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Inter-Industry Diffusion of Technology That Results From ATP Projects

Preliminary Research of the Potential Impacts of ATP Funding

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Abstract

One objective of the Advanced Technology Program (ATP) is to fund research and development (R&D) in industries where the social benefit of the R&D is substantial even though the return to the individual firm performing the R&D may be low. Often these benefits are fluid and quantifying these benefits is daunting. Product innovation, for instance, is embedded in sales flows to customers and thus can be relatively easy to identify and quantify by using input-output (I-O) tables. Process innovation, however, is more complex to analyze and requires measurement of shifts in cost curves. ATP uses a number of ways to determine if its objectives are being met. The I-O approach is used in this study. Economists have used I-O in the past to measure market spillovers. Market spillovers are embodied in goods purchased by industries using those spillovers not purchased directly as intermediate inputs (i.e., those industries that purchase goods and services from those firms that conduct R&D). These market spillovers must also be products or processes that are commercialized. I-O tables, then, can help to predict what kinds of ATP projects are likely to produce larger spillover benefits and higher social returns.

Thirty-six of the first 50 completed ATP projects commercialized a product or process, and that fact is reflected in the I-O tables. Nineteen of the projects produced a product or process with potential to benefit more than one industry. Five projects rated with the highest spillover potential (printed wiring boards, precision mirrors for advanced lithography, interconnected chips, metallo-organic chemical vapor deposition reactor, and ion beam implantation–computer chips) represent a cross-section of ATP funding efforts; that is, two of these five projects are joint ventures, three are single applicants, and one project is a consortium involving a large number of industry leaders and a government laboratory.

This is *preliminary* research of the potential impacts of ATP funding. The analysis focuses on projects that have been commercialized, but some resulted in minimal actual market transactions. A more substantial investigation, using I-O tables more expansively and intensely, must be completed at a later stage to fully understand ATP's role in the economy and society.

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Executive Summary

This report uses U.S. input-output (I-O) tables to identify where projects funded by the Advanced Technology Program (ATP) are located in the industrial structure of the United States and the most direct paths by which the benefits of those projects are likely to have flowed to other industries. Results are shown graphically and are suitable for use in ATP ex post analyses and presentations. A search of the literature revealed that I-O tables have been used in the past to trace and quantify the impact of research and development (R&D), particularly the impact on productivity by industry. The rationale of using I-O tables stems from the belief that industries purchasing goods and services from those that conduct R&D are the most likely beneficiaries of "spillovers."

A useful indicator of the likelihood of spillovers may be captured by intensity of the purchase activities by customers connected to the industry in which the ATP awardee is located. Such intra- and inter-industry transactions can be quantified by using the transactions classifications that constitute I-O tables.

I-O transactions were used here to measure the intensity of transactions between industries that received ATP funding and the primary customers of those industries. The results were used to rank ATP-funded projects by the potential for market spillovers.

The 1998 2-digit (I-O definition) I-O table was used to rank the 36 ATP-funded projects that resulted in commercialization for the years 1992–1997. Ion beam computer chips and metallo-organic chemical vapor deposition reactors had the highest potential spillover ranking.

Another set of rankings, applying the more detailed but older 1992 6-digit I-O table containing about 500 I-O sectors, was developed for the 19 projects that were carried out and sold to industries in Standard Industrial Classification (SIC) 35–38. By using this more detailed analysis, printed wiring boards achieved the highest rank.

The measurement of gains from R&D is difficult. Assessing the gains from ATP-funded R&D is even more daunting because such funding is quite small relative to total R&D spending. This pilot project shows promise as a road map that ATP can use to depict and rank the impact that may be flowing from each funded project that has been commercialized. As a first step, it is recommended that ATP extend the analysis to all 36 commercialized projects using the 6-digit I-O table. Then intensity should be estimated by looking at both intermediate and capital goods purchases. A subsequent research path is to use available applicable quantitative case-study results and more finely disaggregated government data to refine the measures of intensity within the I-O framework.

Contents

1. Introduction

This study describes the inter-industry diffusion of technology that could potentially result from Advanced Technology Program (ATP)-funded projects and develops a road map of the industry distribution of successful ATP grants in a way that highlights the potential transmission of benefits.

There is no dispute about the positive contribution of research and development (R&D) spending to the overall economy. Many studies show that the total returns of R&D to the economy exceed the returns to the private sector firms that conduct R&D (e.g., Mansfield et al., 1977; Griliches, 1992).

Stated alternatively, the social returns from R&D are, in the aggregate and for most individual innovations, positive for the economy but, unfortunately, sometimes negative for the firm undertaking the R&D. It has been found that the greater the ex ante gap between total and private returns, the more likely it is that firms may choose not to fund that R&D project or fund it at less than optimal levels (an exception may occur when one innovation fully supplants another or private return exceeds social return because of the unique position of the innovator). To put it simply, why spend the money on R&D if the money spent is not proportional to the private profit generated regardless of the social benefit.

But R&D does improve the economy as a whole, and that is why one of the objectives of the ATP is to fund R&D in areas where the social benefit of the R&D is substantial even though the return to the individual firm may be low. ATP literature describing its funding criteria distinguishes two types of social benefits. One is to the broader economy and the other diffusion within and across industries.

How then can ATP identify opportunities where there is a large gap between the social benefit of R&D and return to an individual firm? One way is to analyze the interactions between firms receiving R&D funding from ATP and the rest of the economy. But such interactions—usually referred to as "spillovers"—are difficult to identify. Ex post case studies are widely available. While the case studies provide methodology for evaluating the social benefits from a successful project, it is difficult to apply that methodology in a consistent way across such projects.

Product and process are the two basic types of innovation. Product innovation is embedded in sales flows to customers and thus is relatively easy to identify and quantify by using input-output (I-O) tables. Process innovation requires measurement of shifts in cost curves and is more complex to analyze. The I-O methodology does not allow one to quantify the social returns or spillovers of *any particular* ATP project, but rather by tracing how technology flows through industry, it does allow one to predict the kinds of projects that are more likely to have large spillover/social return benefits. The results of approaching the evaluation of potential social returns by using I-O tables as road maps are the subject of this research report.

The Bureau of Economic Analysis (BEA) is responsible for producing and updating the Input-Output (I-O) accounts. The input-output accounts show how industries interact; specifically, they show how industries provide input to, and use output from, each other to produce Gross Domestic Product (GDP). These accounts provide detailed information on the flows of the goods and services that make up the production process of industries. The I-O accounts are presented in a set of tables: Use, Make, Direct Requirements, and Total Requirements. The Use table shows the inputs to industry production and the commodities that are consumed by final users. The Make table shows the commodities that are produced by each industry. The three Requirements tables are derived from the Use and Make tables. The Direct Requirements table shows the amount of a commodity that is required by an industry to produce a dollar of the industry's output. The two Total Requirements tables show the production that is required, directly and indirectly, from each industry and each commodity to deliver a dollar of a commodity to final users. The Use table is the most frequently requested table because of its applications to the estimates of GDP. In the research presented in this paper, the Use and Make tables are used.

2. The Literature Search

An extensive search through the literature presented views that detailed the nature of spillovers and how spillovers have been measured.

THE NATURE OF SPILLOVERS

The term "spillover" is used in many places in the economic literature and in many ways. Here we will focus on technological spillovers, usually associated with spending on R&D.

Spillovers are a subset of externalities, which is a broader concept. As characterized by Stiglitz (1993, p. 588), an externality is "a phenomenon that arises when an individual or firm takes an action but does not bear all the cost (negative externality) or receive all the benefits (positive externality)." Thus a firm may conduct R&D with its own funds or with funds borrowed from the government and then not receive all the benefits. That is, the benefits "spill over" to other firms and individuals. Discussion of externalities is usually cast in terms of private versus social returns. If the social return from an R&D investment exceeds the private return (to the company undertaking it), then there is a positive externality.

Of course, some imprecision and ambiguities exist in the use of the various terms in the literature. (For example, the ATP description of "process" subsumes, for good reason, three distinct categories: the application of a new product, the application of software, and new methods of applying a new technology.) Jaffe (1996) presents a useful taxonomy for characterizing the ways in which spillovers occur. He identifies three paths: knowledge spillovers, market spillovers, and network spillovers.

Knowledge spillovers of technological know-how are defined as those for which the recipients pay nothing. This type of spillover may yield the greatest positive spread between social and private returns, but are hardest to identify because, as Krugman (1991, p. 53) puts it, they leave no paper trail. A simple example is when a researcher leaves one firm for another that does not compete, ex post or ex ante, in the same market. In such a situation it is difficult for the losing firm to control the knowledge the researcher takes.

Network spillovers occur when the development of one technology enhances another technology in different firms or industries. The expected gap between social and private returns for such spillovers is probably smaller than for knowledge spillovers. That is because the innovating firm may be able to gain positive return for the innovation, even if it ends up being shared by other network members. The National Institute of Standards and Technology (NIST) plays a large role in effecting network spillovers by helping network members standardize the metrics they use associated with the innovation. Tassey (1995) refers to these as “infratechnologies.”

But it is the market spillover that presents the innovator the best opportunity to reduce the gap between social and private return. That is because a market spillover implies the embodiment of the innovation in goods or services. The producer may be able to recover at least some of the cost through pricing strategies.

There is considerable literature describing the market conditions necessary for an innovator to appropriate all of the value created by its innovation. The single most important determinant of appropriability is market structure. A monopolist is most able to appropriate all the return and a firm in a competitive industry is the least able. The model Mansfield et al. (1977) used to measure social and private returns graphically depicts the ways different markets allocate the fruits of innovations and their spillovers among market participants. Cohen et al. (2000) conducted and used a survey to analyze the factors affecting appropriability.

Spillover paths, though, have been classified by determining whether or not these spillover paths are embodied in specific goods and services (see Griliches 1991). Embodiment conveys a sense that a firm can examine a purchased input and discern something that can be used or replicated in a way that raises the rate of return of the purchaser. (Backward spillovers can occur if, for example, a customer develops a new specification for a part and then shares the innovation with the supplier of the part.) Disembodied spillovers are roughly synonymous with knowledge spillovers because they flow unattached to a specific product. Network spillovers can be both embodied and disembodied.

HOW SPILLOVERS ARE EVALUATED

The literature on how spillovers may be evaluated is extensive. Brown and Conrad (1967) were the first to develop a systematic metric. They were interested in the use of R&D as an input to production and how much such an input contributed to productivity growth. Their research had a different objective from that of ATP, which seeks to know how a particular innovation it funds spills over to other firms and industries.

From National Science Foundation data, Brown and Conrad developed a data set on R&D spending for selected 2-digit Standard Industrial Classification (SIC) industries. Those data would have been sufficient if each industry Brown and Conrad considered was the only user of its own R&D results and there were no spillovers. But since spillovers are likely, how much R&D spilled over to an industry from the R&D of others? Brown and Conrad wanted to develop an estimate for each industry not only of the R&D it conducted but also how much it imported. They wanted to estimate the amount of R&D in supplying industries that could have spilled over for use by the purchaser. To do this they used I-O transactions flows to weight the R&D spending, but, because they used intermediate purchases as weights, focused on forward market spillovers. They assumed that the likelihood of spillover rises with the importance of each supplying industry's sales to the purchasing industry, reporting that "an inter-industry research weight was estimated, reflecting the cost-reducing possibilities carried by major intermediate flows of goods" (Brown and Conrad, 1967).

Brown and Conrad employed this methodology in a follow-up research paper presented at a National Bureau of Economic Research conference (Kendrick and Vaccara, 1975). A discussant, Nestor Terleckyj (1974), characterized the weighting scheme as novel. Subsequent to the first Brown and Conrad paper, Terleckyj published related research using a somewhat different weighting scheme for the aggregation of R&D outlays. He added to intermediate purchases those of capital goods (a final purchase in national income accounting), figuring the likelihood that R&D spilled over as much, perhaps more, through capital goods use. In other words, spillovers may be particularly important in transmitting enabling or process innovations.

The use of intermediate purchases, whether or not augmented by capital goods flow, was subsequently examined by others.

Griliches (1991), for example, clarifies various approaches and the research questions they address and views market spillovers as largely measurement issues. If price indexes correctly reflected the value of the embodied R&D, then the imported input would be larger (price increase smaller) and would be the proper measure of the imported spillover. But Griliches makes that point in the context of wanting to assess the impact of R&D, wherever produced, on output. He also focused on nonembodied spillovers, pointing out that knowledge spillovers are dependent on the "affinity" of various types of R&D to each other.

Scherer (1982, 1984) classified patents in pools reflecting their affinity. Assuming that patents reflect the nature of R&D, the R&D purchased by an industry is of greater or smaller value depending on how close its scientific content is to that used by the acquiring firm.

Raines (1968) used geographical proximity—or geographically near R&D, defined as that conducted within a specified number of miles of each firm—to develop distance weights, viewing it much as Marshall did the scientific "neighborhood" phenomenon to describe knowledge diffusion at the turn of the twentieth century.

Thus, affinity, to the extent it is reflected by sales transactions, might reflect the potential for disembodied innovation and for knowledge spillovers as well.

3. Identifying the Industries Likely to Benefit From ATP-Funded Projects

The first step in identifying the likely industrial path that spillovers will take is to identify the industry creating the product or process that was an outcome of one of the 36 ATP projects analyzed here. Two-digit Input-Output (I-O) tables for 1998, annual tables estimated from the 1992 benchmark, were used. (Tables incorporating a later benchmark, 1997, and the first on a NAICS basis,[1] will be published later.)

Two-digit I-O tables show the flow of transactions of 97 commodities—goods and services—among 94 industries and have their own 2-digit classification system that does not necessarily coincide with the Standard Industrial Classification (SIC) from which the I-O industries were formed. Subsequently, we will refer to 2-digit I-O tables when distinguishing the order of the table being used and when analyzing some of the tools developed. When discussion centers on specific industries, SIC designations will be used because they are more descriptive and familiar. (The I-O/SIC concordance found in the *Survey of Current Business*, December 2001 (U.S. Government Printing Office, 2001), is reproduced in Table 1 at the end of this chapter.)

The Bureau of Economic Analysis prepares two versions of I-O tables. The first table is called a "make" table and the second a "use" table. The need for a make table arises because industries produce some products primarily and others secondarily. Thus the total production of a product group is likely to be spread among more than one industry.

Each row in the "make" table is an industry, and looking across each row shows the distribution of products that industry produces. The rows in the "use" table show the commodities the industry, in each column, uses to produce its output.

The first step in assigning an ATP-funded project is to determine, using the 1987 SIC manual, the industry that is the primary producer of the product group that is likely to encompass the rather finely classified product or the process used to produce it. (The primary producer was identified by using "Performance of 50 Completed Projects, Status Report No. 2" (NIST SP-950-2), a report that describes the first 50 completed ATP projects about three years after project completion.)[2]

1. The North American Industry Classification System (NAICS) replaces the Standard Industrial Classification (SIC) system. NAICS focuses on the production concept to classify establishments; it emphasizes new and emerging industries, such as the information industries and service industries; it provides for comparability with Canada and Mexico; and it will be regularly maintained—current plans are for revisions every 5 years (in 2002, 2007, etc.)
2. This paper classifies 49 of the 50 projects. One project was not included in this analysis because it was inadvertently left out of the prepublication version of the NIST SP-950-2 report.

The "make" and "use" assignment for the ATP projects studied here are shown in Table 2 at the end of this chapter. The columns in each table are defined as follows:

- Column 1 is the author-assigned (JPC) code for this project to facilitate presentation on subsequent tables.
- Column 2 is the end date for the ATP project.
- Column 3 is a brief description of the ATP project.
- Column 4 is the SIC code that identifies the "Make Industry" of the ATP project.
- Column 5 is the SIC code of the "Use Industry."
- Column 6 is the name of the "Use Industry" corresponding to the SIC code in column 5.

The industries purchasing items from that product group are identified by using the "use" table. Because more than one industry may use products from a product category, multiple paths for spillovers are identified.

Table 3 (see end of chapter) depicts the industries in the U.S. industrial sector that are customers for the products and processes that received ATP funding. The specific project numbers, as assigned in Table 2 (e.g. A1, A2, …), are found in each box, and some boxes contain multiple entries, reflecting multiple "use" industries. The relationship of the "use" industries to "make" industries can be seen by going down the columns for SIC 35–38.

At the 2-digit SIC level of aggregation, the industries that are the potential users of the largest number of the 36 ATP-funded projects are Machinery and Equipment including Computers (SIC 35) with 11 projects, Electronic and Electrical Equipment and Components (SIC 36) with 10 projects, and Health Services (SIC 80) also with 10 projects. The industries receiving the funding for most of the products going into those industries are industries in SIC 35–38.

In fact, 31 of the 36 ATP projects (23 commercialized and 8 non-commercialized) are to industries in SIC 35–38. Those industries are:

- Industrial and Commercial Machinery and Computer Equipment (SIC 35)
- Electronic and Other Electrical Equipment (SIC 36)
- Transportation Equipment (SIC 37)
- Measuring, Analyzing, and Controlling Instruments, Photographic, Medical, Ophthalmic Goods, Watches and Clocks (SIC 38)

Because of the large number of project awards going to the SIC 35–38 industries, we have broken those out into Table 4 (see end of chapter). Along the main diagonal of the table are dark-shaded rectangles that contain entries that reflect sales relationships among the industries. Entries in each rectangle thus represent detailed inter-industry relationships which, upon aggregation to the 2-digit SIC level, would become intra-industry supplier-customer relationships.

By some definitions of distance, the Table 4 entries that fall outside the dark-shaded rectangles may be less likely to result in spillovers than those in the light-shaded rectangles. That is because the projects in the dark-shaded rectangles are more likely to result in knowledge and network spillovers, in addition to market ones. Of the commercialized projects funded by ATP, 19 are both produced and consumed in SIC 35–38 industries.

Of the 19 producers and consumers shown in Table 4, the columns with the most potential users of products and processes funded by ATP is part of SIC 35, Computer and Office Equipment. Eight of the 19 projects are potentially used in that industry (plus one project outside the rectangle). Part of SIC 36, Electronic Components and Accessories, and Audio, Video, and Communication Equipment, are the next most likely to be using ATP-funded research.

Analysis of Table 4 indicates that, while the probability of misassignment is low, the information on these industries may benefit from greater disaggregation. So it was decided to identify ATP projects that were both produced and used in the 2-digit SIC industries 35–38 at a more detailed level by using a 6-digit I-O table that was published for 1992. The 6-digit I-O table has detail on 494 industries and 484 commodities. The detail is roughly analogous to the 4-digit SIC classifications.

Table 1. Classification of Industries in the Annual Input-Output Accounts

I-O number	I-O Title	Related 1987 SIC codes
	AGRICULTURE, FORESTRY, FISHERIES	
01	Livestock and livestock products	*01, *02
02	Other agricultural products	*01, *02
03	Forestry and fishery products	081, 083, 091, 097
04	Agricultural, forestry, and fishery services	0254, *0279, 071, 072, 075, 076, 078, 085, 092
	MINING	
05+06	Metallic ores mining	101-6, *108, 109
07	Coal mining	121-3, *124
08	Crude petroleum and natural gas	131, 132, *138
09+10	Nonmetallic minerals mining	141-7, *148, 149
	CONSTRUCTION	
11	New construction, including own account construction	*108, *124, *138, *148, *15, *16, *17, 6552
12	Maintenance and repair construction, including own account construction	*138, *15, *16, *17
	MANUFACTURING	
13	Ordnance and accessories	348, 3761, 3795
14	Food and kindred products	20
15	Tobacco products	21
16	Broad and narrow fabrics, yarn and thread mills	221-4, *226, 228
17	Miscellaneous textile goods and floor coverings	227, 229
18	Apparel	225, 231-8
19	Miscellaneous fabricated textile products	239
20+21	Lumber and wood products	24
22+23	Furniture and fixtures	25
24	Paper and allied products, except containers	261, 262, 263, 267
25	Paperboard containers and boxes	265
26A	Newspapers and periodicals	271, 272
26B	Other printing and publishing	273-9
27A	Industrial and other chemicals	281, 286, 289
27B	Agricultural, fertilizers and chemicals	287
28	Plastics and synthetic materials	282
29A	Drugs	283
29B	Cleaning and toilet preparations	284
30	Paints and allied products	285
31	Petroleum refining and related products	29
32	Rubber and miscellaneous plastics products	30
33+34	Footwear, leather, and leather products	31
35	Glass and glass products	321-3
36	Stone and clay products	324-9
37	Primary iron and steel manufacturing	331, 332, 339, 3462
38	Primary nonferrous metals manufacturing	333-6, 3463
39	Metal containers	341
40	Heating, plumbing, and fabricated structural metal products	343, 344
41	Screw machine products and stampings	345, 3465-9
42	Other fabricated metal products	342, 347, 349
43	Engines and turbines	351
44+45	Farm, construction, and mining machinery	352, 3531-3
46	Materials handling machinery and equipment	3534-7
47	Metalworking machinery and equipment	354
48	Special industry machinery and equipment	355
49	General industrial machinery and equipment	356
50	Miscellaneous machinery, except electrical	359
51	Computer and office equipment	357
52	Service industry machinery	358
53	Electrical industrial equipment and apparatus	361, 362
54	Household appliances	363
55	Electric lighting and wiring equipment	364
56	Audio, video, and communication equipment	365, 366
57	Electronic components and accessories	367
58	Miscellaneous electrical machinery and supplies	369
59A	Motor vehicles (passenger cars and trucks)	3711
59B	Truck and bus bodies, trailers, and motor vehicles parts	3713-5

Note: An asterisk preceding an SIC code indicates that the SIC industry is included in more than one I-O industry.
*Source: Survey of Current Business (*December 2001).

I-O number	I-O Title	Related 1987 SIC codes
	MANUFACTURING, continued	
60	Aircraft and parts	372, 3764, 3769
61	Other transportation equipment	3716, 373-5, 3792, 3799
62	Scientific and controlling instruments	381, 382, 384, 387
63	Ophthalmic and photographic equipment	385, 386
64	Miscellaneous manufacturing	39
	TRANSPORTATION, COMMUNICATION, AND UTILITIES	
65A	Railroads and related services; passenger ground transportation	40, 41, 474
65B	Motor freight transportation and warehousing	42
65C	Water transportation	44
65D	Air transportation	45
65E	Pipelines, freight forwarders, and related services	46, 472, 473, 478
66	Communications, except radio and TV	481, 482, 484, 489
67	Radio and TV broadcasting	483
68A	Electric services (utilities)	491, 4931
68B	Gas production and distribution (utilities)	492, 4932, 4939
68C	Water and sanitary services	494-7
	WHOLESALE AND RETAIL TRADE	
69A	Wholesale trade	50, 51
69B	Retail trade	52-7, 59
	FINANCE, INSURANCE, AND REAL ESTATE	
70A	Finance	60-2, 67 (excluding 6732)
70B	Insurance	63, 64
71A	Owner-occupied dwellings	n.a.
71B	Real estate and royalties	65 (excluding 6552)
	SERVICES	
72A	Hotels and lodging places	70
72B	Personal and repair services (except auto)	72, 762-4
73A	Computer and data processing services, including own-account software	737
73B	Legal, engineering, accounting, and related services	81, 871, 872, 89
73C	Other business and professional services, except medical	732-6, 738, 769, 8731, 8732, 8734, 874
73D	Advertising	731
74	Eating and drinking places	58
75	Automotive repair and services	75
76	Amusements	78, 79
77A	Health services	074, 80
77B	Educational and social services, and membership organizations	6732, 82-4, 86, 8733
	SPECIAL INDUSTRIES	
78	Federal Government enterprises	n.a.
79	State and local government enterprises	n.a.
80	Noncomparable imports	n.a.
81	Scrap, used and secondhand goods	n.a.
82	General government industry	n.a.
83	Rest of the world adjustment to final uses	n.a.
84	Household industry	n.a.
85	Inventory valuation adjustment	n.a.
VA	Value added	n.a.
91	Personal consumption expenditures	n.a.
92	Gross private fixed investment	n.a.
93	Change in private inventories	n.a.
94	Exports of goods and services	n.a.
95	Imports of goods and services	n.a.
96C	Federal Government consumption expenditures: National defense	n.a.
96I	Federal Government gross investment: National defense	n.a.
97C	Federal Government consumption expenditures: Nondefense	n.a.
97I	Federal Government gross investment: Nondefense	n.a.
98C+99C	State and local government consumption expenditures	n.a.
98I+99I	State and local government gross investment	n.a.

n.a. = not applicable.

Table 2. ATP-Funded Projects

Code (JPC's)	Date ATP Project Ended	Projects	"Make" Industry (SIC)	"Use" Industry (SIC)
		Advanced Materials and Chemicals		
A1	06/30/95	High Performance Ceramic Parts	32	37
A2	12/31/96	Biochemical and Environmental Detectors	38	28,80
A3	07/04/95	High Quality Microlenses	38	n.a.
A4	07/31/95	Optical Switches	36	n.a.
A5	02/28/96	Insulating Foams for Microelectronics	36	n.a.
A6	08/14/95	Waste Plastic Recycling	30	30
A7	11/14/95	Diamond Film	32	n.a.
		Biotechnology		
B1	06/30/94	Stem Cell Harvesting Improvement	80	80
B2	02/14/97	Enzymes in Deep-Sea Microorganisms	87	80
B3	06/30/95	Viral Contamination in Donated Blood	80	n.a.
B4	12/31/96	New Metal Alloy for Medical Implants	38	80
B5	05/31/95	Software for New Molecules and Drugs	73	80,87
B6	05/31/95	Safe Insecticide	28	n.a.
B7	02/28/96	Prostheses That Regenerate Body Parts	28	n.a.
		Electronics, Computer Hardware & Communications		
E1	03/14/95	Expanding Light Signals in an Optical Fiber	36	36,48
E2	08/14/96	Flat Panel Displays	35	35
E3	07/14/95	LED Tech Component	36	35,36,37
E4	03/31/97	Speed and Capacity of CDs and DVDs	35	35
E5	06/14/94	LED - Blue	36	35,36,37
E6	04/30/95	Low-Cost Surgical Laser	38	38,80
E7	06/30/94	Ion Beam Implantation; Computer Chips	36	35,36
E8	12/31/94	High-Capacity Compact Disk	35	n.a.
E9	02/08/95	Dry Clean Computer Chip Wafer	36	n.a.
E10	09/30/92	Large-Scale Technology for X-Ray Lithography	38	n.a.
E11	09/30/93	Turnable Lasers for Many Uses	38	38,80,87
E12	05/14/94	Precision Mirrors for Advanced Lithography	36	35,36
E13	09/15/95	Interconnected Chips	36	35,36
E14	04/14/96	Printed Wiring Boards	36	36
E15	05/31/95	Prototypes of Higher Quality Microchannel Plates (MCPs)	38	n.a.
E16	03/31/95	Metallo-Organic Chemical Vapor Deposition Reactor	36	35,36
E17	01/31/97	Flat Fluorescent Lamps for Displays	36	37
E18	12/31/96	Gallium Arsenide (GaAs-Based ICs)	36	36
		Information Technology		
I1	09/30/93	Computer Recognition of Natural Handwriting	73	35,73
I2	03/19/96	Chinese Character-Recognition; Computer Data Entry Method	73	n.a.
I3	06/30/95	Animated 3D Anatomy	73	80
I4	08/31/95	Restoring and Enhancing Movies	73	36,78
I5	07/31/96	Parallel-Processing Software	73	41,42,45,53,60,73,80
I6	01/14/97	Rail-Traffic Optimization Technology	73	40
		Manufacturing		
M1	06/30/95	High-Temperature Coils for Electric Motor Efficiency	36	49
M2	07/31/95	Thermal Insulation	35	34,35
M3	10/31/95	Systems Solution for Auto Body Manufacturing	38	37
M4	03/31/94	Thallium/Lead Thin Films for Electronic Devices	34	36,48
M5	03/31/94	Robot Navigation	38	42,80
M6	02/29/96	High Temp Superconductivity to Improve Cellular Transmission	34	48
M7	06/14/95	Integrated Force Arrays (IFAs)	38	n.a.
M8	03/31/96	Machines that See in 3D	35	24,33,37
M9	07/31/96	Data Sharing Speeds Components	36	37
M10	12/31/96	Thin-Film Electrochromics	32	32
M11	11/16/93	Thermal-Error Correction for Machine Tools	35	35

Note: p = Process.
n.a. = not applicable.
JPC = Joel Popkin and Company
Source: ATP Status Report No. 2: Performance of 50 Completed Projects.

Code (JPC's)		"Use" Industry
A1		Auto & Aircraft Engines
A2		Environmental Testing, Biomedical Application
A3		No Commercialization
A4		No Commercialization
A5		No Commercialization
A6	P	Low-cost Modular Houses
A7		Commercialization Possible - Market Prospect: Industrial Cutting Tool
B1	P	Medical Cancer Treatment
B2	P	Detection of Genetic Diseases
B3		Commercialization Possible - Market Prospect: Health Care
B4		Health Care
B5		Medical Laboratories, Chemical Research
B6		Commercialization Possible - Market Prospect: Pharmaceuticals Application
B7		Commercialization Underway - Market Prospect: Orthopedic Application
E1	P	Telecommunication Application and Equipment, Fiber Optics Telecommunication Application
E2		Introduced in Flat Panel Production
E3		Consumer Electronics, Office Equipment, Auto Dashboard, Household Cooking Appliances
E4		Optical Data Storage Industry
E5		Electronics Components and Accessories, HDTVs Broadcast Equipment, Auto Dashboard, Computer Peripheral Equipment
E6		Higher Power Medical Laser, Optical System Application Using Diode Laser Array, Heart, Lung, and Blood Institutes
E7		Flat-Panel Production, Computers Equipment, Semiconductor Wafer
E8		Commercialization Failed
E9		Commercialization Uncertain
E10		No Commercialization
E11		Scientific Equipment, Health Care, Academics R&D
E12		Computers, Semiconductor Wafer, Communication Equipment and Other Electronic Devices
E13		Flat-Panel Computer Displays, 3D Microprocessors Technology, Household Audio & Video
E14		Communication Equipment, Electronics Components and Accessories, Semiconductor Industry
E15		Commercialization Uncertain - Prospect Uses for Night Blindness Treatment, Miniature Scientific Instruments
E16		Optoelectronic Epitaxial Wafers including High Speed Laser Printing, Semiconductor Industry
E17		Aircraft Manufacturers (Flat-Panel Displays in Airplane Cockpits)
E18	P	Transceiver Applications in Telecommunications and Data Communications
I1		Computer Hardware & Software
I2		Commercialization Underway - Market Prospect: Computer Software Market in China
I3		Health Care
I4	P	High Definition TV, Motion Pictures
I5		Transportation and Warehousing, Air Transportation, Retail Department Stores, Commercial Banks, Software Industry, Health Care
I6	P	Railroad Transportation
M1	P	Energy Industry for Commercial and Residential Energy Consumption
M2		Heating and Plumbing, Refrigeration
M3	P	Auto Manufacturers, Auto Assembly and Related Industry
M4		Superconductor Applications, Satellite Communications
M5		Factories and Warehousing, Hospitals
M6		Cellular Communications
M7		Commercialization Likely - Market Prospect: Data Storage, Biomedical Devices & Prostheses, Robotics, Optical Shuttle
M8		Lumber Mill, Steel Processing, Automate Automobile Assembling
M9		Airplane Manufacturers
M10	P	High Performance Architecture Glass Market
M11	P	Machine Tools

Table 3. Industries in the U.S. Industrial Sector That Are Customers for the Products and Processes That Received ATP Funding

SICs		Livestock and livestock products	Engines and turbines	Farm, construction, and mining machinery	Materials handling machinery and equipment	Metalworking machinery and equipment	Special industry machinery and equipment	General industrial machinery and equipment	Miscellaneous machinery, except electrical	Computer and office equipment	Service industry machinery	Electrical industrial equipment and apparatus	Household appliances
		21	35	35	35	35	35	35	35	35	35	36	36
21	Livestock and livestock products												
35	Engines and turbines												
35	Farm, construction, and mining machinery												
35	Materials handling machinery and equipment												
35	Metalworking machinery and equipment												
35	Special industry machinery and equipment												
35	General industrial machinery and equipment							M2					
35	Miscellaneous machinery, except electrical								M11				
35	Computer and office equipment									E2, E4			
35	Service industry machinery												
36	Electrical industrial equipment and apparatus												
36	Household appliances												
36	Electric lighting and wiring equipment												
36	Audio, video, and communication equipment												
36	Electronic components and accessories									E3, E5, E7, E12, E13, E16			E3, E5
36	Miscellaneous electrical machinery and supplies												
37	Motor vehicles (passenger cars and trucks)												
37	Truck and bus bodies, trailers, and motor vehicle parts												
37	Aircraft and parts												
37	Other transportation equipment												
38	Scientific and controlling instruments												
38	Ophthalmic and photographic equipment												
72, 762-4	Personal and repair services (except auto)												
73	Computer and data processing services, including own-accounts									I1			
81, 87, 89	Legal, engineering, accounting, and related services												
78, 84, 88	Other business and professional services, except medical												
73	Advertising												
58	Eating and drinking places												
75	Automotive repair and services												
79	Amusements												
80	Health services												
	Total industry output												

Legend:
A: Advanced Materials and Chemicals
B: Biotechnology
E: Electronics, Computer Hardware & Communication
I: Information Technology
M: Manufacturing
C: Commercialization possible or underway
NC: No commercialization or commercialization failed
Source: Shaded boxes show the author's assignment of ATP projects using I-O/SIC concordance.

SICs	Electric lighting and wiring equipment	Audio, video, and communication equipment	Electronic components and accessories	Miscellaneous electrical machinery and supplies	Motor vehicles (passenger cars and trucks)	Truck and bus bodies, trailers, and motor vehicles parts	Aircraft and parts	Other transportation equipment	Scientific and controlling instruments	Ophthalmic and photographic equipment	Personal and repair services (except auto)	Computer and data processing services, including own-accounts	Legal, engineering, accounting, and related services	Other business and professional services, except medical	Advertising	Eating and drinking places	Automotive repair and services	Amusements	Health services	Commercialization failed or underway
SICs	36	36	36	36	37	37	37	37	38	38	72	73	81,87, 89	78,84, 88	73	58	75	79	80	
21																				
35																				
35																				
35																				
35																				
35																				
35																				
35																				E8
35																				
36																				
36																				
36		E14	E14				E17													
36		E1																		
36		E5, E12, E13, E18	E3, E5, E7, E12, E13		E3, E5		M9													E3, E9, A5
36																				
37																				
37																				
37																				
37																				
38					M3, M8					E6,E11			E11						A2, B4 E6, E11 M5	A3, E10, E15, M7
38																				
72, 762-4																				
73		I4									I4	I1, I5	B5						B5, I3, I5	I2
81, 87, 89																			B2	
78, 84, 88																				
73																				
58																				
75																				
79																				
80																			B1	B3

Table 4. SIC 35–38 Industries That Received ATP Funding

SICs		Engines and turbines 351	Farm, construction, and mining machinery 352	Materials handling machinery and equipment 353	Metalworking machinery and equipment 354	Special industry machinery and equipment 355	General industrial machinery and equipment 356
351	Engines and turbines						
352	Farm, construction, and mining machinery			SIC 35 Industrial Machinery and Equipment			
353	Materials handling machinery and equipment						
354	Metalworking machinery and equipment						
355	Special industry machinery and equipment						
356	General industrial machinery and equipment						
	M2: Thermal Insulation						M2
359	Miscellaneous machinery, except electrical						
	M11: Thermal Error Correction for Machine Tools						
357	Computer and office equipment						
	E2: Flat Panel Displays						
	E4: Speed and Capacity of CDs and DVDs						
	E8: High Capacity Compact Disk						
358	Service industry machinery						
361-2	Electrical industrial equipment and apparatus						
	M1: High Temp Coils for Electric Motor Efficiency						
363	Household appliances						
364	Electric lighting and wiring equipment						
	E14: Printed Wiring Boards						
	E17: Flat Fluorescent Lamps for Display						
365-6	Audio, video, and communication equipment						
	E1: Expanding Light Signals in an Optical Fiber						
367	Electronic components and accessories						
	A4: Optical Switches						
	A5: Insulating Foams for Microorganisms						
	E3: LED Tech Components						
	E5: LED - Blue						
	E7: Ion Beam Implantation: Computer Chips						
	E9: Dry Clean Computer Chip Wafer						
	E12: Precision Mirrors for Advanced Lithography						
	E13: Interconnected Chips						
	E16: Metallo-Organic Chemical Vapor Deposition Reactor						
	E18: Gallium Arsenide (GaAs-Based ICs)						
	M9: Data Sharing Speed Components						
369	Miscellaneous electrical machinery and supplies						
3711	Motor vehicles (passenger cars and trucks)						
3713-5	Truck and bus bodies, trailers, and motor vehicles parts						
372	Aircraft and parts						
3716	Other transportation equipment						
381,2,4,7	Scientific and controlling instruments						
	A2: Biochemical and Environmental Detectors						
	A3: High Quality Microlenses						
	B4: New Metal Alloy for Medical Implants						
	E6: Low-Cost Surgical Laser						
	E10: Large Scale Technology for X-Ray Lithography						
	E11: Turnable Lasers						
	E15: Prototypes of Higher Quality Microchannel Plates						
	M3: Systems Solution for Auto Body Manufacturing						
	M5: Robot Navigation						
	M7: Integrated Force Arrays						
	M8: Machines that See in 3D						
385,6	Ophthalmic and photographic equipment						

Source: Shaded boxes show the author's assignment of ATP projects using I-O/SIC concordance. The dark shaded boxes outline an entire industry as represented by the two-digit SIC code, e.g. SIC 35, Industrial Machinery and Equipment.

SICs	Miscellaneous machinery, except electrical 359	Computer and office equipment 357	Service industry machinery 358	Electrical industrial equipment and apparatus 361-2	Household appliances 363	Electric lighting and wiring equipment 364	Audio, video, and communication equipment 365,6	Electronic components and accessories 367	Miscellaneous electrical machinery and supplies 369	Motor vehicles (passenger cars and trucks) 3711	Truck & bus bodies, trailers, and motor vehicles parts 3713-5	Aircraft and parts 372	Other transportation equipment 3716	Scientific and controlling instruments 381, 2,4,7	Ophthalmic and photographic equipment 385,6
351															
352		SIC 35 Industrial Machinery and Equipment													
353															
354															
355															
356															
	M2														
359															
	M11														
357															
	E2	E2													
	E4	E4													
	E8														
358															
361-2															
	M1						SIC 36 Electronics & Other Electrical Equipment								
363															
364															
	E14						E14	E14							
	E17											E17			
365-6															
	E1						E1								
367															
	A4														
	A5														
	E3	E3			E3			E3		E3					
	E5	E5			E5		E5	E5		E5					
	E7	E7						E7							
	E9														
	E12	E12					E12	E12							
	E13	E13					E13	E13							
	E16	E16													
	E18						E18								
	M9											M9			
369															
3711															
3713-5												SIC 37 Transportation Equipment			
372															
3716															
381,2,4,7															
	A2													SIC 38 Instruments	
	A3														
	B4														
	E6													E6	
	E10														
	E11													E11	
	E15														
	M3									M3					
	M5														
	M7														
	M8									M8					
385,6															

4. Measuring Spillovers by Distance

Once the ATP projects were mapped to the industries of their customers, it seemed relevant to determine if all relationships are equally important. So the research turned to addressing this issue quantitatively. This analysis was not contemplated at the outset of the project, but the literature search provided some ideas about how to measure this “distance.” One that could be readily tested was to use, as Brown and Conrad (1967) first did, shipments of intermediate products quantified in the I-O framework. (The method Terleckyj (1975) used, to weight by intermediate and capital goods purchases, would involve much more work; the latest capital goods I-O table is for 1992.)

IDENTIFYING POTENTIAL SPILLOVERS—A SUMMARY

Between 1992 and 1997, 36 out of 49 ATP-funded projects resulted in commercialization. Total ATP funding for those projects amounted to $102 million. Despite the relatively small amount of taxpayer dollars that were invested, the program reaches a broad cross-section of U.S. industry.

The diffusion of ATP-funded projects was depicted in Table 3. The rows in Table 3 represent the major groups of goods and services produced in the U.S. economy. The columns designate the industries that use these goods and services (referred to as commodities). The groups are defined by the 1987 SIC definition. These 94 SIC industries and 97 commodities are those used by the government to construct the annual (2-digit, 97C x 94I) U.S. I-O table. All industries and commodities are counted somewhere in the I-O table.[3]

ATP has funded research leading to commercialization in 14 of the 94 industry groups. In 19 cases, more than one funded project is used by more than one of the 94 using industries. While this represents considerable diversity, it is nonetheless the case that a number of projects were awarded in commodity groups that are part of durable goods and are used by durable goods industries. Nineteen of 49 projects can be so characterized. The scope of potential impact from these projects is visible in this table.

A more detailed glance at those 19 projects that fall in SICs 35-38 was shown in Table 4. The table identifies the 19 projects that both originate and destinate (at least once) in industries 35–38 and are embedded in the commodities that comprise them.

3. Not all industries are presented in Table 3 due to space constraints.

The table also shows four of the 2-digit SIC categories for which the production and purchase of the product is in the same industry (darkly shaded rectangles). Clearly the Electronic and Other Electronic Equipment (SIC 36) sectors have the largest number of cells with project entries, and 14 funded projects are produced and used in three industries. Such concentration increases the likelihood of spillovers.

Table 4 provides a close project view of the interconnection between each specific commercialized ATP-funded research and the users of the products or processes of such research. This analysis can be extended to the entire (or 6-digit SIC) I-O table, which is what is done in this chapter for projects that fall in SICs 35–38.

The road maps, identified in Chapter 3 and summarized above, permit the user to view the paths that ATP-funded projects and processes could take as they flow through the U.S. economy. But they say very little about differences in the likelihood of market spillovers. That is because all cells are equally represented in the analysis.

RANKING SPILLOVERS

To get a better sense of spillover potential, it is useful to take account of the intensity of commercial transactions between the cell in which the ATP-funded research took place and the transactional flows within that cell, and the transaction between the same cell and its customers (users). In this section, rankings of ATP projects are computed that can be used to answer the question *What is the likelihood that an ATP-funded research project will produce external spillovers to other market participants?*

Four categories of transactions can be identified in the I-O tables:

- The percentage of intra-industry shipments are quantified among firms within the industry that receives ATP funding, that is, the “make” industry.
- The percentage of “make” industry shipments that go to particular using industries.
- The percentage of intra-industry shipments of total shipments of the “use” industry.
- The percentage of “use” industry purchases from the “make” industry relative to the “use” industry’s total intermediate purchases.

Table 5 presents data from the 6-digit and 2-digit I-O table for those ATP projects that fall in SIC industries 35–38.[4] Some ATP projects flow to more than one industry. When that occurs there is an indented row for each. The aggregate results for all using industries for each project appear darkly shaded above such multi-user rows.

4. The column numbers stated in the text refer to the numbered columns in the tables.

Column 1 shows the I-O code for the “make” industry.

Column 2 shows the percentage of total shipments of primary products from the ATP-funded industry sold to purchasers in that industry. (That total is derived from the last row of the “make” table, which shows the total production of an industry of both primary and secondary product.) The data in column 2 can be regarded as indicative of the strongest spillover path; that is, that from one firm to others in its industry. Included in that classification would be both purchasers who use the product innovation as an input to its products as well as those that might use the innovation to compete with the innovator. So both market and knowledge spillovers can be involved. Knowledge spillovers may be less likely when customers in other industries buy the product as an input to their own products.[5]

Column 3 shows the percentage of the “make” industry shipments to the “use” industry. (Those data are from the “use” table.)

Column 4 repeats the I-O code of the industry using the output of the ATP project.

The percentages in column 5 and 6 describe the interactions within the “use” industry. The data in column 5 contain the purchases of its own primary products by the “use” industry as a percentage of all its purchased intermediate inputs. The higher the percentage the more likely it is that the purchasing industries may be learning about the product innovation from others in its industry. In other words, there is potential knowledge spillover. (The I-O cell, even at the 6-digit level, is relatively aggregated. Nonetheless, it is possible that the spillover is a market one, since one firm in an I-O industry may sell to another.)

Column 6 is a measure of the proportion of the total intermediate purchases of a “use” industry that are the primary products of the “make” industry alone. That proportion indicates the importance of the “make” industry’s primary products to the “use” industry and is a less ambiguous indicator of market spillover.

Column 7 contains the sum of all four types of spillovers and determines the ordering of the 19 projects (darkly shaded rows) ATP has funded that are both “made” and “used” in SIC industries 35–38.

Column 8 is obtained by summing columns 2, 3, 5, and 6 for each “make” and “use” industry—5703, 5605, and 5702—and combining the two percentages—68 and 44—using as weights the relative shipments of the three industries.

As an example, consider printed wiring boards. Printed wiring boards are made in I-O industry 5703. In that industry, almost 20 percent of shipments are to firms within that SIC. Among other industries in SICs 35–38 (I-O industries 5100–6200), two industries, 5605 and 5702, purchase from I-O 5703. They take about 10 percent of 5703’s output. In turn, 5605

5. In general, even though knowledge spillovers to other industries may be less likely, ATP funds projects that have the potential for spillovers to other industries. The different types of spillovers are discussed in Chapter 2.

and 5702 sell about 25 percent of their output within their industries, and their purchases from 5703 account for almost 40 percent of their total purchases.

Column 9 is the sum of these weighted sums (59 percent). Taken by itself, 59 percent has no meaning; it must be compared with similar statistics for all other rows represented in this exercise. What is meaningful is that among all ATP-funded projects classified in I-O sectors 5100–6200, printed wiring boards have the greatest possibility of affecting products and processes in I-O sectors 5100–6200. Rankings by such a metric are reflected in Table 5a. (Table 5b considers only interactions of the 2-digit I-O level. The probabilities are less clearly measured and show that the higher the aggregation order, the higher the probability but the less meaningful they are.)

The sum of these percentages as a measure of spillover is the most straightforward of many weighting schemes. For example, some avenues of potential spillover may have more impact than others. Weighting schemes that include the relative importance of the product/industry in the broader economy could be considered. Those possibilities could be investigated in future research of potential spillover.

As shown in Table 5a, the 6-digit level I-O, the 1996 funding of research on printed wiring boards provided the probability for the largest spillovers (59 percent). The potential spillover to the Communication Equipment sector (SIC 3663) is substantially larger than to the Semiconductor sector (SIC 3674). About half the spillover to Communication Equipment—34 percent of 68 percent—reflects the significant importance of purchases from the I-O sector in which printed wiring boards are made in the sector's total intermediate purchases.

Precision mirrors for advanced lithography and interconnected chips are virtually tied for second place. That these two projects get the same rating on the spillovers within their respective industry components (column 2) reflects the fact that both projects are classified in the same industry.

Table 5b shows the same data as Table 5a, but reflects results based on the 2-digit I-O table. Ion beam implantation, interconnected chips, and metallic-organic chemical vapor deposition reactor were tied for top rank with respect to potential spillovers at the 2-digit level I-O. Although the rankings are different, four of the five top projects are the same as in the 6-digit I-O table (Table 5a). The number-one-ranked project in the 6-digit level I-O table, printed wiring boards, is ranked sixth in the 2-digit level I-O table.

The 6-digit table (Table 5a) seems preferable on two counts. The first is the logic of using a more disaggregated set of industries. The second is observable by comparing the mean variance rows at the bottom of each table. All 2-digit means are much larger than 6-digit ones and have more than proportionally higher variances.

The ranking for all 36 of 49 ATP projects by the metrics used in the previous tables are presented in Table 6a. The calculation is made at the 2-digit level I-O only. If this methodology were employed in subsequent research covering all 49 projects at the 6-digit level I-O, then the results could change. That happened in the exercise limited to SIC 35–38, shown in Tables 5a and 5b. Thirteen projects that had no commercialization—commercialization failed or commercialization underway or possible—were excluded. These 13 are listed in Table 6b.

This brief presentation of summary results is intended only as a prototype for one approach to presenting interested audiences the scope and potential effect of ATP funding. Other approaches are likely to come to light as the analytical framework is refined and used. One likelihood is that ATP's Business Reporting System (BRS) and Post-Project Survey (PPS) data can be integrated into this analysis to leverage its usefulness.

Table 5a. ATP-Funded Projects in SICs 35–38: Spillovers Within 6-Digit Level I-O Industry

Code (JPC's)	Date ATP Project Ended	"Make" (SIC)	Projects	"Make" I-O Code (1)	To "Same" Industry (2)	To "Use" Industry (3)
				Shipments of "Make" Industry as a Percent of Total Shipments		
E14			Printed Wiring Boards - TOTAL			
	04/15/00	3672	Printed Wiring Boards	570300	20%	9%
	04/15/00	3672	Printed Wiring Boards	570300	20%	2%
E12			Precision Mirrors for Advanced Lithography - TOTAL			
	05/15/98	3674	Precision Mirrors for Advanced Lithography	570200	8%	7%
	05/16/98	3674	Precision Mirrors for Advanced Lithography	570200	8%	9%
	05/17/98	3674	Precision Mirrors for Advanced Lithography	570200	8%	0%
E13			Interconnected Chips - TOTAL			
	09/16/99	3674	Interconnected Chips	570200	8%	7%
	09/16/99	3674	Interconnected Chips	570200	8%	9%
	09/16/99	3674	Interconnected Chips	570200	8%	0%
E16			Metallo-Organic Chemical Vapor Deposition Reactor -TOTAL			
	04/01/99	3674	Metallo-Organic Chemical Vapor Deposition Reactor	570200	8%	9%
	04/01/99	3674	Metallo-Organic Chemical Vapor Deposition Reactor	570200	8%	9%
E7	07/01/98	3674	Ion Beam Implantation; Computer Chips	570200	8%	9%
M9	08/01/00	3672	Data Sharing Speeds Components	570300	20%	1%
M8	04/01/00	3599	Machines that See in 3D	500400	6%	12%
E5			LED - Blue - TOTAL			
	06/15/98	3674	LED - Blue	570200	8%	9%
	06/15/98	3674	LED - Blue	570200	8%	4%
	06/15/98	3674	LED - Blue	570200	8%	2%
E17	02/01/01	3672	Flat Fluorescent Lamps for Displays	570300	20%	3%
M2	08/01/99	3585	Thermal Insulation	520300	9%	0%
E18	01/01/01	3674	Gallium Arsenide (GaAs-Based ICs)	570200	8%	2%
E2	08/15/00	3572	Flat Panel Displays	510104	9%	0%
E4	04/01/01	3572	Speed and Capacity of CDs and DVDs	510104	9%	0%
E11	10/01/97	3842	Turnable Lasers for Many Uses	620500	4%	5%
M11	11/17/97	3599	Thermal-Error Correction for Machine Tools	500400	6%	0%
E3			LED Tech Component - TOTAL			
	07/15/99	3674	LED Tech Component	570200	8%	4%
	07/15/99	3674	LED Tech Component	570200	8%	4%
	07/15/99	3674	LED Tech Component	570200	8%	0%
	07/15/99	3674	LED Tech Component	570200	8%	0%
E6	05/01/99	3841	Low-Cost Surgical Laser	620400	1%	1%
M3	11/01/99	3823	Systems Solution for Auto Body Manufacturing	620200	2%	7%
E1	03/15/99	3663	Expanding Light Signals in an Optical Fiber	560500	2%	0%
			Mean		9%	4%
			Variance		0.24	0.14

Table 5b. ATP-Funded Projects in SICs 35–38: Spillovers Within 2-Digit Level I-O Industry

E7	07/01/98	36	Ion Beam Implantation; Computer Chips	57	20%	24%
E16	04/01/99	36	Metallo-Organic Chemical Vapor Deposition Reactor	57	20%	24%
E13			Interconnected Chips - TOTAL			
	09/16/99	36	Interconnected Chips	57	20%	24%
	09/16/99	36	Interconnected Chips	57	20%	18%
E12			Precision Mirrors for Advanced Lithography - TOTAL			
	05/15/98	36	Precision Mirrors for Advanced Lithography	57	20%	24%
	05/15/98	36	Precision Mirrors for Advanced Lithography	57	20%	18%
E18	01/01/01	36	Gallium Arsenide (GaAs-Based ICs)	57	20%	18%
E14	04/15/00	36	Printed Wiring Boards	57	20%	18%
E5			LED - Blue - TOTAL			
	06/15/98	36	LED - Blue	57	20%	24%
	06/15/98	36	LED - Blue	57	20%	18%
	06/15/98	36	LED - Blue	57	20%	4%
E3			LED Tech Component - TOTAL			
	07/15/99	36	LED Tech Component	57	20%	24%
	07/15/99	36	LED Tech Component	57	20%	3%
	07/15/99	36	LED Tech Component	57	20%	0%
M9	08/01/00	36	Data Sharing Speeds Components	57	20%	1%
E17	02/01/01	36	Flat Fluorescent Lamps for Displays	57	20%	1%
E2	08/15/00	35	Flat Panel Displays	51	14%	0%
E4	04/01/01	35	Speed and Capacity of CDs and DVDs	51	14%	0%
E11	10/01/97	38	Turnable Lasers for Many Uses	62	3%	3%
M11	11/17/97	35	Thermal-Error Correction for Machine Tools	50	5%	0%
E1	03/15/99	36	Expanding Light Signals in an Optical Fiber	56	7%	0%
M2	08/01/99	35	Thermal Insulation	52	7%	0%
M8	04/01/00	35	Machines that See in 3D	50	16%	0%
E6	05/01/99	38	Low-Cost Surgical Laser	62	3%	0%
M3	11/01/99	38	Systems Solution for Auto Body Manufacturing	62	3%	1%
			Mean		16%	10%
			Variance		0.46	1.11

Source: Author's calculations using Input-Output (I-O) table.

	Purchases of "Use" Industry as a Percent of Total Purchases			Potential Spillover 6-Digit I-O Industry				
	"Use"	From "Same"	From "Make"	Sum of	Weighted	Weighted		
Code (JPC's)	I-O Code (4)	Industry (5)	Industry (6)	(2)+(3)+(5)+(6) (7)	Sum (8)	Average (9)	"Use" (SIC)	"Use" Industry
E14						**59%**		
	560500	6%	34%	68%	41%		3663	Communication Equipment
	570200	19%	5%	44%	18%		3674	Semiconductor Industry
E12						**49%**		
	570300	34%	9%	58%	30%		3672	Communication Equipment and Other Electronic Devices
	510104	13%	16%	45%	18%		3572	Computers
	620800	1%	1%	10%	1%		3844	X-Ray Application
E13						**48%**		
	570300	34%	9%	58%	28%		3672	[P] 3D Microprocessors Technology
	510104	13%	16%	45%	17%		3572	Flat-Panel Computer Displays
	560100	5%	2%	15%	2%		3651	Household Audio & Video
E16						**45%**		
	510104	13%	16%	45%	23%		3572	Optoelectronic Epitaxial Wafers Including High Speed Laser Printing
	510104	13%	16%	45%	23%		3575	Office Equipment
E7	510104	13%	16%	45%		**45%**	3572	[P] Flat-Panel Production, Computers Equipment
M9	600400	12%	5%	38%		**38%**	3728	Airplane Manufacturers
M8	590302	13%	5%	36%		**36%**	3714	Automate Automobile Assembling
E5						**35%**		
	510104	13%	16%	45%	22%		3572	Computer Peripheral Equipment
	590302	13%	2%	27%	8%		3714	Auto Dashboard
	560500	6%	8%	23%	6%		3663	HDTVs Broadcast Equipment
E17	600100	0%	3%	25%		**25%**	3721	Aircraft Manufacturers (Flat-Panel Displays in Airplane Cockpits)
M2	520300	15%	0%	25%		**25%**	3585	Refrigeration
E18	560500	6%	8%	23%		**23%**	3663	[P] Transceiver Applications in Telecommunications and Data Communications
E2	510104	13%	0%	22%		**22%**	3572	Introduced in Flat Panel Production
E4	510104	13%	0%	22%		**22%**	3572	Optical Data Storage Industry
E11	620400	2%	12%	22%		**22%**	3841	Scientific Equipment
M11	500400	15%	0%	22%		**22%**	3599	[P] Machine Tools
E3						**20%**		
	590302	13%	2%	27%	10%		3714	Auto Dashboard
	560100	5%	2%	18%	4%		3651	Household Cooking Appliances
	560100	5%	2%	15%	3%		3651	Consumer Electronics
	510400	0%	5%	14%	3%		3579	Office Equipment
E6	620500	9%	3%	14%		**14%**	3842	Optical System Application Using Diode Laser Array
M3	590301	1%	1%	10%		**10%**	3711	[P] Auto Manufacturers, Auto Assembly and Related Industry
E1	560500	6%	0%	8%		**8%**	3663	[P] Telecommunication Application and Equipments
		11%	7%	31%		**30%**		[P] = Process
		0.68	0.61	2.61		**2.04**		

E7	51	17%	35%	97%		**97%**	35	[P] Flat-Panel Production, Computers Equipment
E16	51	17%	35%	97%		**97%**	35	Optoelectronic Epitaxial Wafers Including High Speed Laser Printing
E13						**94%**		
	51	17%	35%	97%	50%		35	Flat-Panel Computer Displays
	56	11%	41%	90%	44%		36	Household Audio & Video
E12						**94%**		
	51	17%	35%	97%	50%		35	Computers
	56	11%	41%	90%	44%		36	Communication Equipment and Other Electronic Devices
E18	56	11%	41%	90%		**90%**	36	[P] Transceiver Applications in Telecommunications and Data Communications
E14	56	11%	41%	90%		**90%**	36	Communication Equipment
E5						**85%**		
	51	17%	35%	97%	44%		35	Computer Optical Storage
	56	11%	41%	90%	38%		36	HDTVs Broadcasting
	59B	0%	3%	28%	4%		37	Auto Dashboard
E3						**72%**		
	51	17%	35%	97%	59%		35	Office Equipment
	59B	13%	4%	41%	11%		37	Auto Dashboard
	54	0%	1%	22%	3%		36	Household Cooking Appliances
M9	60	34%	3%	58%		**58%**	37	Airplane Manufacturers
E17	60	34%	3%	58%		**58%**	37	Aircraft Manufacturers (Flat-Panel Displays in Airplane Cockpits)
E2	51	17%	0%	31%		**31%**	35	Introduced in Flat Panel Production
E4	51	17%	0%	31%		**31%**	35	Optical Data Storage Industry
E11	62	7%	0%	19%		**19%**	38	Scientific Equipment
M11	50	13%	0%	18%		**18%**	35	[P] Machine Tools
E1	56	11%	0%	17%		**17%**	36	[P] Telecommunication Application and Equipments
M2	52	13%	0%	17%		**17%**	35	Refrigeration
M8	59B	0%	0%	16%		**16%**	37	Automate Automobile Assembling
E6	62	7%	0%	10%		**10%**	38	Optical System Application Using Diode Laser Array
M3	59B	0%	1%	5%		**5%**	37	[P] Auto Manufacturers, Auto Assembly and Related Industry
Mean		13%	17%	56%		**53%**		[P] = Process
Variance		0.75	3.56	13.06		**12.63**		

Table 6a. All ATP-Funded Projects (Excluding Non-Commercialized Projects): Spillovers Within 2-Digit Level I-O Industry

				Shipments of "Make" Industry as a Percent of Total Shipments			Purchases of "Use" Industry as a Percent of Total Purchases		
				"Make"	To "Same"	To "Use"	"Use"	From "Same"	From "Make"
Code (JPC's)	Date ATP Project Ended	"Make" (SIC)	Projects	I-O Code (1)	Industry (2)	Industry (3)	I-O Code (4)	Industry (5)	Industry (6)
E7	07/01/98	36	Ion Beam Implantation; Computer Chips	57	20%	24%	51	17%	35%
E16	04/01/99	36	Metallo-Organic Chemical Vapor Deposition Reactor	57	20%	24%	51	17%	35%
E13			Interconnected Chips - TOTAL						
	09/16/99	36	Interconnected Chips	57	20%	24%	51	17%	35%
	09/16/99	36	Interconnected Chips	57	20%	18%	56	11%	41%
E12			Precision Mirrors for Advanced Lithography - TOTAL						
	05/15/98	36	Precision Mirrors for Advanced Lithography	57	20%	24%	51	17%	35%
	05/15/98	36	Precision Mirrors for Advanced Lithography	57	20%	18%	56	11%	41%
E14	04/15/00	36	Printed Wiring Boards	57	20%	18%	56	11%	41%
E18	01/01/01	36	Gallium Arsenide (GaAs-Based ICs)	57	20%	18%	56	11%	41%
E5			LED - Blue - TOTAL						
	06/15/98	36	LED - Blue	57	20%	24%	51	17%	35%
	06/15/98	36	LED - Blue	57	20%	18%	56	11%	41%
	06/15/98	36	LED - Blue	57	20%	4%	59B	0%	3%
E3			LED Tech Component - TOTAL						
	07/15/99	36	LED Tech Component	57	20%	24%	51	17%	35%
	07/15/99	36	LED Tech Component	57	20%	3%	59B	13%	4%
	07/15/99	36	LED Tech Component	57	20%	0%	54	0%	1%
E17	02/01/01	36	Flat Fluorescent Lamps for Displays	57	20%	1%	60	34%	3%
M9	08/01/00	36	Data Sharing Speeds Components	51	20%	1%	60	34%	3%
M8			Machines that See in 3D - TOTAL						
	04/01/00	35	Machines that See in 3D	50	16%	0%	59	49%	0%
	04/01/00	35	Machines that See in 3D	50	16%	4%	37	27%	3%
	04/01/00	35	Machines that See in 3D	50	16%	0%	59A	0%	0%
E1	03/15/99	36	Expanding Light Signals in an Optical Fiber	56	7%	7%	66	32%	4%
I5			Parallel-Processing Software - TOTAL						
	08/01/00	73	Parallel-Processing Software	73A	10%	6%	70A	47%	6%
	08/01/00	73	Parallel-Processing Software	73A	10%	0%	65B	39%	1%
	08/01/00	73	Parallel-Processing Software	73A	10%	1%	65A	12%	4%
	08/01/00	73	Parallel-Processing Software	73A	10%	2%	77A	5%	2%
	08/01/00	73	Parallel-Processing Software	73A	10%	2%	69B	1%	2%
M4			Thallium/Lead Thin Films for Electronic Devices - TOTAL						
	04/01/98	34	Thallium/Lead Thin Films for Electronic Devices	42	6%	6%	57	35%	6%
	04/01/98	34	Thallium/Lead Thin Films for Electronic Devices	42	6%	1%	66	32%	0%
M6	03/01/00	34	High Temp Superconductivity to Improve Cellular Transmission	42	6%	1%	66	32%	0%
M10	01/01/01	32	Thin-Film Electrochromics	36	11%	1%	35	21%	4%
I4			Restoring and Enhancing Movies - TOTAL						
	09/01/99	73	Restoring and Enhancing Movies	73A	10%	3%	76	25%	6%
	09/01/99	73	Restoring and Enhancing Movies	73A	10%	0%	56	11%	1%
M5			Robot Navigation - TOTAL						
	04/01/98	38	Robot Navigation	62	3%	0%	65B	39%	0%
	04/01/98	38	Robot Navigation	62	3%	11%	77A	5%	5%
B5			Software for New Molecules and Drugs - TOTAL						
	06/01/99	73	Software for New Molecules and Drugs	73A	10%	3%	73C	22%	7%
	06/01/99	73	Software for New Molecules and Drugs	73A	10%	2%	77A	5%	2%
A2			Biochemical and Environmental Detectors - TOTAL						
	01/01/01	38	Biochemical and Environmental Detectors	62	3%	0%	27B	36%	0%
	01/01/01	38	Biochemical and Environmental Detectors	62	3%	11%	77A	5%	5%
E2	08/15/00	35	Flat Panel Displays	51	14%	0%	51	17%	0%
E4	04/01/01	35	Speed and Capacity of CDs and DVDs	51	14%	0%	51	17%	0%
I1	10/01/97	73	Computer Recognition of Natural Handwriting	73A	10%	0%	51	17%	2%
I6	01/15/01	73	Rail-Traffic Optimization Technology	73A	10%	0%	65B	11%	5%
B4	01/01/01	38	New Metal Alloy for Medical Implants	62	3%	11%	77A	5%	5%
E6	05/01/99	38	Low-Cost Surgical Laser	62	3%	11%	77A	5%	5%
E11			Turnable Lasers for Many Uses - TOTAL						
	10/01/97	38	Turnable Lasers for Many Uses	62	3%	0%	73C	22%	0%
	10/01/97	38	Turnable Lasers for Many Uses	62	3%	11%	77A	5%	5%
	10/01/97	38	Turnable Lasers for Many Uses	62	3%	3%	62	7%	7%
A1	07/01/99	32	High Performance Ceramic Parts	36	11%	1%	59B,60	8%	0%
B2	02/15/01	87	Enzymes in Deep-Sea Microorganisms	73C	8%	3%	77A	5%	4%
I3	07/01/99	73	Animated 3D Anatomy	73A	10%	2%	77A	5%	2%
M11	11/17/97	35	Thermal-Error Correction for Machine Tools	50	5%	0%	50	13%	0%
M2	08/01/99	35	Thermal Insulation	52	7%	0%	40	10%	0%
A6	08/15/99	30	Waste Plastic Recycling	32	6%	0%	32	10%	0%
M1	07/01/99	36	High-Temperature Coils for Electric Motor Efficiency	42	7%	1%	68A	0%	0%
B1	07/01/98	80	Stem Cell Harvesting Improvement	77A	2%	0%	77A	5%	0%
M3	11/01/99	38	Systems Solution for Auto Body Manufacturing	62	3%	1%	59A	0%	1%
			Mean		11%	6%		16%	10%
			Variance		0.45	0.68		1.62	2.12

Source: Authors assignment of ATP projects using I-O/SIC concordance.

Code (JPC's)	Potential Spillover 2-Digit I-O Industry: Sum of (2)+(3)+(5)+(6) (7)	Weighted Sum (8)	Weighted Average (9)	"Use" (SIC)		"Use" Industry
E7	97%		**97%**	35		Flat-Panel Production, Computers Equipment
E16	97%		**97%**	35		Optoelectronic Epitaxial Wafers Including High Speed Laser Printing
E13			**94%**			
	97%	50%		35		Flat-Panel Computer Displays
	90%	44%		36		Household Audio & Video
E12			**94%**			
	97%	50%		35		Computers
	90%	44%		36		Communication Equipment and Other Electronic Devices
E14	90%		**90%**	36		Communication Equipment
E18	90%		**90%**	36	p	Transceiver Applications in Telecommunications and Data Communications
E5			**85%**			
	97%	44%		35		Computer Optical Storage
	90%	38%		36		HDTVs Broadcasting
	28%	4%		37		Auto Dashboard
E3			**72%**			
	97%	59%		35		Office Equipment
	41%	11%		37		Auto Dashboard
	22%	3%		36		Household Cooking Appliances
E17	58%		**58%**	37		Aircraft Manufacturers (Flat-Panel Displays in Airplane Cockpits)
M9	58%		**58%**	37		Airplane Manufacturers
M8			**53%**			
	65%	33%		24		Lumber Mill
	49%	19%		33		Steel Processing
	16%	2%		37		Automate Automobile Assembling
E1	49%		**49%**	48	p	Fiber Optics Telecommunication Application
I5			**47%**			
	69%	26%		60		Commercial Banks
	49%	14%		42		Transportation and Warehousing
	27%	4%		45		Air Transportation
	19%	2%		80		Health Care
	15%	1%		53		Retail Department Stores
M4			**46%**			
	52%	30%		36		Superconductor Applications
	38%	16%		48		Satellite Communications
M6	38%		**38%**	48		Cellular Communications
M10	37%		**37%**	32	p	High Performance Architecture Glass Market
I4			**36%**			
	43%	29%		78	p	Motion Pictures
	22%	7%		36	p	High Definition TV
M5			**35%**			
	42%	27%		42		Factories and Warehousing
	23%	8%		80		Hospitals
B5			**35%**			
	42%	29%		87		Chemical Research
	19%	6%		80		Medical Laboratories
A2			**33%**			
	39%	25%		28		Environmental Testing,
	23%	9%		80		Biomedical Application
E2	31%		**31%**	35		Introduced in Flat Panel Production
B4	31%		**31%**	35		Optical Data Storage Industry
I1	29%		**29%**	35		Computer Hardware
I6	26%		**26%**	40	p	Railroad Transportation
B4	23%		**23%**	80		Health Care
E6	23%		**23%**	80		Heart, Lung, and Blood Institutes
E11			**23%**			
	25%	9%		87		Academics R&D
	23%	8%		80		Health Care
	19%	5%		38		Scientific Equipment
A1	21%		**21%**	37		Auto & Aircraft Engines
B2	20%		**20%**	80	p	Detection of Genetic Diseases
I3	19%		**19%**	80		Health Care
M11	18%		**18%**	35	p	Machine Tools
M2	17%		**17%**	34		Heating and Plumbing
A6	16%		**16%**	30	p	Low-cost Modular Houses
M1	8%		**8%**	49	p	Energy Industry for Commercial and Residential Energy Consumption
B1	7%		**7%**	80	p	Medical Cancer Treatment
M3	5%		**5%**	37	p	Auto Manufacturers, Auto Assembly and Related Industry
Mean	43%		**43%**		p	= Process
Variance	8.44		**8.12**			

Table 6b. ATP-Funded Projects That Had No Commercialization

Code (JPC's)	Date ATP Project Ended	"Make" (SIC)	Projects	"Use" Industry
A3	07/04/95	38	High Quality Microlenses	No Commercialization
A4	07/31/95	36	Optical Switches	No Commercialization
A5	02/28/96	36	Insulating Foams for Microelectronics	No Commercialization
A7	11/14/95	32	Diamond Film	Commercialization Possible - Market Prospect: Industrial Cutting Tool
B3	06/30/95	80	Viral Contamination in Donated Blood	Commercialization Possible - Market Prospect: Health Care
B6	05/31/95	28	Safe Insecticide	Commercialization Possible - Market Prospect: Pharmaceuticals Application
B7	02/28/96	28	Prostheses That Regenerate Body Parts	Commercialization Underway - Market Prospect: Orthopedic Application
E8	12/31/94	35	High-Capacity Compact Disk	Commercialization Failed
E9	02/08/95	36	Dry Clean Computer Chip Wafer	Commercialization Uncertain
E10	09/30/92	38	Large-Scale Technology for X-Ray Lithography	No Commercialization
E15	05/31/95	38	Prototypes of Higher Quality Microchannel Plates (MCPs)	Commercialization Uncertain - Prospect Uses for Night Blindness Treatment, Miniature Scientific Instruments
I2	03/19/96	73	Chinese Character-Recognition; Computer Data Entry Method	Commercialization Underway - Market Prospect: Computer Software Market in China
M7	06/14/95	38	Integrated Force Arrays (IFAs)	Commercialization Likely - Market Prospect: Data Storage, Biomedical Devices & Prostheses, Robotics, Optical Shuttle

Source: Authors assignment of ATP projects using I-O/SIC concordance.

5. Recommendations for Future Research

Since this method of analysis is more definitive at the very detailed I-O level, it is recommended that initial follow-up research be devoted to extending the 6-digit I-O sector analysis to all 50 ATP projects and not just those in SIC 35–38. If more projects have resulted in commercialization, then those projects should be entered into the analysis. This analysis should use the 1997 benchmark table, at which point this research should be revised to reflect the more up-to-date data. A system linked to the ATP's Business Reporting System (BRS) and Post-Project Survey (PPS) data should be developed to update the analysis as new projects result in commercialization.

A second research endeavor would be to extend the "distance" measure to include not only intermediate goods but capital goods as well, although the potential for double counting will need to be more carefully considered in that analysis. Capital goods matrices are available with more of a time lag. The latest one available is for 1992. It should be used as a complement to the intermediate purchases approach used in this report, but, for consistency, both should employ 1992 tables until the 1997 capital matrices become available. Thus, for 1992, the importance of adding capital can be discerned by rankings based both on capital and on intermediate purchases.

By comparing intermediate purchases' ranking using both 1992 and 1997 tables, the stability of the I-O structure over time can be evaluated. If relatively stable, then we can look forward from the latest quinquennial benchmark I-O table with more confidence. This analysis can extend to final demand components of gross domestic product, such as exports and personal consumption to look at potential for spillover to end purchasers. For example, an increase in spillover potential over several years can be meaningful for the analysis of U.S. competitiveness.

A complementary line of research using intermediate purchases can be developed from the even more detailed unpublished I-O tables for 1992 that have approximately 700 sectors. Presumably that can offer even more refinement to the estimates, but the value added by such an expansion needs to be evaluated. Quantitative analysis, again using BRS and PPS results, from case studies of the 50 projects may permit even further refinement. It would, however, be only partial; that is, only employable in circumstances where case studies yield relevant quantitative results. But such studies can potentially be used to pinpoint areas where the grossness of the I-O tables might lead to distortions.

Another source of refinement is to gain access to census' longitudinal establishment file, which has been under continuous development and updating since 1980. It offers the potential of tracing spillover in finer detail than the 6-digit I-O table.

Several additional research issues relate to the way distance is measured (as opposed to data source issues described above). One is to examine alternatives to the additive use of the components of the distance measures used in this study. Perhaps the outcomes are not insensitive to whether other (e.g., nonlinear) distance proxies are used for the ranking. Also, it would be interesting to know how the distance measure calculated here differs from the mean value of transaction interaction throughout the whole industrial structure.

This analysis focused on projects that have commercialized; but some resulted in minimal actual market transactions. Without market transactions, there are no market spillovers. A more substantial investigation, using the detailed I-O tables to study the impact of fully commercialized projects, is needed to fully understand ATP's role in the economy and society.

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About the Advanced Technology Program

The Advanced Technology Program (ATP) is a partnership between government and private industry to conduct high-risk research to develop enabling technologies that promise significant commercial payoffs and widespread benefits for the economy. ATP provides a mechanism for industry to extend its technological reach and push the envelope beyond what it otherwise would attempt.

Promising future technologies are the domain of ATP:

- Enabling technologies that are essential to the development of future new and substantially improved projects, processes, and services across diverse application areas;
- Technologies for which there are challenging technical issues standing in the way of success;
- Technologies whose development often involves complex "systems" problems requiring a collaborative effort by multiple organizations;
- Technologies that will go undeveloped and/or proceed too slowly to be competitive in global markets without ATP.

ATP funds technical research, but it does not fund product development—that is the domain of the company partners. ATP is industry driven, and that keeps it grounded in real-world needs. For-profit companies conceive, propose, co-fund, and execute all of the projects cost-shared by ATP.

Smaller firms working on single-company projects pay a minimum of all the indirect costs associated with the project. Large "Fortune 500" companies participating as a single company pay at least 60 percent of total project costs. Joint ventures pay at least half of total project costs. Single-company projects can last up to three years; joint ventures can last as long as five years. Companies of all sizes participate in ATP-funded projects. To date, more than half of ATP awards have gone to individual small businesses or to joint ventures led by a small business.

Each project has specific goals, funding allocations, and completion dates established at the outset. Projects are monitored and can be terminated for cause before completion. All projects are selected in rigorous competitions, which use peer review to identify those that score highest against technical and economic criteria.

Contact ATP for more information:

- On the Internet: http://www.atp.nist.gov
- By e-mail: atp@nist.gov
- By phone: 1-800-ATP-FUND (1-800-287-3863)
- By writing: Advanced Technology Program, National Institute of Standards and Technology, 100 Bureau Drive, Mail Stop 4701, Gaithersburg, MD 20899-4701

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