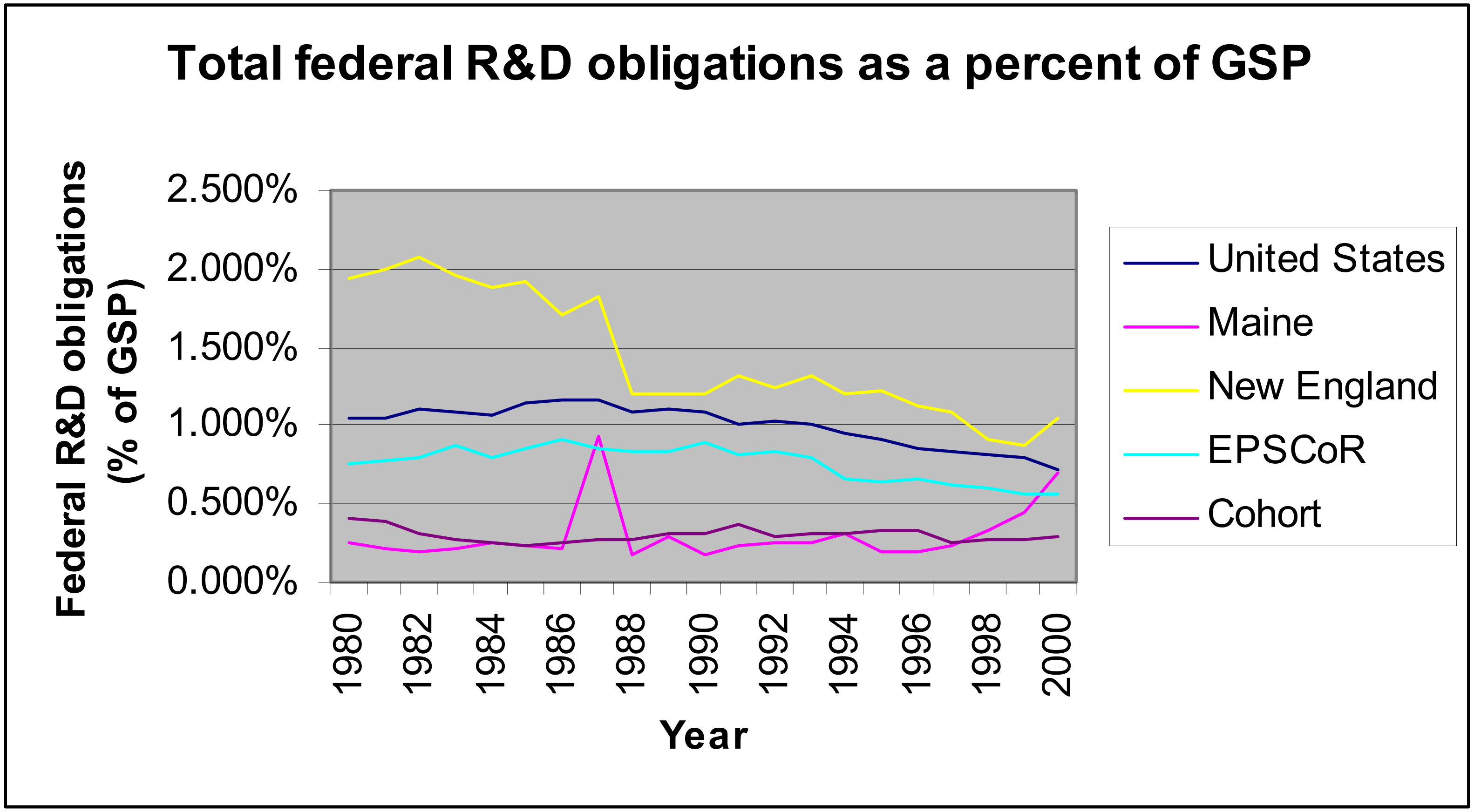
Sources: National Science Foundation/Division of Science Resources Statistics; National Patterns of R&D Resources 2002 Data Update, derived from four NSF surveys: Survey of Industrial R&D; Survey of R&D Expenditures at Universities and Colleges, Survey of Federal Funds for R&D, and Survey of R&D Funding and Performance by Nonprofit Organizations; http://www.nsf.gov/sbe/srs/nsf03313/start.htm. All Other R&D includes R&D performed by the Federal Government and R&D performed at Federally Funded Research & Development Centers, FFRDC'S

Figure A3.15



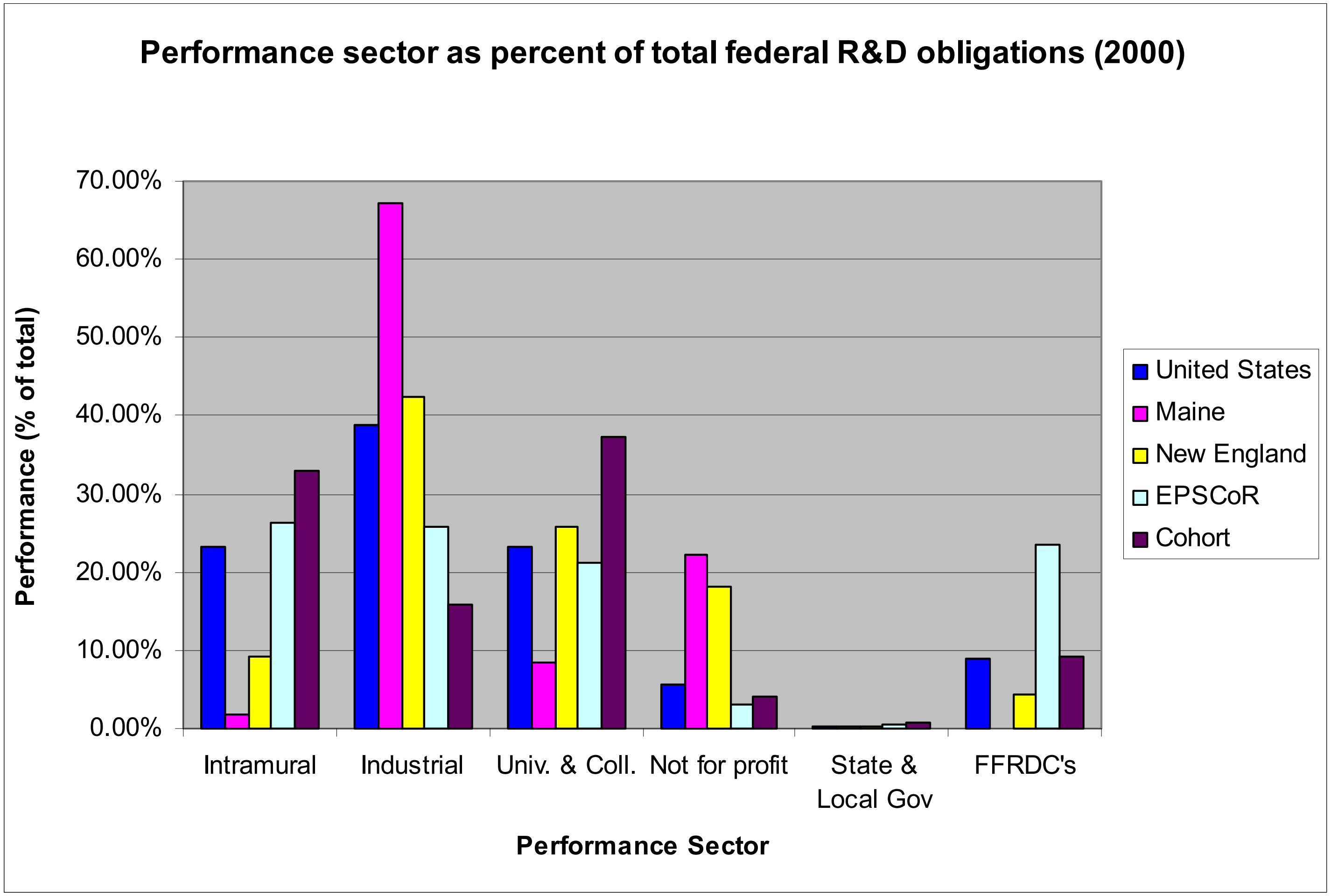
Sources: University & College R&D Performed - National Science Foundation/Division of Science Resources Statistics; Survey of R&D Expenditures at Universities and Colleges 2001; http://www.nsf.gov/sbe/sr

Figure A3.16



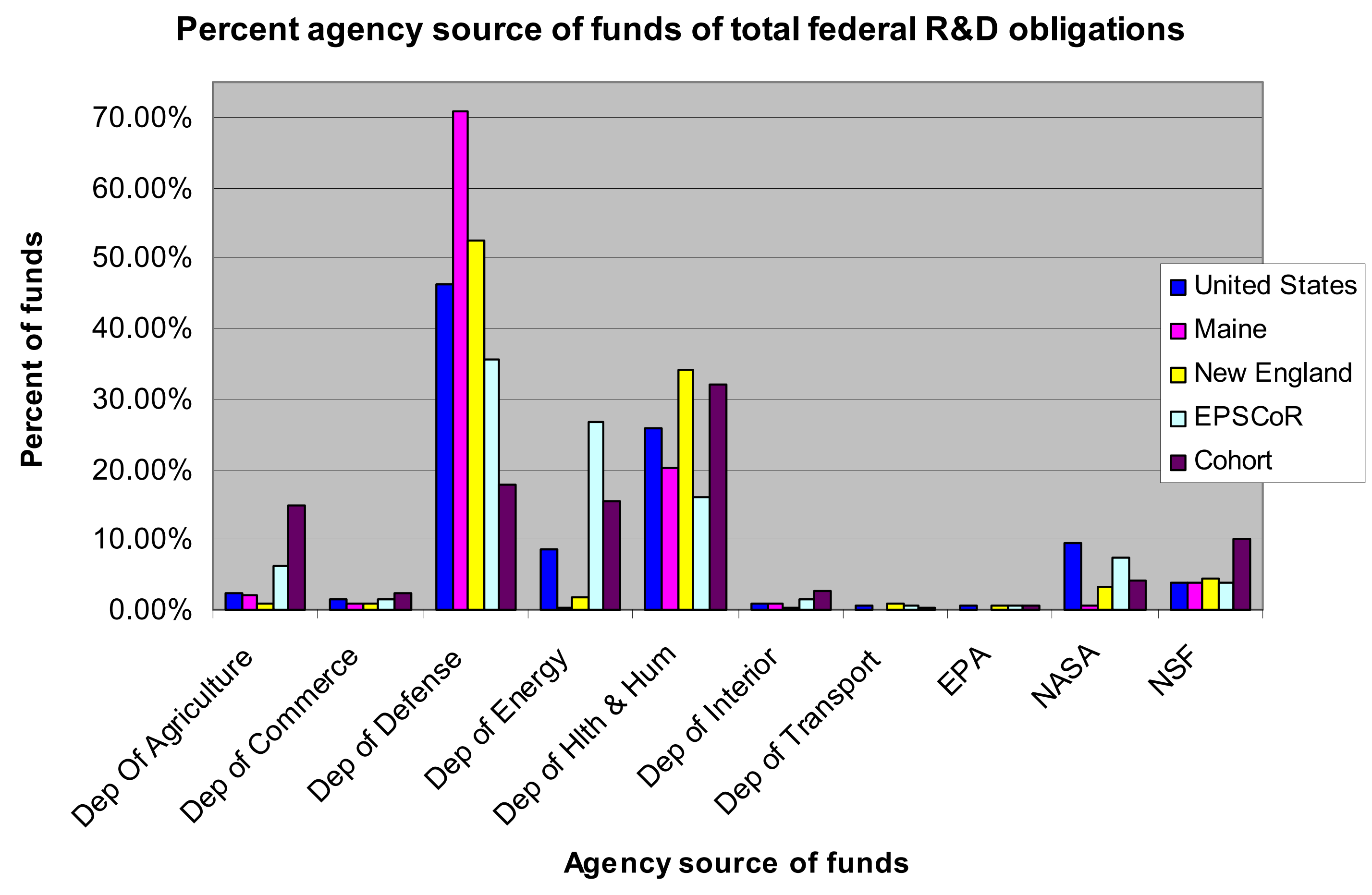
Sources: Total Federal R&D Obligations - National Science Foundation/Division of Science Resources Statistics; Survey of Federal Funds for Research and Development: Fiscal Years 2000, 2001, and 2002; http://www.nsf.gov/sbe/srs/nsf02321/start.htm. Workers - Civilian Labor Force - U.S. Department of Labor, Bureau of Labor Statistics, Local Area Unemployment Statistics - http://www.bls.gov/lau/staadoc.htm. Gross State Product - Bureau of Economic Analysis, U.S. Department of Commerce, http://www.bea.doc.gov/bea/regional/gsp/A33; released May 22,2003. Includes the obligations of the major R&D supporting agencies which were requested to report this information, together they represent 95 percent or more of the total R&D obligations

Figure A3.17



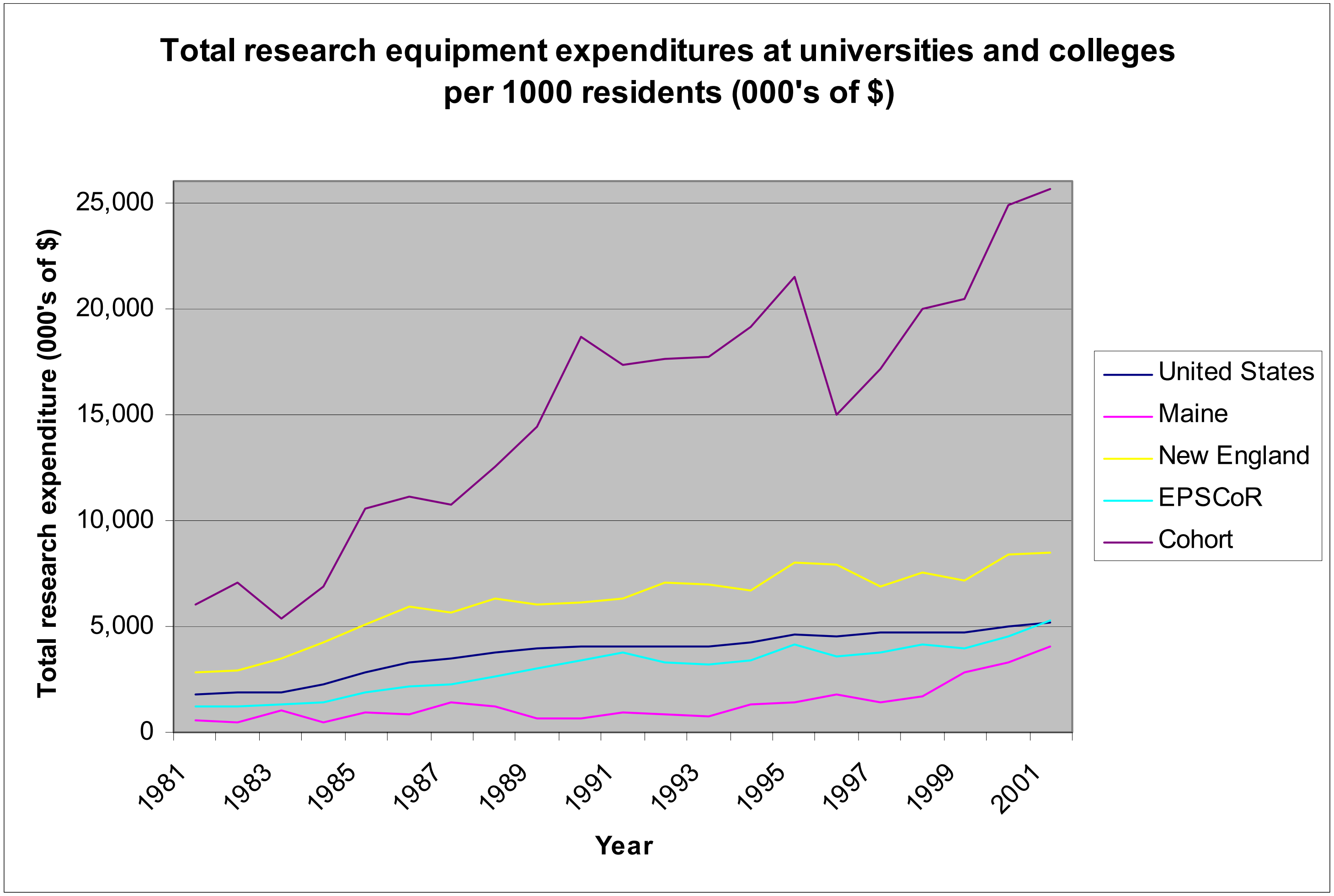
Sources: Federal R&D Obligations - National Science Foundation/Division of Science Resources Statistics; Survey of Federal Funds for Research and Development: Fiscal Years 2000, 2001, and 2002; http://www.nsf.gov/sbe/srs/nsf02321/start.htm. FFRDC's = Federally Funded Research & Development Centers. Includes the obligations of the major R&D supporting agencies which were requested to report this information, together they representmore than 98 percent of the total R&D Federal obligations

Figure A3.18



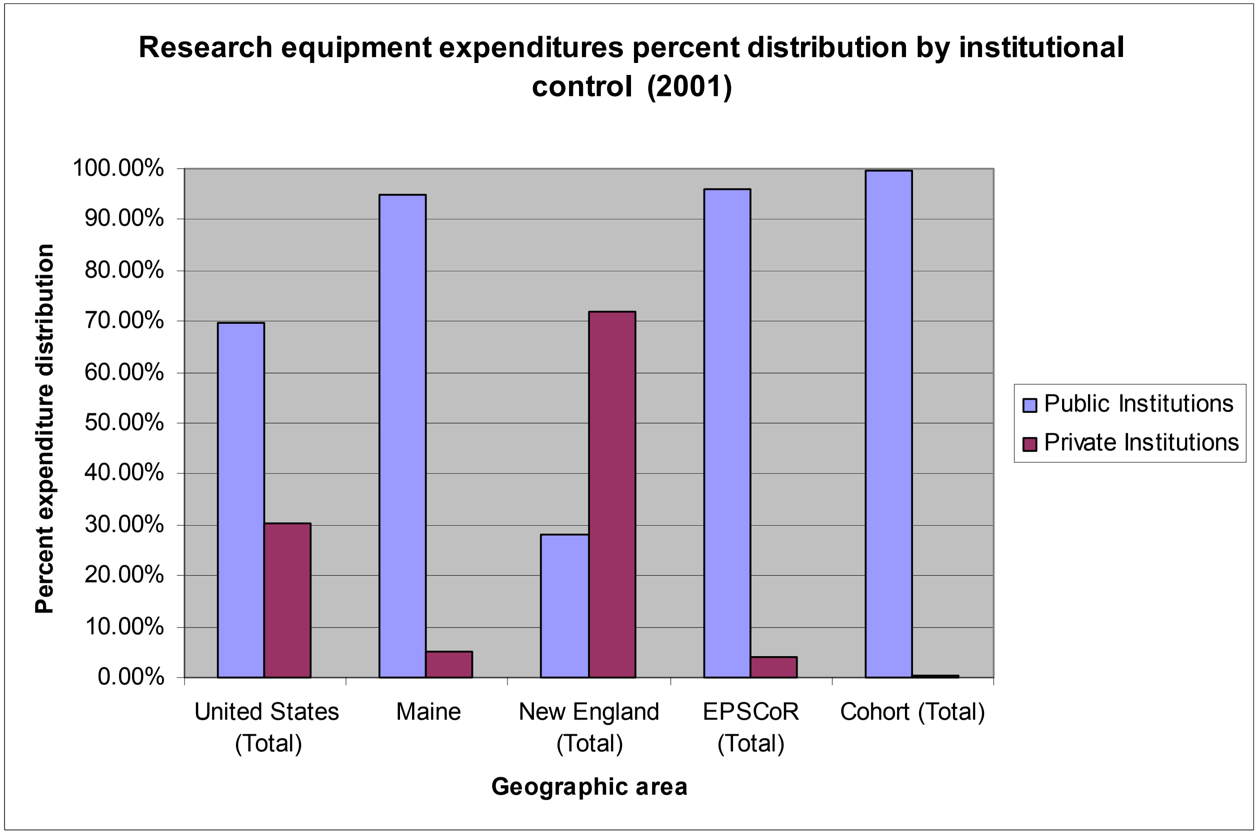
Sources: Federal R&D Obligations - National Science Foundation/Division of Science Resources Statistics; Survey of Federal Funds for Research and Development: Fiscal Years 2000, 2001, and 2002; http://www.nsf.gov/sbe/srs/nsf02321/start.htm. FFRDC's = Federally Funded Research & Development Centers. Includes the obligations of the major R&D supporting agencies which were requested to report this information, together they represent more than 98 percent of the total R&D Federal obligations

Figure A3.19



Sources: Research Equipment Expenditures - National Science Foundation, WebCASPAR Database System from "Survey of Research and Development Expenditures at Universities and Colleges"; http://caspar.nsf.gov. Population - 1981-1989 - Intercensal Estimates of the Total Resident Population of the States, release date Aug. 1996; 1990-1999 - Table CO-EST2001-12-00 - Time Series of Intercensal State Population Estimates: April 1, 1990 to April 1, 2000; Population Division, U.S. Census Bureau; Release Date: April 11, 2002; July 2000-July 2001 -Table NST-EST2003-01 - Annual Estimates of the Population for the United States and States, and for Puerto Rico: April 1, 2000 to July 1, 2003; Population Division, U.S. Census Bureau; Release Date: December 18, 2003

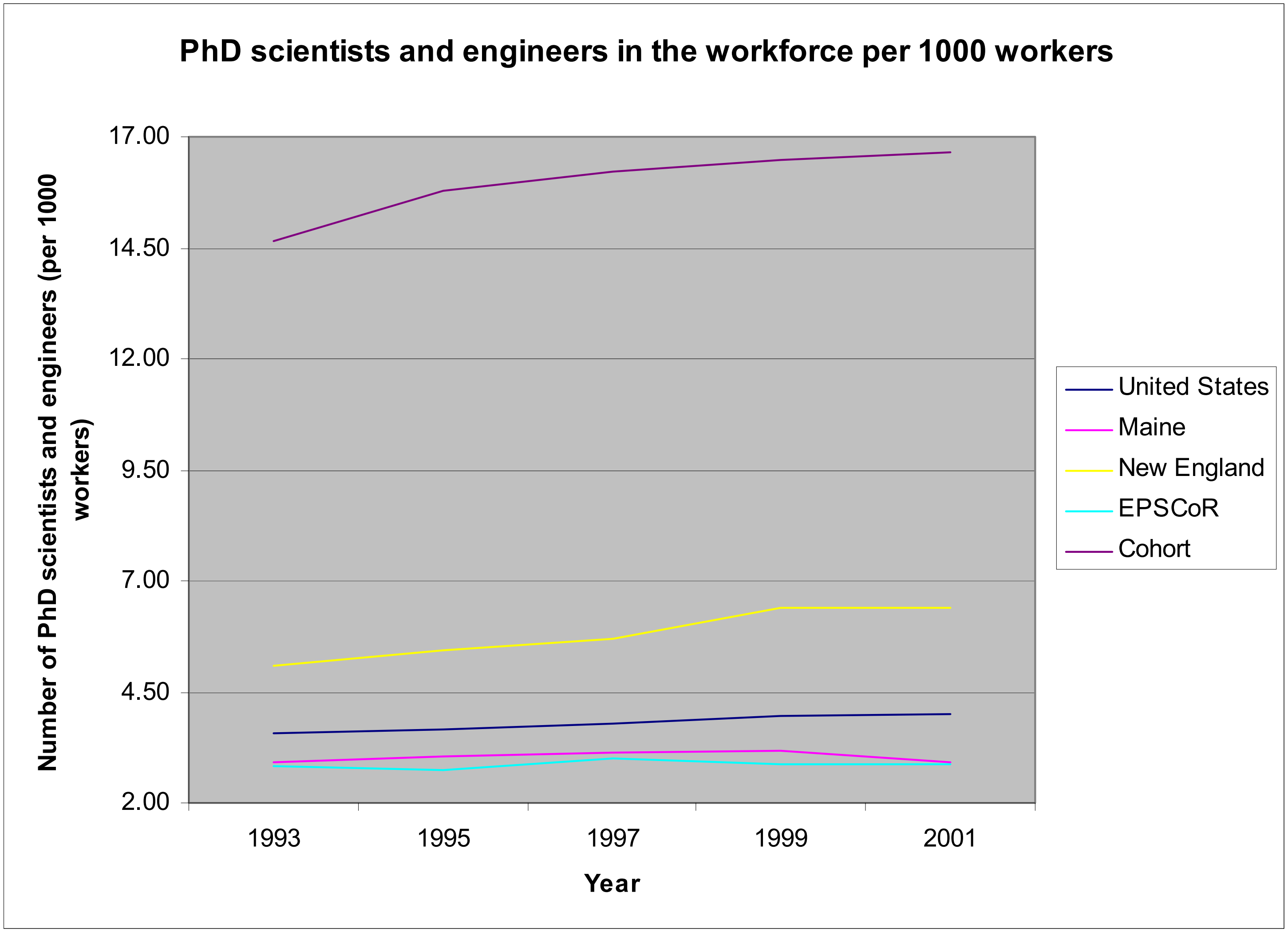
Figure A3.20



Research equipment expenditures percent distribution by institutional control (2001)

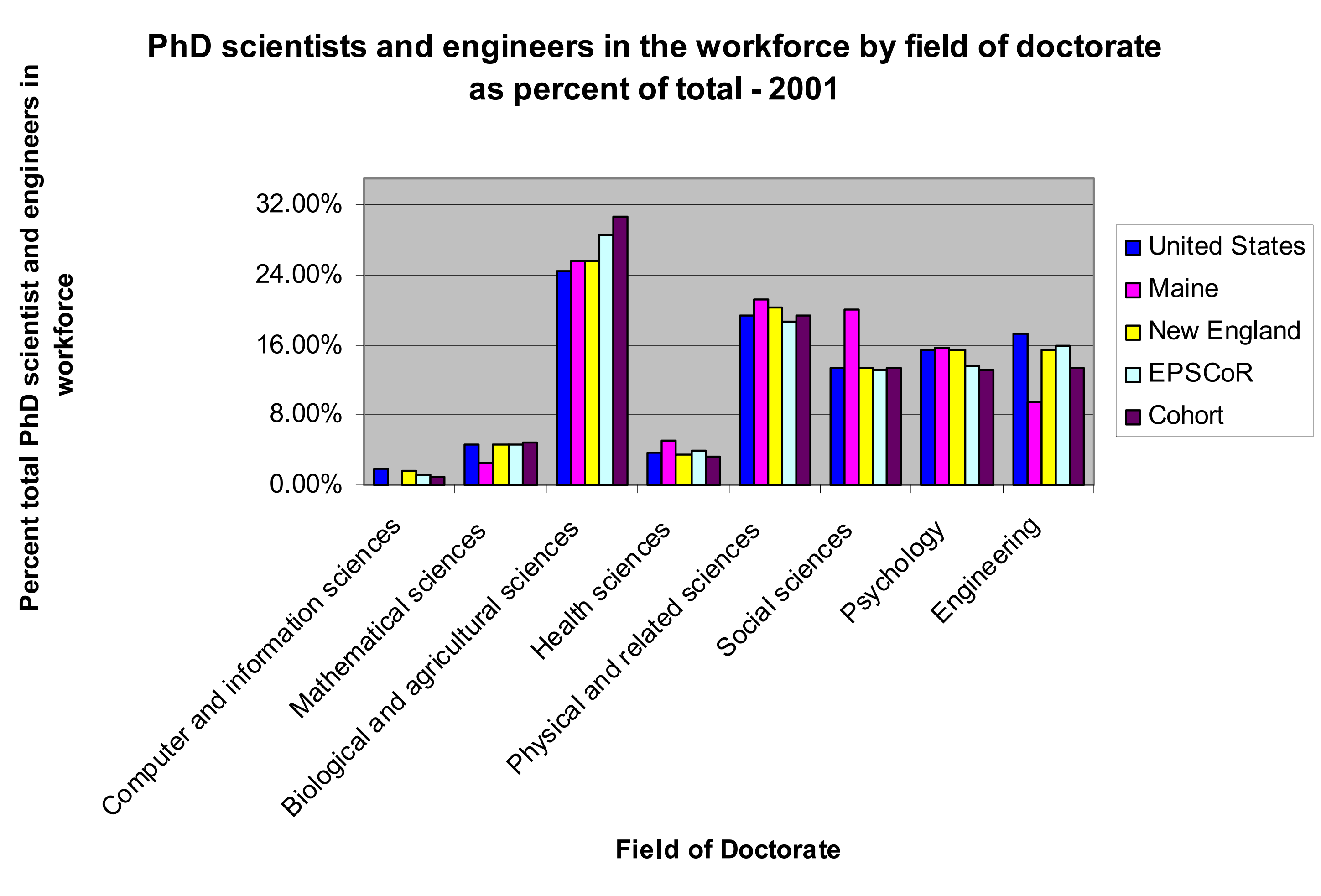
Sources: Research Equipment Expenditures - National Science Foundation, WebCASPAR Database System from "Survey of Research and Development Expenditures at Universities and Colleges"; http://caspar.nsf.gov

Figure A3.21



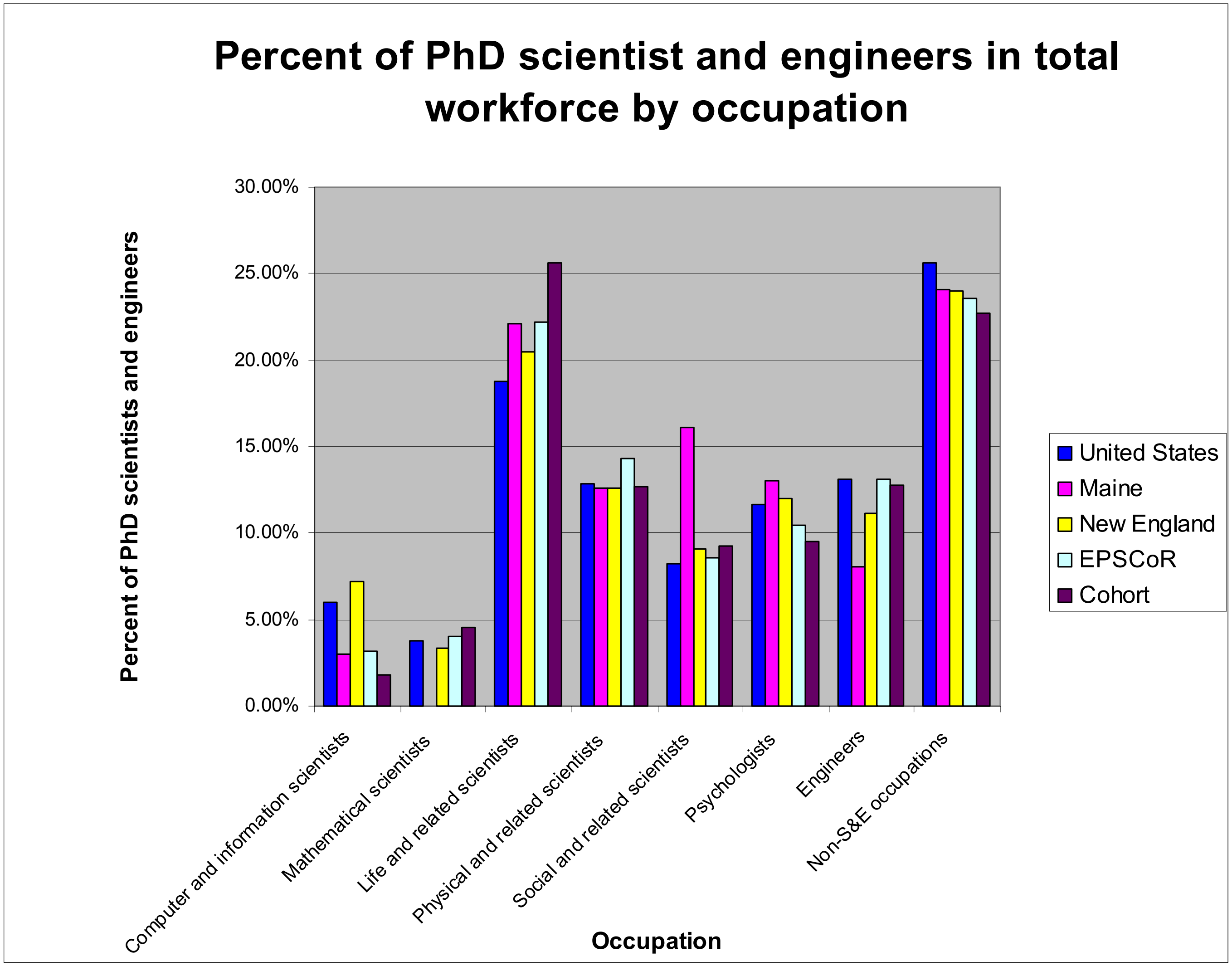
Sources: PhD Scientists and Engineers - National Science Foundation/Division of Science Resources Statistics, Survey of Doctorate Recipients, http://www.nsf.gov/sbe/srs. Workers - Civilian Labor Force - U.S. Department of Labor, Bureau of Labor Statistics, Local Area Unemployment Statistics - http://www.bls.gov/lau/staadoc.htm

Figure A3.22



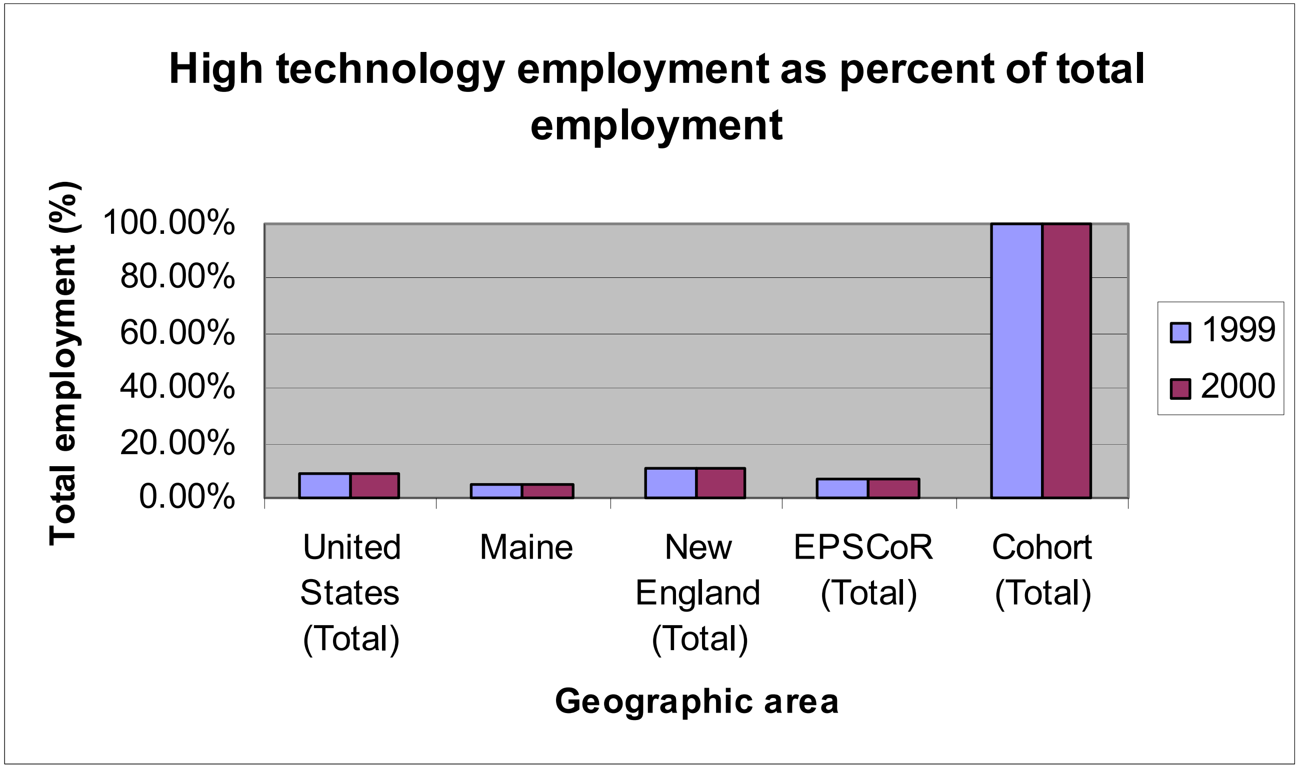
Sources: PhD Scientists and Engineers - National Science Foundation/Division of Science Resources Statistics, Survey of Doctorate Recipients, http://www.nsf.gov/sbe/srs

Figure A3.23



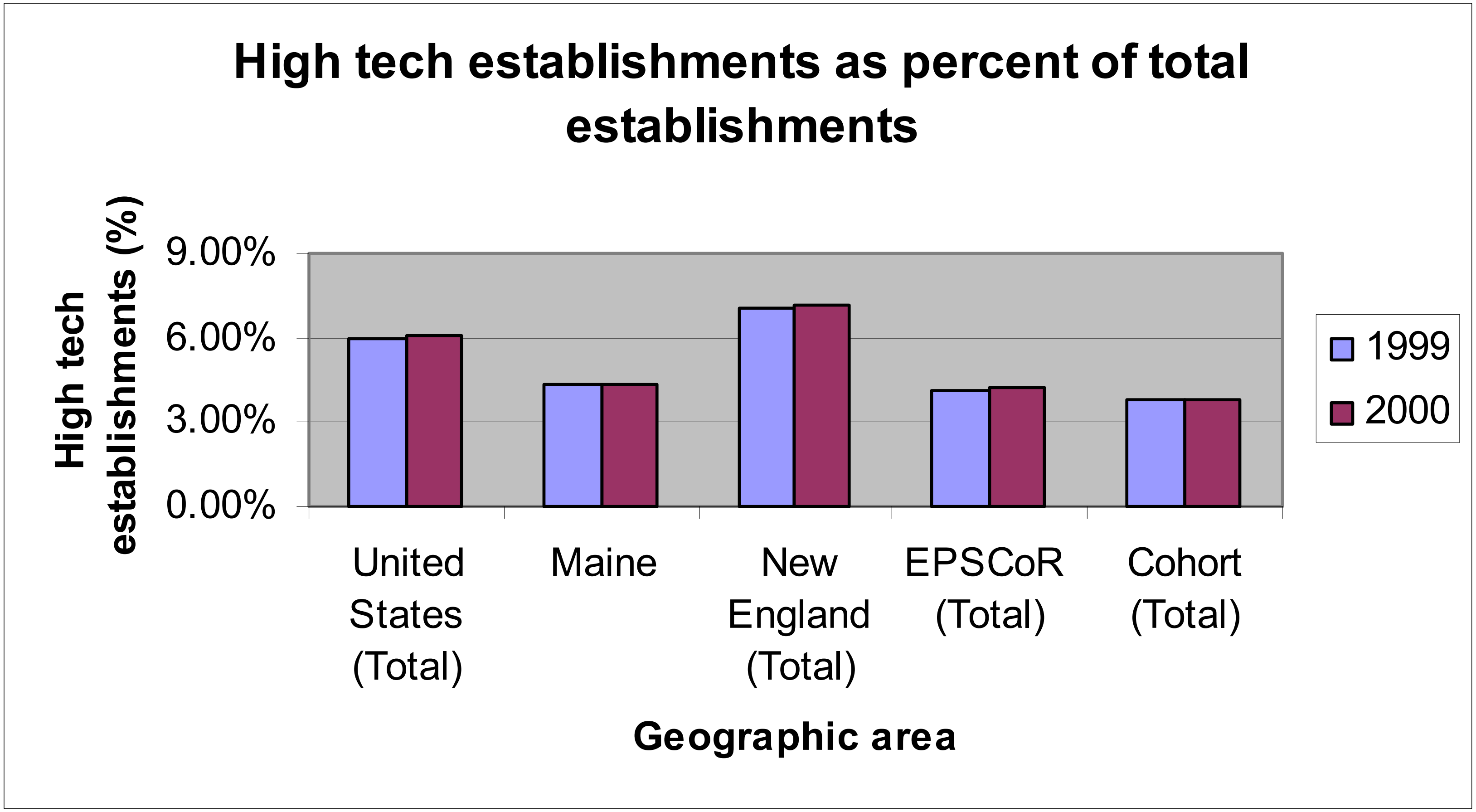
Sources: PhD Scientists and Engineers - National Science Foundation/Division of Science Resources Statistics, Survey of Doctorate Recipients, http://www.nsf.gov/sbe/srs

Figure A3.24



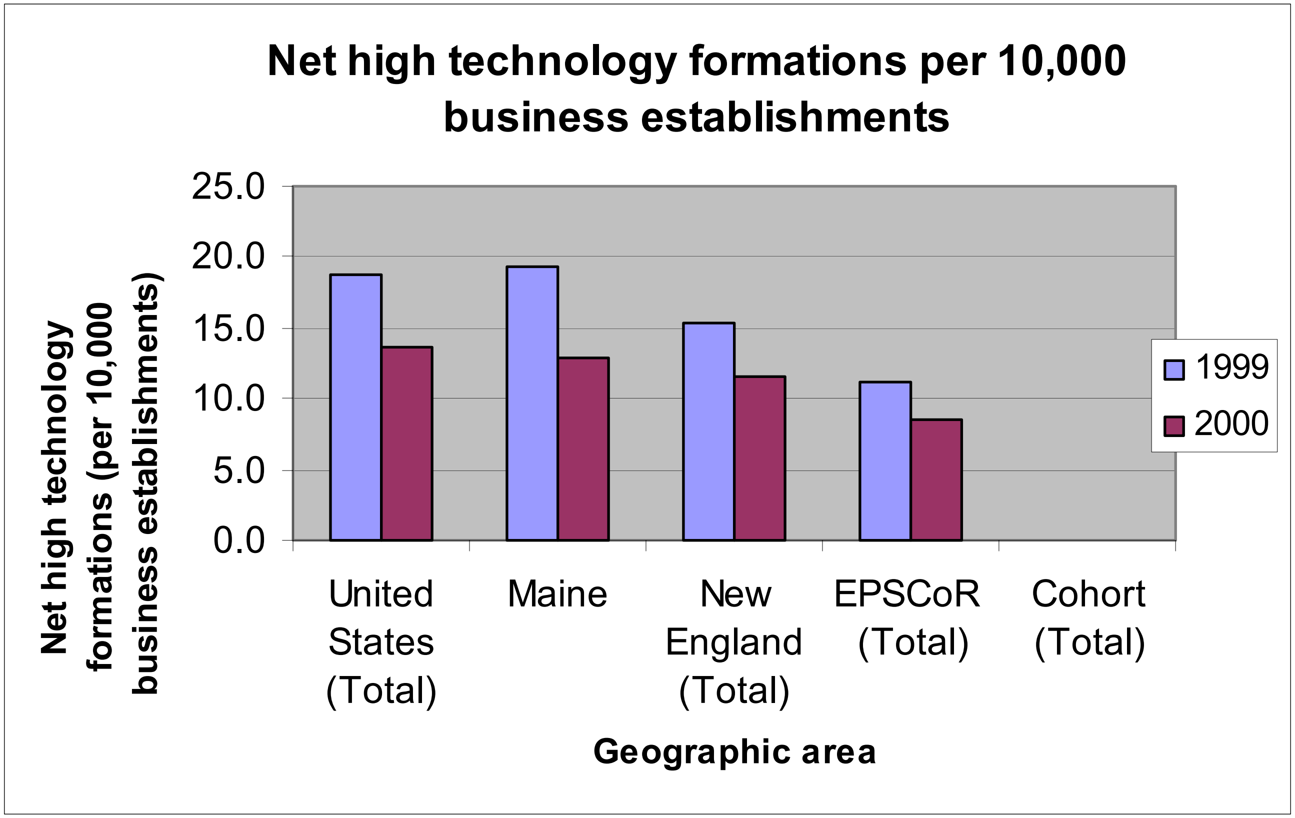
Sources: High Technology Employment - based on special data tabulations from the County Business Patterns, U.S. Census Bureau, U.S Department of Commerce. Total Employment - U.S. Census Bureau, County Business Patterns, http://www.census.gov. Definition of High Technology is from the U.S. Department of Commerce, based on 39 NAICS codes corresponding to high-technology industries.

Figure A3.25



Sources: High Technology Establishments - based on special data tabulations from the County Business Patterns, U.S. Census Bureau, U.S Department of Commerce. Total Establishments - U.S. Census Bureau, County Business Patterns, http://www.census.gov. Definition of High Technology is from the U.S. Department of Commerce, based on 39 NAICS codes corresponding to high-technology industries

Figure A3.26



Sources: High Technology Births, Deaths, and Establishments - based on special data tabulations from the County Business Patterns, U.S. Census Bureau, U.S Department of Commerce. Total Establishments - U.S. Census Bureau, County Business Patterns, http://www.census.gov. Definition of High Technology is from the U.S. Department of Commerce, based on 39 NAICS codes corresponding to high-technology industries.

Table A3.1 Population

Year	Geographic area			
	Maine	New England	EPSCoR	COHORT
1980	1	1	1	1
1981	0.995	0.994	1.000	0.997
1982	0.988	0.987	1.002	0.991
1983	0.995	0.993	1.011	0.987
1984	1.005	1.001	1.016	0.984
1985	1.011	1.009	1.020	0.977
1986	1.017	1.016	1.021	0.970
1987	1.030	1.026	1.021	0.963
1988	1.047	1.036	1.021	0.954
1989	1.061	1.044	1.023	0.948
1990	1.071	1.048	1.029	0.942
1991	1.076	1.049	1.042	0.941
1992	1.077	1.051	1.057	0.940
1993	1.080	1.056	1.071	0.940
1994	1.081	1.061	1.085	0.939
1995	1.081	1.067	1.098	0.938
1996	1.086	1.073	1.109	0.937
1997	1.091	1.080	1.121	0.936
1998	1.095	1.088	1.132	0.933
1999	1.102	1.096	1.142	0.931
2000	1.111	1.105	1.151	0.928
2001	1.117	1.112	1.157	0.923
2002	1.126	1.119	1.166	0.920
2003	1.135	1.125	1.176	0.918

Table A3.2
Total Gross State Product per capita (millions of current dollars) 1980-2001

Geographic area	1980	1990	2000	2001
United States	0.012	0.023	0.035	0.036
Maine	0.009	0.019	0.028	0.029
New England	0.012	0.026	0.042	0.042
EPSCoR	0.011	0.020	0.029	0.030
Cohort	0.009	0.017	0.026	0.026

Table A3.3: Employment rate 1980-2002

	Year																						
Geographic area	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
U.S.	0.47	0.47	0.48	0.48	0.48	0.49	0.49	0.49	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.51	0.50	0.50
Maine	0.45	0.45	0.45	0.47	0.48	0.48	0.48	0.50	0.50	0.50	0.52	0.52	0.53	0.51	0.49	0.51	0.53	0.53	0.52	0.53	0.54	0.53	0.53
New England	0.50	0.50	0.51	0.51	0.52	0.52	0.52	0.53	0.53	0.53	0.54	0.53	0.53	0.53	0.52	0.52	0.52	0.52	0.52	0.52	0.53	0.53	0.53
EPSCoR	0.45	0.45	0.45	0.46	0.46	0.47	0.47	0.47	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Cohort	0.44	0.44	0.45	0.44	0.44	0.45	0.46	0.46	0.47	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.47	0.47

Table A3.4: Per Capita Personal Income 1980-2002, actual $

Geographic area	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
United States (Total)	$10,183	$11,280	$11,901	$12,554	$13,824	$14,705	$15,397	$16,284	$17,403	$18,566	$19,572	$20,023	$20,960	$21,539	$22,340	$23,255	$24,270	$25,412	$26,893	$27,880	$29,760	$30,413	$30,832
Maine	$8,408	$9,231	$9,873	$10,551	$11,665	$12,533	$13,463	$14,595	$15,813	$16,886	$17,473	$17,638	$18,309	$18,749	$19,453	$20,142	$21,163	$22,134	$23,404	$24,218	$25,732	$26,853	$27,804
New England (Total)	$10,701	$11,883	$12,800	$13,755	$15,341	$16,471	$17,638	$19,156	$20,915	$22,200	$22,884	$23,175	$24,299	$24,984	$25,928	$27,040	$28,340	$29,924	$31,829	$33,227	$36,195	$37,096	$37,494
EPSCoR (Average)	$9,263	$10,362	$10,932	$11,334	$12,295	$12,934	$13,313	$13,881	$14,654	$15,749	$16,842	$17,434	$18,325	$18,930	$19,654	$20,252	$21,126	$21,891	$23,051	$23,733	$25,032	$25,939	$26,593
Cohort (Average)	$8,174	$9,081	$9,534	$9,981	$10,898	$11,442	$11,980	$12,547	$13,283	$14,200	$15,158	$15,805	$16,625	$17,279	$17,830	$18,459	$19,183	$19,974	$21,013	$21,576	$22,748	$23,624	$24,337

Table A3.5: Total patents by geographic area

	Year				
Geographic area	1981	1990	1995	2000	2001
United States	43,249	52,977	64,510	97,014	98,666
Maine	93	115	137	151	156
New England	3,655	4,394	5,226	7,562	7,711
EPSCoR	3,182	4,101	4,498	7,201	7,318
Cohort	616	800	956	1,179	1,189

Table A3.6: S&E Graduate students per 1,000 population 1980-2001

Geographic area	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
United States	1.620	1.635	1.650	1.670	1.674	1.698	1.730	1.740	1.736	1.760	1.811	1.863	1.924	1.940	1.917	1.876	1.834	1.787	1.760	1.768	1.753	1.789
Maine	0.415	0.349	0.366	0.445	0.502	0.450	0.460	0.518	0.539	0.547	0.559	0.604	0.690	0.678	0.660	0.724	0.708	0.610	0.577	0.556	0.507	0.514
New England	2.376	2.330	2.394	2.442	2.257	2.310	2.335	2.313	2.493	2.441	2.559	2.603	2.661	2.730	2.750	2.765	2.710	2.603	2.655	2.652	2.629	2.706
EPSCoR	1.074	1.090	1.114	1.135	1.066	1.069	1.084	1.117	1.204	1.259	1.315	1.382	1.463	1.505	1.512	1.502	1.477	1.421	1.399	1.377	1.361	1.428
Cohort	6.699	7.156	7.767	7.035	6.306	6.171	6.282	6.222	6.696	6.828	7.212	7.710	8.483	8.992	8.939	9.110	8.871	8.562	8.678	8.405	8.026	8.119

Table A3.7: Total SBIR & STTR $ as a % of Gross State Product, 1997-2001

Geographic area	1997	1998	1999	2000	2001
United States	0.0145%	0.0128%	0.0118%	0.0115%	0.0120%
Maine	0.0052%	0.0041%	0.0064%	0.0082%	0.0090%
New England	0.0501%	0.0424%	0.0389%	0.0373%	0.0365%
EPSCoR	0.0071%	0.0061%	0.0064%	0.0076%	0.0072%
Cohort	0.0018%	0.0000%	0.0027%	0.0000%	0.0035%

Table A3.8: Investments in $ millions

Geographic area	1995	1996	1997	1998	1999	2000	2001	2002	2003
United States (Total)	$7,627.2	$11,522.0	$14,799.5	$21,258.8	$54,525.3	$105,859.1	$40,582.0	$21,409.4	$18,186.9
Maine	$1.5	$1.5	$9.7	$61.8	$57.4	$140.2	$35.5	$14.4	$12.9
New England (Total)	$878.0	$1,382.3	$1,756.7	$2,624.8	$6,117.0	$12,980.7	$5,768.2	$2,927.5	$2,951.9
EPSCoR (Total)	$195.0	$318.3	$366.1	$528.2	$1,043.0	$1,601.1	$541.1	$335.0	$355.1
Cohort	$58.4	$94.6	$75.5	$61.4	$116.5	$271.2	$60.0	$36.9	$67.3

Table A3.9: Total R&D as a percent of GSP 1987-2000

Geographic area	1987	1989	1991	1993	1995	1997	1998	1999	2000
United States (Total)	2.697%	2.623%	2.729%	2.544%	2.512%	2.579%	2.587%	2.633%	2.675%
Maine	0.394%	0.315%		0.449%	1.234%	0.489%	0.494%	0.659%	0.879%
New England (Total)	3.916%	3.752%	3.071%	3.666%	3.947%	3.575%	4.027%	3.778%	3.595%
EPSCoR (Total)	1.582%	1.149%	1.162%	1.167%	1.234%	1.192%	1.187%	1.215%	1.153%
Cohort (Total)	0.885%	0.532%	0.570%	0.947%	1.251%	1.193%	1.098%	1.067%	1.135%

Table A3.10: Industry R&D as a percent of GSP 1987-2000

Geographic area	1987	1989	1991	1993	1995	1997	1998	1999	2000
United States	1.925%	1.845%	1.945%	1.772%	1.776%	1.889%	1.910%	1.950%	2.000%
Maine	0.212%	0.143%		0.233%	1.022%	0.273%	0.255%	0.411%	0.554%
New England	2.880%	2.818%	2.246%	2.703%	3.087%	2.758%	3.258%	3.022%	2.832%
EPSCoR	0.979%	0.507%	0.478%	0.536%	0.656%	0.664%	0.622%	0.653%	0.599%
Cohort	0.617%	0.334%	0.377%	0.543%	0.769%	0.754%	0.653%	0.614%	0.677%

Table A3.11: University & College R&D as a percent of GSP 1987-2001

Geographic area	1987	1989	1991	1993	1995	1997	1998	1999	2000	2001
United States	0.273%	0.289%	0.309%	0.315%	0.309%	0.302%	0.299%	0.304%	0.313%	0.323%
Maine	0.088%	0.087%	0.115%	0.098%	0.114%	0.109%	0.109%	0.130%	0.159%	0.182%
New England	0.386%	0.406%	0.441%	0.468%	0.435%	0.419%	0.411%	0.408%	0.404%	0.430%
EPSCoR	0.203%	0.216%	0.244%	0.250%	0.257%	0.249%	0.270%	0.274%	0.281%	0.298%
Cohort	0.154%	0.180%	0.212%	0.243%	0.279%	0.280%	0.291%	0.287%	0.307%	0.341%

Table A3.12: Not for Profit R&D as a percent of GSP 1987-2000

Geographic area	1987	1989	1991	1993	1995	1997	1998	1999	2000
United States	0.034%	0.038%	0.045%	0.044%	0.039%	0.037%	0.037%	0.041%	0.044%
Maine	0.067%	0.067%	0.070%	0.067%	0.083%	0.088%	0.096%	0.103%	0.152%
New England	0.230%	0.139%	0.142%	0.157%	0.154%	0.153%	0.156%	0.167%	0.188%
EPSCoR	0.015%	0.016%	0.018%	0.012%	0.012%	0.012%	0.013%	0.013%	0.017%
Cohort	0.010%	0.011%	0.013%	0.006%	0.009%	0.013%	0.005%	0.010%	0.014%

Table A3.13: All other R&D as a percent of GSP 1987-2000

Geographic area	1987	1989	1991	1993	1995	1997	1998	1999	2000
United States	0.465%	0.450%	0.430%	0.414%	0.388%	0.351%	0.341%	0.338%	0.317%
Maine	0.028%	0.019%	0.059%	0.051%	0.015%	0.019%	0.034%	0.015%	0.013%
New England	0.421%	0.330%	0.356%	0.337%	0.272%	0.246%	0.202%	0.179%	0.170%
EPSCoR	0.385%	0.388%	0.363%	0.369%	0.309%	0.268%	0.281%	0.284%	0.256%
Cohort	0.104%	0.143%	0.124%	0.155%	0.194%	0.146%	0.149%	0.156%	0.136%

Table A3.14: R&D Performance by sector as a percent of Total – 2000

Geographic area	Industry	Univ. & Coll.	Not for profit	All Other
United States	74.77%	11.71%	1.66%	11.87%
Maine	63.06%	18.12%	17.32%	1.49%
New England	78.78%	11.25%	5.23%	4.74%
EPSCoR	51.92%	24.39%	1.49%	22.20%
Cohort	59.66%	27.07%	1.26%	12.01%

Table A3.15: University & college R&D by field of study as a % of total - 2001

Geographic area	Engineering	Physical Sciences	Environ-mental Sciences	Math & Computer Sciences	Life Sciences	Psychology	Social Sciences	Other Sciences
United States	15.28%	8.56%	5.58%	4.01%	58.64%	1.78%	4.39%	1.77%
Maine	12.94%	9.51%	30.38%	2.41%	37.70%	0.37%	5.38%	1.30%
New England	13.65%	9.95%	8.89%	4.54%	53.17%	2.05%	4.57%	3.18%
EPSCoR	16.24%	7.31%	8.23%	2.68%	54.94%	1.46%	3.76%	5.38%
Cohort	17.84%	7.70%	4.64%	1.85%	60.43%	0.77%	4.77%	2.00%

Table A3.16: Total Federal R&D obligations as a percent of GSP 1980-2000

Geographic area	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
United States	1.048%	1.040%	1.099%	1.092%	1.064%	1.137%	1.155%	1.154%	1.089%	1.099%	1.088%	1.015%	1.032%	1.009%	0.950%	0.913%	0.859%	0.833%	0.808%	0.798%	0.720%
Maine	0.254%	0.218%	0.198%	0.223%	0.256%	0.228%	0.204%	0.922%	0.184%	0.293%	0.169%	0.242%	0.248%	0.257%	0.310%	0.190%	0.196%	0.226%	0.328%	0.442%	0.689%
New England	1.944%	1.994%	2.081%	1.954%	1.879%	1.919%	1.702%	1.816%	1.202%	1.204%	1.210%	1.326%	1.249%	1.322%	1.196%	1.219%	1.125%	1.079%	0.919%	0.878%	1.038%
EPSCoR	0.760%	0.782%	0.803%	0.863%	0.795%	0.851%	0.914%	0.849%	0.832%	0.841%	0.897%	0.811%	0.826%	0.791%	0.667%	0.642%	0.650%	0.619%	0.592%	0.570%	0.560%
Cohort	0.413%	0.381%	0.315%	0.273%	0.244%	0.232%	0.244%	0.264%	0.270%	0.302%	0.318%	0.365%	0.295%	0.308%	0.303%	0.320%	0.323%	0.252%	0.275%	0.277%	0.288%

Table A3.17: Federal R&D obligations by Performance Sector as a percent of total – 2000

Geographic area	Intramural	Industrial	Univ. & Coll.	Not for profit	State & Local Gov	FFRDC's
United States	23.18%	38.79%	23.28%	5.56%	0.27%	8.92%
Maine	1.90%	67.20%	8.42%	22.10%	0.37%	0.00%
New England	9.32%	42.29%	25.76%	18.12%	0.16%	4.36%
EPSCoR	26.21%	25.73%	21.15%	3.08%	0.43%	23.39%
Cohort	32.98%	15.86%	37.20%	4.01%	0.66%	9.29%

Table A3.18: Federal R&D Obligations by agency source of Funds as a percent of total – 2000

Geographic area	Dept of Agriculture	Dept of Commerce	Dept of Defense	Dept of Energy	Dept of Health & Human Services	Dept of Interior	Dept of Transport	EPA	NASA	NSF
United States	2.45%	1.45%	46.26%	8.51%	25.76%	0.81%	0.66%	0.70%	9.60%	3.81%
Maine	2.10%	0.94%	70.85%	0.32%	20.22%	0.98%	0.13%	0.08%	0.63%	3.74%
New England	0.91%	0.93%	52.50%	1.82%	34.22%	0.44%	0.98%	0.47%	3.27%	4.46%
EPSCoR	6.35%	1.40%	35.48%	26.61%	16.11%	1.53%	0.48%	0.64%	7.54%	3.87%
Cohort	14.86%	2.42%	17.65%	15.39%	31.95%	2.62%	0.30%	0.74%	4.05%	10.03%

Table A3.19: Total research equipment expenditures at universities and colleges per 1,000 residents 1981-2001 (000's of $)

Geographic area	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
United States	1,797	1,840	1,927	2,276	2,823	3,260	3,455	3,730	3,996	4,058	4,053	4,032	4,009	4,206	4,651	4,504	4,723	4,691	4,722	5,035	5,228
Maine	570	435	1,031	451	904	811	1,405	1,196	684	688	915	889	743	1,283	1,445	1,779	1,448	1,657	2,824	3,276	4,065
New England	2,858	2,964	3,504	4,227	5,107	5,908	5,699	6,306	5,997	6,079	6,284	7,054	6,998	6,659	8,031	7,893	6,885	7,541	7,145	8,350	8,521
EPSCoR	1,229	1,227	1,304	1,407	1,894	2,122	2,242	2,622	2,999	3,366	3,762	3,309	3,214	3,427	4,135	3,535	3,793	4,102	3,971	4,529	5,254
Cohort	6,020	7,029	5,354	6,856	10,553	11,137	10,741	12,510	14,438	18,688	17,310	17,627	17,716	19,153	21,522	14,997	17,184	20,004	20,424	24,858	25,590

Table A3.20: Research equipment expenditures % Distribution by institutional control – 2001

Geographic area	Public Institutions	Private Institutions
United States (Total)	69.54%	30.46%
Maine	94.71%	5.29%
New England (Total)	28.07%	71.93%
EPSCoR (Total)	96.15%	3.85%
Cohort (Total)	99.58%	0.42%

Table A3.21: PhD Scientists and Engineers in the workforce by field of doctorate as a percent of total – 2001

Geographic area	Computer and information sciences	Mathematical sciences	Biological and agricultural sciences	Health sciences	Physical and related sciences	Social sciences	Psychology	Engineering
United States	1.88%	4.52%	24.49%	3.72%	19.37%	13.25%	15.46%	17.32%
Maine	0.00%	2.51%	25.63%	5.03%	21.11%	20.10%	15.58%	9.55%
New England	1.52%	4.62%	25.59%	3.56%	20.36%	13.41%	15.37%	15.47%
EPSCoR	1.21%	4.60%	28.52%	3.95%	18.62%	13.05%	13.54%	15.98%
Cohort	0.91%	4.90%	30.58%	3.27%	19.42%	13.25%	13.07%	13.34%

Table A3.22: PhD Scientist and Engineers in the workforce by occupation as a percent of total – 2001

Geographic area	Computer and information scientists	Mathematical scientists	Life and related scientists	Physical and related scientists	Social and related scientists	Psychologists	Engineers	Non-S&E occupations
United States	6.03%	3.81%	18.76%	12.84%	8.21%	11.63%	13.12%	25.60%
Maine	3.02%	0.00%	22.11%	12.56%	16.08%	13.07%	8.04%	24.12%
New England	7.17%	3.37%	20.51%	12.63%	9.13%	12.02%	11.11%	23.97%
EPSCoR	3.13%	4.04%	22.18%	14.30%	8.55%	10.47%	13.13%	23.56%
Cohort	1.81%	4.54%	25.59%	12.70%	9.26%	9.53%	12.79%	22.69%

Table A3.23: High Tech employment as a percent of total employment 1999-2000

Geographic Area	1999	2000
United States (Total)	8.89%	8.84%
Maine	5.06%	5.35%
New England (Total)	10.72%	10.77%
EPSCoR (Total)	6.95%	6.91%
Cohort (Total)	100.00%	100.00%

Table A3.24: Net High Technology formations per 10,000 business Establishments 1999-2000

Geographic Area	1999	2000
United States	18.8	13.7
Maine	19.3	12.9
New England	15.4	11.5
EPSCoR	11.1	8.5
Cohort	0.0	0.0

APPENDIX 4

Survey of Research Institutions 2003

Most of Maine's public and non-profit research institutions that received state research and development funding from 1996 to 2003 responded to a survey sent in October 2003. The respondents were the University of Maine, Orono, the University of Southern Maine, the Jackson Laboratory, Maine Medical Center Research Institute, Wells National Estuarine Research Reserve, Maine Maritime Academy, Mount Desert Island Biological Laboratory, University of New England, College of Osteopathic Medicine, The University of Maine at Machias/Downeast Institute for Applied Marine Research and Education, and the Foundation for Blood Research.

The respondents were chosen because they had received funding during the period from one or more state-funded research and development investments. Specifically, these were:

- Maine Biomedical Research Program
- EPSCoR
- Marine Technology Fund
- Research Challenge Grants Program
- Marine Connectivity
- 1998 Referendum Bond
- $25 million University Bond
- Maine Economic Improvement Fund
- Strategic Technology Initiative.

These programs are described in detail in *Initial Evaluation*, Appendix 2, 2001.

The survey, included in appendix 5, asked the institutions to describe their institutional capacity for research and development as well as for indicators of specific outcomes of research and development activities such as publications, research grants and patents. The institutions were asked to distinguish between the total activity at their institution and those specifically funded by the state research and development funds.

FY 2003	2003				2002			
Institutional Research Capacity TOTAL	Total		Total Attributable to State R&D Funding		Total		Total Attributable to State R&D Funding	
INSTITUTIONAL CAPACITY	Number	Value	Number	Value	Number	Value	Number	Value
a. Number (FTE) of enrolled science & engineering graduate students.	496		341		1,102		1,099	
b. Number of science & engineering graduate degrees awarded.	152		140		207		207	
c. Number of degree programs.	278		179		83		0	
d. Number (FTE) undergraduate students enrolled in science & engineering majors.	3,593		2,425		7,565		7,565	
e. Number (FTE) of undergraduate students participating in science & engineering programs.	6,927		5,115		8,114		8,101	
f. Number (FTE) of graduate students participating in science & engineering programs.	492		410					
g. R&D space (new or renovated this fiscal year)	274,713		34,639		837,660		645,733	
h. Current, depreciated, value of facilities & fixed equipment		$252,307,676		$135,884,788		$277,115,710		$139,821,518
i. Major (purchase price >$50,000) research equipment purchased this year.		$2,980,801		$2,506,031		$22,632,050		$19,229,239
j. Number of positions (FTE):								
(1) Faculty	882		453		904		455	
(2) Non-faculty PIs (Post Docs)	143		46		99		24	
(3) Technical and professional staff	1,850		455		1,834		493	
(4) Students	257		222		674		230	
(5) Support personnel	995		160		907		214	
(6) Administrative	31		31		0		0	
Total FTE's	4,158		1,367		4,417		1,416	

FY 2003	2003				2002			
Institutional Research Capacity TOTAL	Total		Total Attributable to State R&D Funding		Total		Total Attributable to State R&D Funding	
RESEARCH & DEVELOPMENT OUTCOMES	**Number**	**Value**	**Number**	**Value**	**Number**	**Value**	**Number**	**Value**
A. Publications								
1. Number of scientific peer-reviewed journal articles published.	1,064		837		861		810	
2. Number of scientific peer-reviewed book chapters published.	207		199		41		40	
3. Number of scientific peer-reviewed books published.	47		44		70		69	
4. Number of other papers published.	526		353		278		264	
5. Number of other papers not published (e.g. research reports for industry).	1,658		1,561		621		609	
B. Research Proposals								
1. Number of peer-reviewed and/or competitive research proposals submitted.	930		768		849		692	
2. Dollar Value of these proposals (face value)		$348,739,720		$255,435,244		$281,817,458		$237,725,518
3. Number & value of these proposals submitted jointly w/ other Maine institutions only	48	$60,967,508	15	$33,987,700	43	$12,114,583	38	$5,872,714
4. Number & value of these proposals submitted jointly w/ non-Maine institutions only	57	$27,611,927	37	$18,838,518	83	$17,256,846	80	$16,986,489
5. Number & value of proposals submitted jointly w/ both Maine & non-Maine institutions.	35	$35,752,444	28	$17,976,045	24	$13,093,005	20	$12,329,348

FY 2003	2003				2002			
Institutional Research Capacity TOTAL	Total		Total Attributable to State R&D Funding		Total		Total Attributable to State R&D Funding	
	Number	Value	Number	Value	Number	Value	Number	Value
C. Research Awards								
1. Number & value of new Federal research grants, contracts, subcontracts awarded (total value for all costs & all years)	357	$96,494,300	327	$87,316,983	492	$115,037,993	448	$104,742,815
2. Number & value of these awarded under EPSCOR (total value for all costs and all years)	7	$16,176,273	6	$16,004,047	5	$2,878,875	4	$750
3. Number & value of these that were earmarked (total value for all costs & all years)	9	$5,732,798	7	$5,242,798	5	$3,851,260	1	$2,951,260
4. Federal obligations for research and development for FY03	0	$68,503,231	0	$57,216,263	n/a		n/a	
5. Number & value of industrial research grants, contracts and subcontracts awarded (total value for all costs and all years)	244	$5,735,645	202	$3,320,064	34	$410,624	3	$3,806,336
6. Number & value of these industrial research grants, contracts and subcontracts awarded by Maine companies (total value for all costs and all years).	19	$75,188	0	$0				
7. Number & value of new foundation/individual grants and gifts	41	$7,417,437	15	$2,108,079	24	$3,189,580	11	$2,655,684
Total	**7**	**$1,900,532**	**7**	**$1,900,532**				

FY 2003	**2003**				**2002**			
Institutional Research Capacity TOTAL	**Total**		**Total Attributable to State R&D Funding**		**Total**		**Total Attributable to State R&D Funding**	
	Number	**Value**	**Number**	**Value**	**Number**	**Value**	**Number**	**Value**
D. Intellectual Property								
1. Number of disclosures made.	38		29		16		14	
2. Number of patents applied for.	18		11		12		9	
3. Number of patents awarded.	7		4		n/a		n/a	
4. Number of copyrights obtained.	0		0		1		1	
5. Number of plant breeder's rights obtained.	1		1		1		1	
6. Number of licensing agreements signed this year.	145		145		2		2	
7. Number of licensing agreements signed this year with Maine companies.	2		2		0		0	
8. License income received this year.		$279,000		$263,000		$150,000		$150,000
E. Spin-off Companies								
1. Number of new companies formed.	6		6		0		0	
2. Number of jobs in these companies at spin-off.	16		16		0		0	

Cautions:

Numbers attributable to State R&D Funding in 2002 survey may not be accurate.

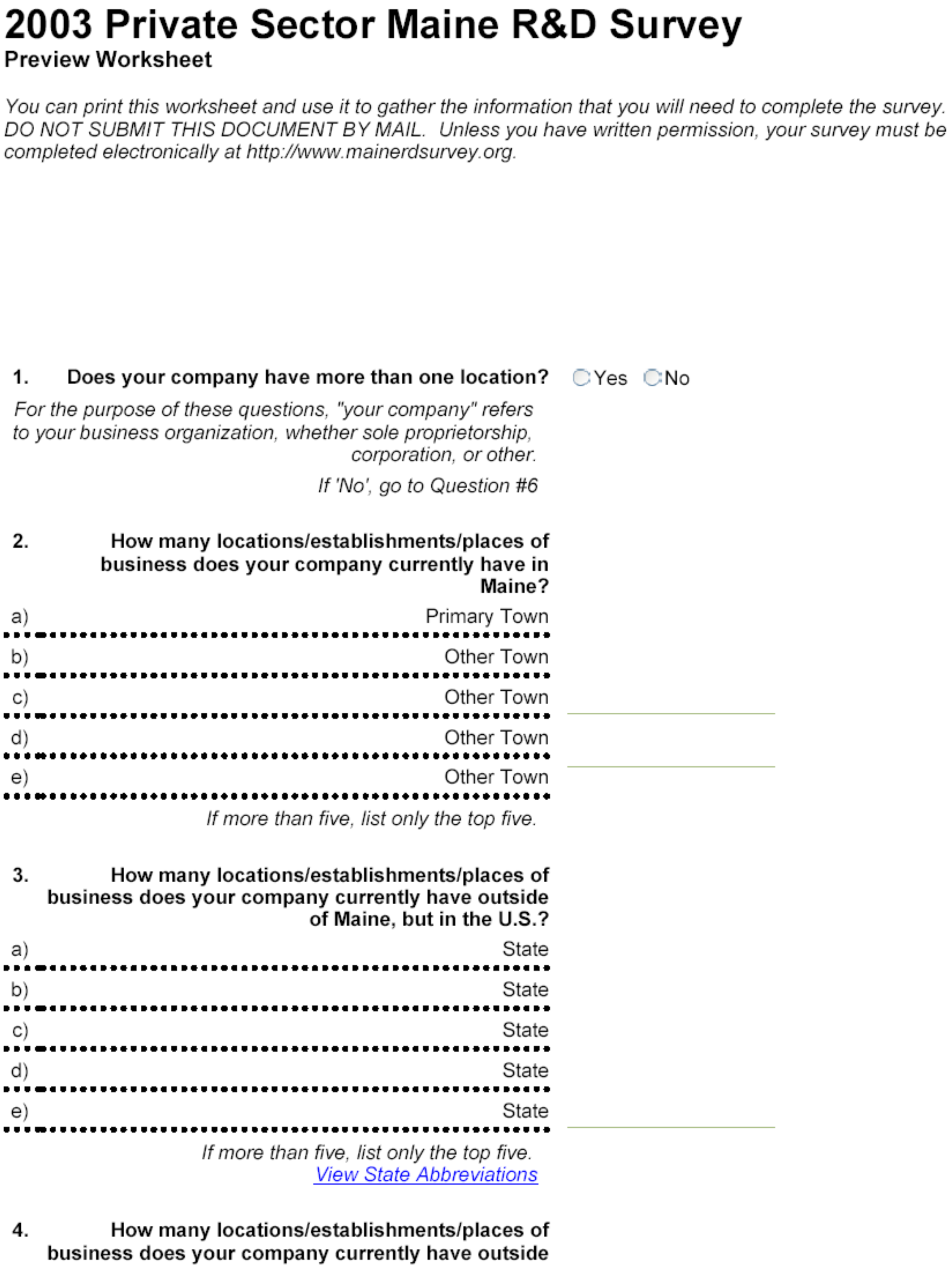
Ten entities responded to FY 2003 survey; five responded to FY 2002.

Umaine, Jackson Labs, University Southern Maine, Maine Maritime, MMCRI, Foundation for Blood Research, MDIBL, Umaine Machias, Wells, UNE Osteopathic Medicine.

APPENDIX 5

Survey Instruments

Two survey instruments were developed in 2002 and revised in 2003 with the assistance of the Advisory Council. The instruments were designed to be used with the educational and research institutions that received funding from the state to enhance their capacity and with private companies and individuals that received assistance from one of the programs. The private sector instrument was closely coordinated with the Maine Technology Institute because they also are required to conduct an evaluation. The Maine Technology Institute instrument contains all of these questions as well as additional questions germane to their program only.



2003 Private Sector Maine R&D Survey

Preview Worksheet

You can print this worksheet and use it to gather the information that you will need to complete the survey. DO NOT SUBMIT THIS DOCUMENT BY MAIL. Unless you have written permission, your survey must be completed electronically at http://www.mainerdsurvey.org.

1. Does your company have more than one location? ○ Yes ○ No

For the purpose of these questions, "your company" refers to your business organization, whether sole proprietorship, corporation, or other.

If 'No', go to Question #6

2. How many locations/establishments/places of business does your company currently have in Maine?

a) Primary Town
b) Other Town
c) Other Town
d) Other Town
e) Other Town

If more than five, list only the top five.

3. How many locations/establishments/places of business does your company currently have outside of Maine, but in the U.S.?

a) State
b) State
c) State
d) State
e) State

If more than five, list only the top five.
View State Abbreviations

4. How many locations/establishments/places of business does your company currently have outside

the U.S.?

a) Country

b) Country

c) Country

d) Country

e) Country

If more than five, list only the top five.

5. Where is your company's headquarters?

a) City

b) State/Province

c) Country

View State Abbreviations

6. In the last completed fiscal year, has your company

a) Been acquired? ○ Yes ○ No

b) Purchased other companies? ○ Yes ○ No

c) Had an Initial Public Offering (IPO)? ○ Yes ○ No

d) Other change in organizational structure

7. In what year was your company first organized?

Use year of incorporation, partnership, formation, or comparable year.

8. In what month does your fiscal year end?

○ January
○ February
○ March
○ April
○ May
○ June
○ July
○ August
○ September
○ October
○ November

○ December

9. Employees, Wages, and Salaries.

a) How many employees did your company have last month, including the owner?

b) How many employees did your company have twelve months ago, including the owner?

c) What was the total value of wages and salaries paid to your employees (excluding the employer share of benefits) in the last full fiscal year?

10. What were your company's total revenues in the last completed fiscal year?

a) What percentage of the above total revenue is attributable to sales of products and services (enter a number between 0 and 100 with <u>no</u> percent sign)?

b) What percentage of the above total revenue is attributable to grants and research contracts (enter a number between 0 and 100 with <u>no</u> percent sign)?

c) What percentage of the above total revenue is attributable to other sources?

d) What were your company's total revenues in the prior fiscal year?

The total of (a), (b), and (c) should be 100 percent.

11. How much corporate income tax did your company pay to the State of Maine for the last tax year?

Enter '0' if you did not pay any Maine corporate income taxes in the last tax year.

12. Indicate the dollar amount of Maine R&D Tax Credits your company claimed in the last tax year for each of the following programs:

a) Research Expense Tax Credit

b) Super Tax Credit for Substantially Increased R&D

c) High Technology Investment Tax Credit

If none, please enter '0'.

13. What percentage of your company's sales for your last completed fiscal year were made to customers

a) In Maine?

b) Outside of Maine, but in New England?

c) Outside of New England, but in the U.S.?

d) Outside of the U.S.?

For each question, enter a number between 0 and 100 with no percent sign. The total of a-d should equal 100%. Estimate as closely as possible.

14. Did you receive any new debt financing in the last completed fiscal year? ○ Yes ○ No

If 'No', go to Question #16

15. Please indicate the amount from each source of all new debt financing you received in the last completed fiscal year.

a) Bank

b) Small Business Administration Guaranteed Loans

c) Friends and Family

d) Other

Enter 0 for those categories in which you did not receive any financing.

16. Did you receive any new equity funding in the last completed fiscal year? ○ Yes ○ No

If 'No', go to Question #18

17. Please indicate the amount from each source of all new equity financing you have received in the last completed fiscal year.

a) Venture Capital Firms

b) State Seed Capital Funds (e.g. Small Enterprise Growth Fund)

c) Angel Investors

d) Friends and Family

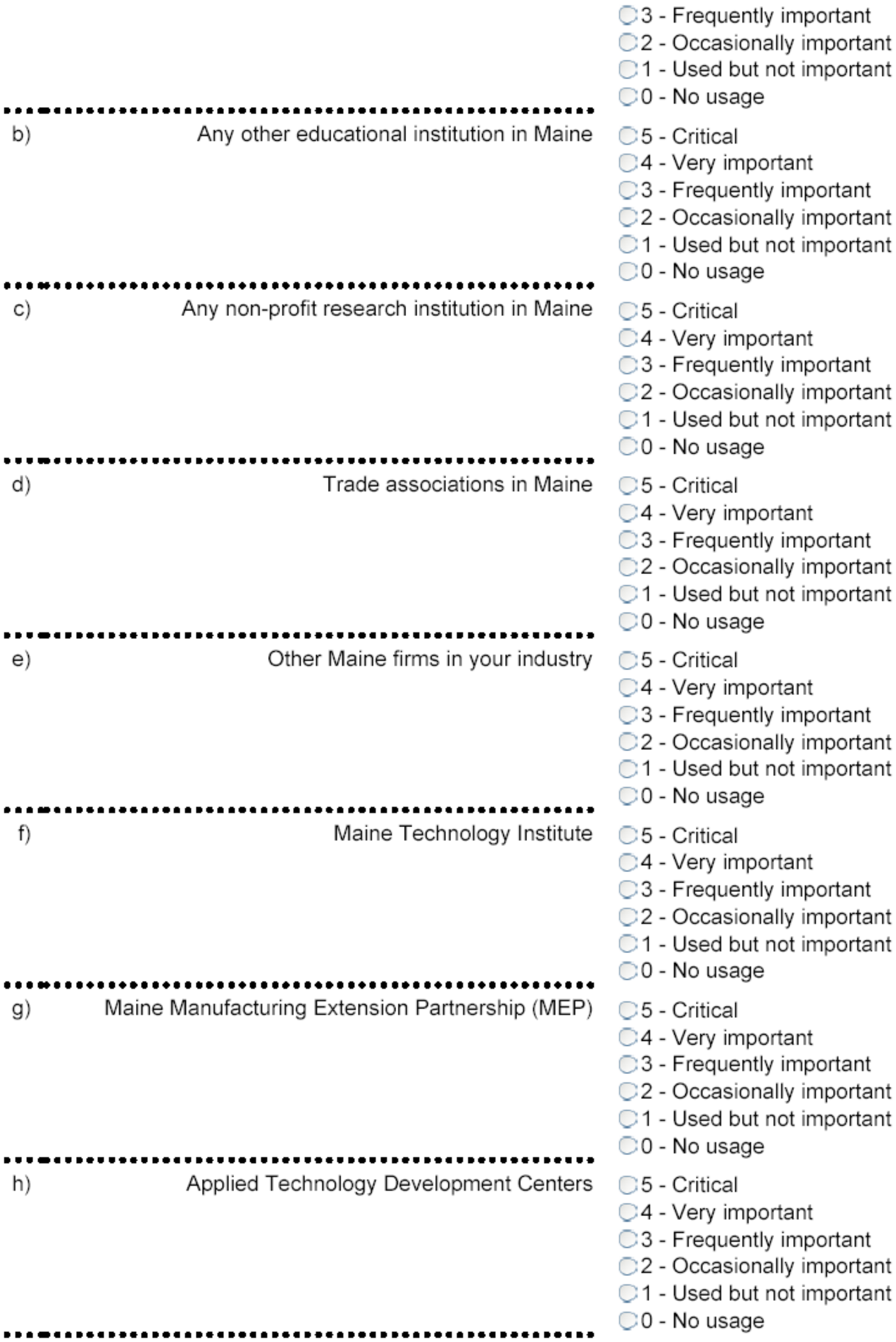
e) Other

Enter 0 for those categories in which you did not receive any financing.

18. With respect to your company's research and development activities, please rank your usage of and the importance of each of the following support organizations.

a) Any campus of the University of Maine system

○ 5 - Critical
○ 4 - Very important



○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

b) Any other educational institution in Maine

○5 - Critical
○4 - Very important
○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

c) Any non-profit research institution in Maine

○5 - Critical
○4 - Very important
○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

d) Trade associations in Maine

○5 - Critical
○4 - Very important
○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

e) Other Maine firms in your industry

○5 - Critical
○4 - Very important
○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

f) Maine Technology Institute

○5 - Critical
○4 - Very important
○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

g) Maine Manufacturing Extension Partnership (MEP)

○5 - Critical
○4 - Very important
○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

h) Applied Technology Development Centers

○5 - Critical
○4 - Very important
○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

i) Maine Patent Program

○5 - Critical
○4 - Very important
○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

j) Maine Small Business Development Centers (SBDC)

○5 - Critical
○4 - Very important
○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

k) Market Development Center (MDC)

○5 - Critical
○4 - Very important
○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

l) Educational or research institutions, outside Maine

○5 - Critical
○4 - Very important
○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

m) Other firms in your industry, outside Maine

○5 - Critical
○4 - Very important
○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

n) Trade associations outside Maine

○5 - Critical
○4 - Very important
○3 - Frequently important
○2 - Occasionally important
○1 - Used but not important
○0 - No usage

19. Did you license any technology from any of the sources mentioned in the previous question, as a result of your interactions? ○Yes ○No

20. In total, including those supported by your R&D funding, how many products or services are currently offered for sale or licensed to a commercialization partner by your company

21. In the last completed fiscal year, did you receive any

Federal R&D grants (ATP, SBIR, STTR, etc.)? ○ Yes ○ No

If 'No', go to Question #32

22. In the last completed fiscal year, did you receive a Federal R&D grant from the NIST Advanced Technology Program (ATP)? ○ Yes ○ No

If 'No', go to Question #24

23. What was the total award amount for your NIST ATP grant(s)?

24. In the last completed fiscal year, did you receive a Federal R&D grant from the Small Business Innovation Research (SBIR) Program, Phase I? ○ Yes ○ No

If 'No', go to Question #26

25. What was the total award amount for your SBIR Phase I grant(s)?

26. In the last completed fiscal year, did you receive a Federal R&D grant from the Small Business Innovation Research (SBIR) Program, Phase II? ○ Yes ○ No

If 'No', go to Question #28

27. What was the total award amount for your SBIR Phase II grant(s)?

28. In the last completed fiscal year, did you receive a Federal R&D grant from the Small Business Technology Transfer Research (STTR) Program, Phase I? ○ Yes ○ No

If 'No', go to Question #30

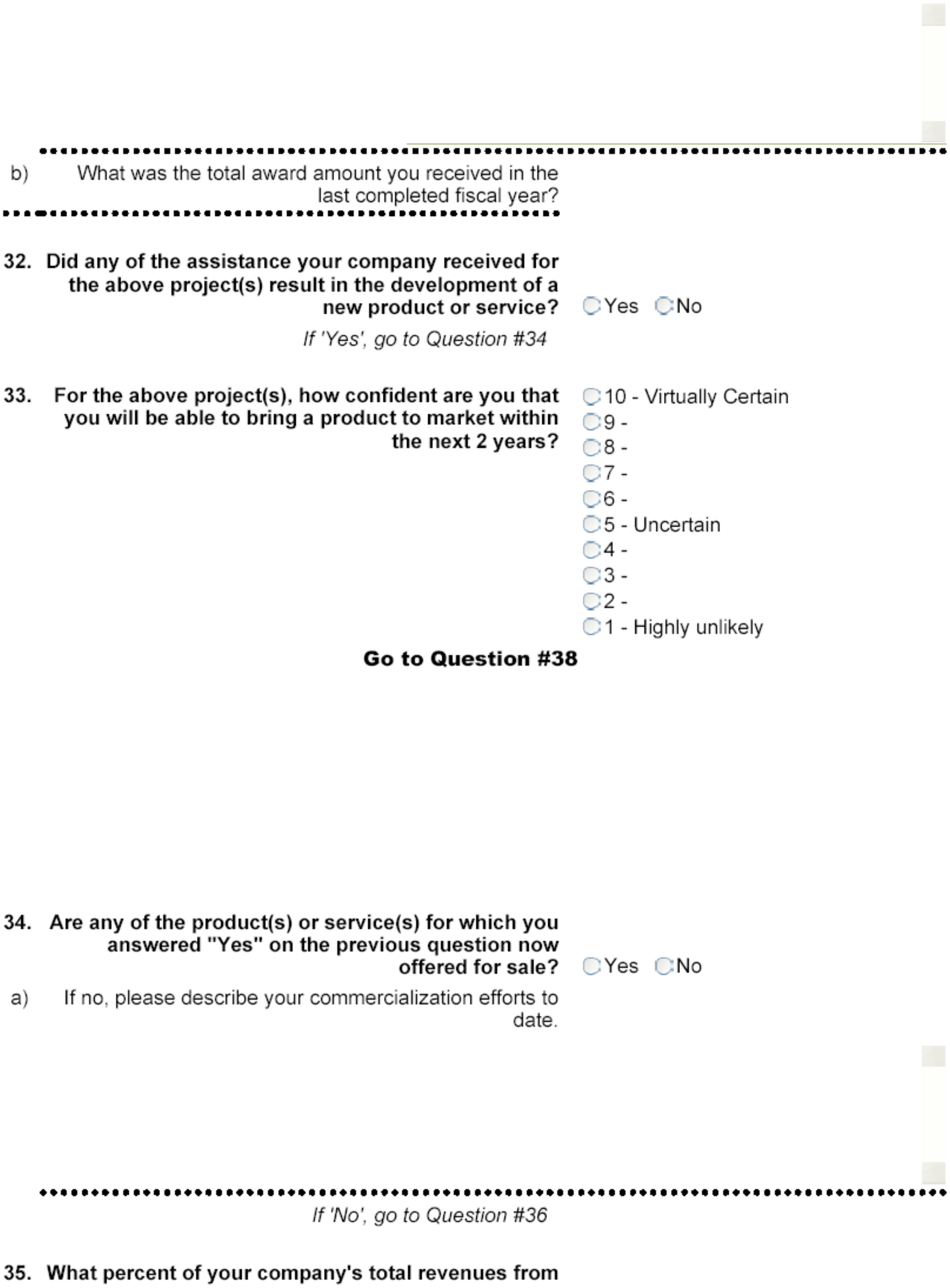
29. What was the total award amount for your STTR Phase I grant(s)?

30. In the last completed fiscal year, did you receive any other Federal R&D grants or contracts not mentioned in the preceding questions? ○ Yes ○ No

If 'No', go to Question #32

31. With regard to the other Federal R&D funding mentioned in the previous question.

a) What were the agency and grant program(s)?



b) What was the total award amount you received in the last completed fiscal year?

32. Did any of the assistance your company received for the above project(s) result in the development of a new product or service? ○ Yes ○ No

If 'Yes', go to Question #34

33. For the above project(s), how confident are you that you will be able to bring a product to market within the next 2 years?

- ○ 10 - Virtually Certain
- ○ 9 -
- ○ 8 -
- ○ 7 -
- ○ 6 -
- ○ 5 - Uncertain
- ○ 4 -
- ○ 3 -
- ○ 2 -
- ○ 1 - Highly unlikely

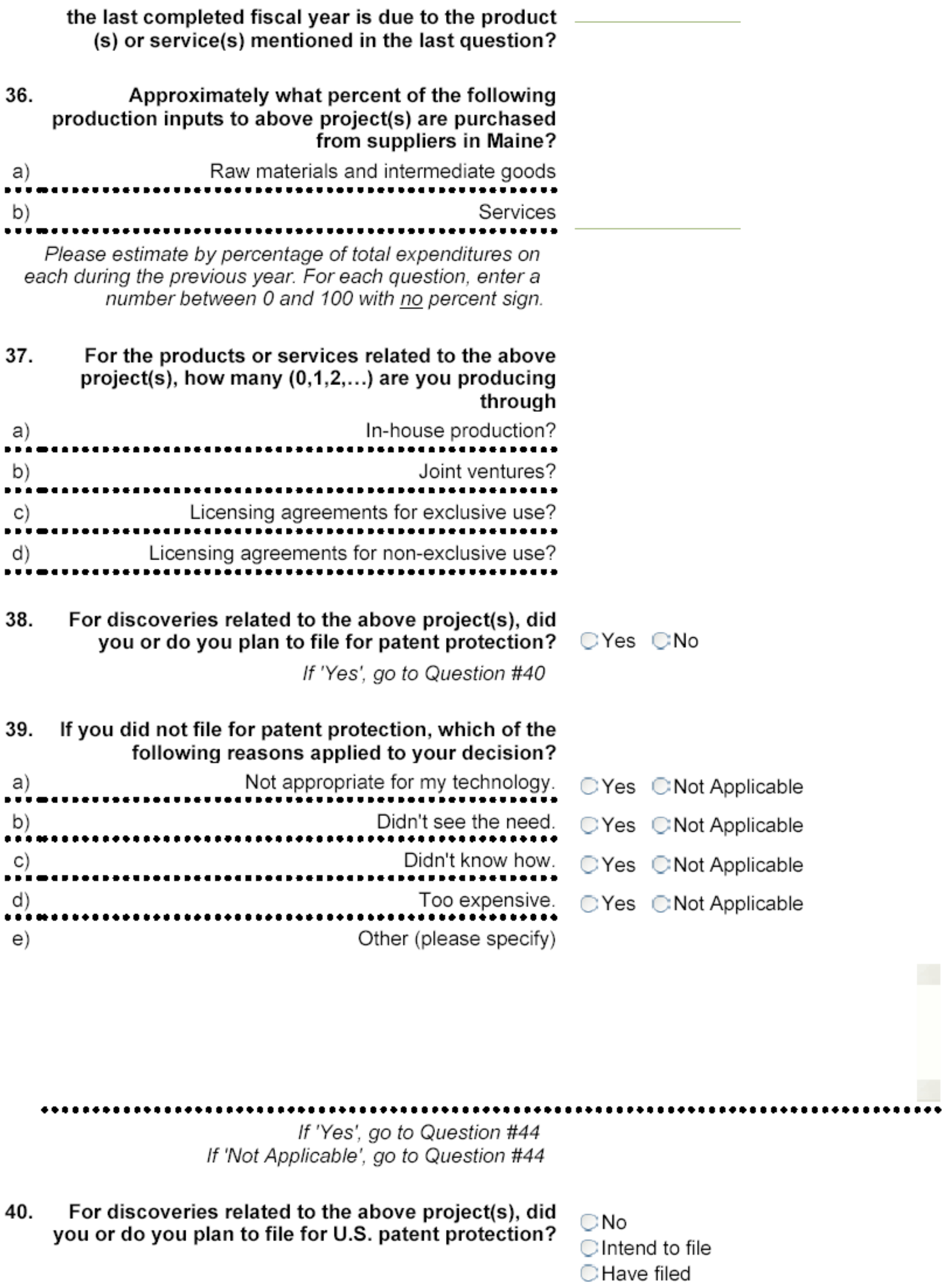
Go to Question #38

34. Are any of the product(s) or service(s) for which you answered "Yes" on the previous question now offered for sale? ○ Yes ○ No

a) If no, please describe your commercialization efforts to date.

If 'No', go to Question #36

35. What percent of your company's total revenues from



the last completed fiscal year is due to the product (s) or service(s) mentioned in the last question?

36. Approximately what percent of the following production inputs to above project(s) are purchased from suppliers in Maine?

a) Raw materials and intermediate goods

b) Services

Please estimate by percentage of total expenditures on each during the previous year. For each question, enter a number between 0 and 100 with no percent sign.

37. For the products or services related to the above project(s), how many (0,1,2,...) are you producing through

a) In-house production?

b) Joint ventures?

c) Licensing agreements for exclusive use?

d) Licensing agreements for non-exclusive use?

38. For discoveries related to the above project(s), did you or do you plan to file for patent protection? ○Yes ○No

If 'Yes', go to Question #40

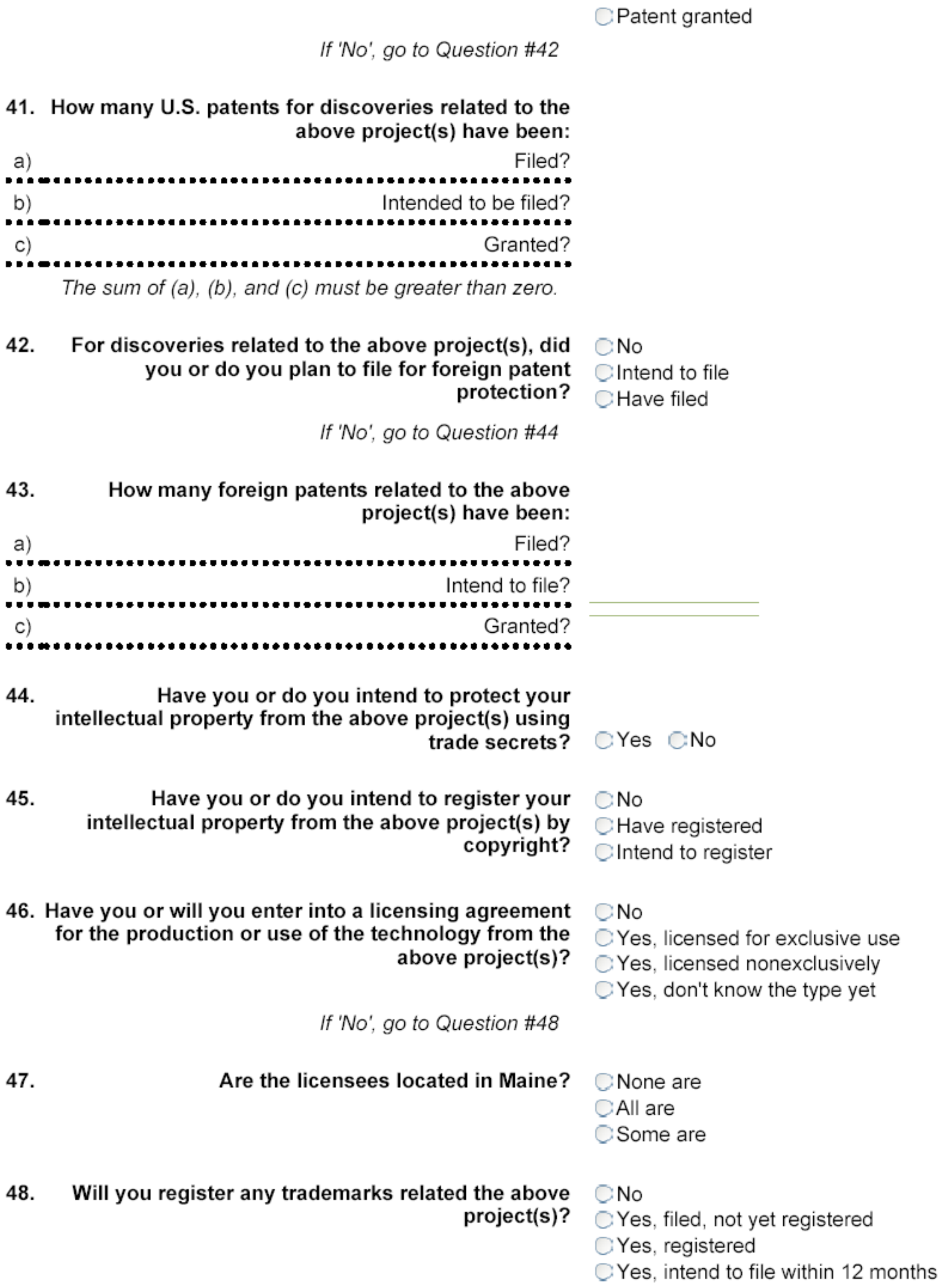
39. If you did not file for patent protection, which of the following reasons applied to your decision?

a) Not appropriate for my technology.	○Yes	○Not Applicable
b) Didn't see the need.	○Yes	○Not Applicable
c) Didn't know how.	○Yes	○Not Applicable
d) Too expensive.	○Yes	○Not Applicable
e) Other (please specify)		

If 'Yes', go to Question #44
If 'Not Applicable', go to Question #44

40. For discoveries related to the above project(s), did you or do you plan to file for U.S. patent protection?

○No
○Intend to file
○Have filed



○ Patent granted

If 'No', go to Question #42

41. How many U.S. patents for discoveries related to the above project(s) have been:

a) Filed?

b) Intended to be filed?

c) Granted?

The sum of (a), (b), and (c) must be greater than zero.

42. For discoveries related to the above project(s), did you or do you plan to file for foreign patent protection?

○ No
○ Intend to file
○ Have filed

If 'No', go to Question #44

43. How many foreign patents related to the above project(s) have been:

a) Filed?

b) Intend to file?

c) Granted?

44. Have you or do you intend to protect your intellectual property from the above project(s) using trade secrets?

○ Yes ○ No

45. Have you or do you intend to register your intellectual property from the above project(s) by copyright?

○ No
○ Have registered
○ Intend to register

46. Have you or will you enter into a licensing agreement for the production or use of the technology from the above project(s)?

○ No
○ Yes, licensed for exclusive use
○ Yes, licensed nonexclusively
○ Yes, don't know the type yet

If 'No', go to Question #48

47. Are the licensees located in Maine?

○ None are
○ All are
○ Some are

48. Will you register any trademarks related the above project(s)?

○ No
○ Yes, filed, not yet registered
○ Yes, registered
○ Yes, intend to file within 12 months

49. Will you utilize any other form of intellectual property protection for the above project(s)(other than patent, copyrights, licensing, and trademarks)?

○ No
○ Have filed
○ Intend to file

a) Description

50. Which of the following areas were affected by the assistance you received for the award(s) listed above?

a)	Concept	○ Yes ○ No
b)	Prototype	○ Yes ○ No
c)	Alpha Test	○ Yes ○ No
d)	Product Design	○ Yes ○ No
e)	Beta Test	○ Yes ○ No
f)	Manufacturing Design	○ Yes ○ No
g)	Market Research, Planning and Development	○ Yes ○ No
h)	Seeking External Financing (Debt or Equity)	○ Yes ○ No
i)	Production for Market	○ Yes ○ No
j)	Preparation of Intellectual Property Protection	○ Yes ○ No
k)	Business Planning	○ Yes ○ No

54. Considering all of the State R&D assistance you received in the last completed fiscal year, how important has this assistance been?

○ Critically important
○ Very important
○ Frequently important
○ Occasionally important
○ Not important

55. Considering all of the State R&D assistance you received in the last completed fiscal year, how satistfied have you been?

○ Very Satisfied
○ Satisfied
○ Somewhat satisfied
○ Unsatisfied
○ Very unsatisfied

56. If you have additional comments regarding this survey, please enter them here.

2003 SURVEY FOR RESEARCH INSTITUTION RECIPIENTS OF STATE R&D FUNDING

1. Name of Research Institution: ________________________________

2. Name of Person Completing Survey: ___________________________
Position: ____

3. Date of Response: ____

GENERAL INSTRUCTIONS:

If your fiscal year is other than July 1 to June 30, please indicate your starting and ending dates and use the most recent year for which you have complete data in place of FY03.

On the left side, enter the total amount for each category for your institution in FY03.

On the right hand side, list only the FY03 amounts attributable to the state R&D funding sources listed below. For instance, if state R&D funding was used to hire a faculty member, all his/her activity would count, even if that person is now funded by other sources. If a building or laboratory was built with the R&D funding, all activity in the building would count. The possible sources of state R&D funding for research institutions that are relevant for this evaluation are:

- 1998 Research and Development Bond (Referendum) $13.5 million
- EPSCOR matching for DOE (1993-2000), NSF (1980-200?), NASA 200?
- Marine Technology Fund including Marine Connectivity Fund
- Research Challenge Grants
- Capital Improvements to Support Research - $25 million University Bond
- Maine Economic Improvement Fund: $20 million
- Strategic Technology Initiative
- Maine Technology Institute Cluster Enhancement Awards
- Maine Biomedical Research Grants.

Answer by taking into account specific programs, research activities, personnel, buildings and equipment funding by these sources. Where necessary, estimate as best as possible.

The answers to all questions will be kept confidential and will only be reported in the aggregate. If you have a question, please contact Jim Damicis, Maine Science and Technology Foundation, jdamicis@mstf.org or (207) 772-9241, ext. 2.

SPECIFIC INSTRUCTIONS:

Question 4: Institutional Capacity

If you are an accredited educational institution, enter the number of students enrolled, degrees awarded, and total number of degree programs in **4 A-D**. Note that **4D** refers to undergraduates. FTE is defined as 18 credit hours.

For all institutions, enter the number of undergraduates participating in your science and engineering programs, including summer programs, in **4E**. Enter the number of graduate students participating in **4F**. If the student is being paid by the R&D funds, they should be included in **4J**, below, as well.

The total square footage available for research and development should be entered in **4G**. This is defined as research laboratories, controlled environment space such as clean or white rooms; technical support space such as carpentry and machine shops; space for laboratory animals, such as animal production colonies, holding rooms, isolation and germ-free rooms; faculty and staff offices to the extent that they are used for research; department libraries, to the extent that they are used for research; fixed equipment, such as fume hoods and benches; single pieces of non-fixed equipment each costing at least $1 million, such as MRI equipment; and leased space. It does not include: space that is designated as federally funded research and development centers (FFRDCs); space used by faculty but not administered by the institution; and space administered by the institution but leased to others for their use. Square footage is measured from the inside faces of walls.

The current value of facilities and fixed equipment should be the depreciated value of these assets. Enter in **4H**. However, **4I** requests only the total value of all major moveable research equipment purchased this year. Major is defined as having a purchase price of >$50,000 for each item.

In **4J**, enter the number of FTE positions you have in each of these categories. Faculty include tenured and tenure-track professors. Research scientists include research faculty and other senior scientists that are principal investigators. Post-docs refer to short-term positions for recent Ph.Ds. Technical and professional refers to those technicians and other professionals directly engaged in research and development activities. Students would include any research and development positions held by undergraduate or graduate students. Support personnel includes clerical and administrative positions that are not directly involved in research and development activities.

Question 5: Research and Development Outcomes

5A, Publications, refers to all articles, books and reports published in the reporting period. If the research supporting the publications was done substantially at your institution, e.g., during a summer, or by an adjunct faculty member, you should include it.

5B, Research Proposals, counts all peer-reviewed or competitive research proposals officially submitted by your institution. Proposals made by individuals associated with your institution on their own behalf are not included. Maine institutions mean any institution headquartered or chartered in Maine, or with substantial operations in Maine. The Maine campus of an institution headquartered elsewhere would be a Maine institution.

For value, enter the face value of the proposal, the total value of all costs for all years proposed, including option years.

5C, Research Awards, asks about the contracts awarded to the institution during the year. The start date of the contract does not have to be in the year. Include all costs including overhead.

- For **5C1**, enter the total value of the award, including all costs for all years, including option years.

- For **5C2**, enter the number of awards and their total value of awards under the EPSCOR program.

- In **5C3**, earmarked means that the award was the result of a legislative action by the U.S. Congress where an agency was directed to support a specific institution or project with a specific amount of funding. Do not include formula grants for land grant institutions, or funding for national programs such as Agricultural Extension, Manufacturing Extension, Sea Grant, etc.

- Under **5C4**, enter only the Federal obligations to your institution for this fiscal year. This means all orders placed, contracts awarded, services received and similar transactions, regardless of when the funds were appropriated or when payment is required.

- **5C5** should include all grants, contracts and subcontracts awarded to your institution by industry. Industry is defined as for-profit organizations (corporations, partnerships, sole proprietorships, etc). This does not include not-for-profit entities such as educational institutions, elements of state, federal or local government or foundations. Enter the total, face value of the contract, including all costs for all years, including option years. Please include subcontracts from companies that have Federal contracts – this intent of this questions is to ascertain the level of interaction between research institutions and industry, not the source of that funding.

- In **5C6**, Maine company is defined as a company headquartered in Maine or with substantial operations in Maine. (BIW is a Maine company, although it is owned by a company outside of Maine.)

- In **5C7**, on the left, enter all foundation grants and gifts related to research and development. On the right, enter only those foundation grants and gifts enabled by the state R&D support. Include both conditional and unconditional amounts. Enter the full amount of the grant or gift, including all costs for all years.

Intellectual Property, Question **5D**. Count the number of items in each category. For **5D8**, Show the total license income received in the fiscal year, including royalties and cashed-in equity.

Spin-off Companies, **5E**. Please indicate the number of new companies formed based on intellectual property licensed from your institution. Date of incorporation should be within this fiscal year. Include the number of jobs in these companies at spin-off. (Future growth in these companies will be captured in the private company survey.)

4. Institutional Capacity

Your fiscal year, if different: ____________________, 20__ to _______________, 20__

FY 03	Total for your institution	Attributable to State R&D Funding
a. Number (FTE) of enrolled science and engineering graduate students.		
b. Number of science and engineering graduate degrees awarded.		
c. Number of degree programs.		
d. Number (FTE) undergraduate students enrolled in science and engineering majors.		
e. Number (FTE) or undergraduate students participating in science and engineering programs.		
f. Number (FTE) or graduate students participating in science and engineering programs.		
g. R&D space	Sq ft	Sq ft
h. Current, depreciated, value of facilities and fixed equipment	$	$
i. Major (purchase price >$50,000) research equipment purchased this year.	$	$
j. Number of positions (FTE) • Faculty • Non-faculty PIs • Technical and professional staff • Students • Support personnel	 ________________ ________________ ________________ _________________ _________________	 ___________________ ___________________ ____________________ ___________________ ____________________

5. Research and Development Outcomes

FY 03	*Total for your institution*	*Attributable to State R&D Funding*
A. Publications		
1. Number of scientific peer-reviewed journal articles published.		
2. Number of scientific peer-reviewed book chapters published.		
3. Number of scientific peer-reviewed books published.		
4. Number of other papers published.		
5. Number of other papers not published (e.g. research reports for industry).		
B. Research Proposals		
1. Number of peer-reviewed and/or competitive research proposals submitted.		
2. Dollar Value of these proposals (face value)	$	$
3. Number and value of these proposals submitted jointly with other Maine institutions only		
	$	$
4. Number and value of these proposals submitted jointly with non-Maine institutions only		
	$	$
5. Number and value of these proposals submitted jointly with both Maine and non-Maine institutions.		
	$	$
C. Research Awards		
1. Number and value of new Federal research grants, contracts, subcontracts		

awarded (total value for all costs and all years)		
	$	$
2. Number and value of these awarded under EPSCOR (total value for all costs and all years)		
	$	$
3. Number and value of these that were earmarked (total value for all costs and all years)		
	$	$
4. Federal obligations for research and development for FY03	$	$
5. Number and value of industrial research grants, contracts and subcontracts awarded (total value for all costs and all years)		
	$	$
6. Number and value of these industrial research grants, contracts and subcontracts awarded by Maine companies (total value for all costs and all years).		
	$	$
7. Number and value of new foundation grants and gifts		
	$	$
D. Intellectual Property		
1. Number of disclosures made.		
2. Number of patents applied for.		
3. Number of patents awarded.		
4. Number of copyrights obtained.		
5. Number of plant breeder's rights obtained.		
6. Number of licensing agreements signed this year.		

7. Number of licensing agreements signed this year with Maine companies.		
8. License income received this year.		
E. Spin-off Companies		
1. Number of new companies formed.		
2. Number of jobs in these companies at spin-off.		

Please return this survey to Jim Damicis, Maine Science and Technology Foundation, 20 Free Street, Portland, ME, 04101