



The Bureau of Business and Economic Research

National Economic Impacts from TechLink-Brokered Partnerships between the Department of Defense and U.S. Industry, 2000-2011

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SUBMITTED TO:

TechLink
2310 University Way, Bldg. 2-2
Bozeman, Montana 59715

SUBMITTED BY:

Bureau of Business and Economic Research
The University of Montana
Missoula, Montana 59812





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PURPOSE OF STUDY

This study was undertaken to estimate the economic contribution to the national economy of Department of Defense (DoD) technology transfer agreements brokered or facilitated by TechLink from 2000-2011. Its primary purpose was to determine the degree to which these agreements have contributed to new economic activity and job creation in the United States. Researchers first conducted a survey to determine the total sales of new products and services resulting from the DoD technology transfer agreements, then used IMPLAN economic impact assessment software to estimate the gross changes in economic output, value added, employment, labor income, and tax revenues related to these total sales. Because TechLink brokers a significant portion of DoD's overall license and other technology transfer agreements with industry nationwide, this represents a substantial case study of the economic impacts associated with Department of Defense technology transfer.

TECHLINK OVERVIEW

TechLink is a federally funded technology transfer center at Montana State University. Since 1999, TechLink has served as DoD's primary national "partnership intermediary," helping to develop technology transfer partnerships between DoD laboratories and U.S. industry nationwide. (For more information, see www.techlinkcenter.org.)

TechLink's primary focus is helping DoD labs to transfer their inventions to U.S. companies. DoD labs generate over 500 patented inventions a year in virtually all technology fields, including biomedicine, software, electronics, communications, advanced materials, and energy-related technologies.

TechLink currently brokers or facilitates approximately 60 percent of all DoD's license agreements with industry. These license agreements enable companies to develop, manufacture, and sell new products and services using DoD inventions. In addition, TechLink helps to establish cooperative research and development agreements (CRADAs) between DoD labs and companies for joint development of new technology. Finally, TechLink helps companies secure competitive research and development (R&D) contracts from DoD to develop new technologies that have both military and commercial applications. These R&D contracts are primarily through the DoD Small Business Innovation Research (SBIR) Program and Broad Agency Announcements (BAAs).

TechLink-facilitated partnerships for DoD are almost exclusively with small companies that are not traditional defense contractors. These partnerships have resulted in substantial new economic activity, jobs, and transition of innovative technology to the U.S. military. This study estimates these economic impacts as well as the extent of transition of new technology from DoD labs to DoD operational use via licensing to industry for manufacture and DoD acquisition.

METHODOLOGY

In January 2012, TechLink initiated a study of the economic outcomes and impacts resulting from its DoD-funded technology transfer activities. (A similar but smaller study was conducted in 2009.) The period covered by this study was 2000-2011, which was effectively the period that TechLink had been assisting DoD with technology transfer at the time of the study.



To undertake the study, TechLink contracted with two independent market research specialists who gathered data from January-April 2012. These researchers contacted each of the companies that TechLink had assisted in establishing a technology transfer agreement with DoD. A total of 361 companies were contacted by email and telephone about the outcomes of 590 different technology transfer agreements with DoD. (Note: Many companies—a total of 114, or 32 percent—had two or more TechLink-facilitated agreements with DoD. The median number of agreements for these companies with multiple agreements was 2, although the mean was 3 because of skewing by a few companies with as many as 13 agreements.)

Companies were asked a series of questions that focused on the economic outcomes and impacts related to their agreements with DoD. Companies were informed that their responses would be treated as confidential information and that these responses would be aggregated with the responses of other companies, without company names, before submission to DoD. Questions asked included the following:

- Did your company develop any new products or services based on the technology transfer agreement?
- What were the total cumulative sales of new products or services related to this technology transfer agreement? (Contracts to further develop the technology were considered sales of R&D services and included in total sales.)
- Of the total sales, what was the dollar value of sales to the U.S. military, either directly or through a prime contractor?
- What was the size category of your company when the agreement was signed (1-9 employees, 10-99 employees, 100-499 employees, or 500 and more employees)?
- Prior to this agreement, had your company previously had a technology transfer agreement with DoD?

The company response rate was extremely high—virtually 100 percent. Only five of the 361 companies contacted declined to participate in the study, yielding a response rate of 99 percent. Fortunately, all five of these companies specialized in government sales of products based on the licensed technologies. The research team was able to determine their cumulative government sales figures by consulting web sites such as www.USAspending.gov, the website of the Office of Management and Budget (OMB), which provides searchable information on all federal contracts awarded; www.governmentcontractswon.com, which lists awards to thousands of defense contractors throughout the 2000-2011 period; and www.dibbs.bsm.dla.mil, the Defense Logistics Agency (DLA) Internet Bid Board System (DIBBS), which provides information on all DLA awards to industry.

The data gathered by the two market research specialists were reviewed by TechLink's fiscal manager, who is a Certified Public Accountant, as well as by TechLink technology managers familiar with the agreements, to check for apparent anomalies. In several cases, companies were recontacted to verify their information.

TechLink next assigned each company to the appropriate North American Industry Classification System (NAICS) code. NAICS is the U.S. federal government's standard industry classification system. It is a comprehensive production-oriented system that groups companies into industries based on the activities in which they are primarily engaged. NAICS recognizes 1,175 different industries in the United States and assigns each its own code. In assigning NAICS codes, the TechLink team used LexisNexis Academic, www.lexisnexis.com, which lists company NAICS codes, as well as a combination of their personal knowledge of the companies/technologies and the website, www.naics.com, which provides a convenient system for looking up NAICS codes by industry sectors and subsectors.

TechLink then provided a final economic impact dataset to the Bureau of Business and Economic Research



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(BBER) at The University of Montana, which has been analyzing local, state, and national economies and providing economic forecasts for more than 50 years (see www.bber.umt.edu). The dataset included, for each company reporting sales of products or services, the company name, its NAICS code, and its total sales figures.

MODELING METHODOLOGY

BBER employed a widely used model, IMPLAN, to determine the economic contribution effects of the total sales resulting from the DoD technology transfer agreements facilitated by TechLink. IMPLAN originated in efforts by the U.S. Forest Service in the late 1970s to model the economic impacts of land management decisions on local communities. Researchers at the University of Minnesota in the late 1980s began to develop IMPLAN for other applications. That led to the creation in 1993 of a spin-out company, the Minnesota IMPLAN Group, Inc. (now MIG, Inc.) to make IMPLAN accessible to a wide range of users. Today, IMPLAN is used by more than 1,500 entities in academia, the private sector, and government to model economic impacts. It is employed to determine economic impacts on regions ranging in size from zip code area to county, state, and national levels.

IMPLAN draws on a mathematical input-output framework originally developed by Wassily Leontief, the 1973 Nobel laureate in economics, to study the flow of money through a regional economy. IMPLAN assumes fixed relationships between producers and their suppliers, based on demand, and that inter-industry relationships within a given region's economy largely determine how that economy responds to change. Increases in demand for a certain product or service causes a multiplier effect—a cascade of ripples through the economy. Thus, increased demand for a product affects the producer of the product, the producer's employees, the producer's suppliers, the supplier's employees, and so on, ultimately generating a total impact on the economy that significantly exceeds the initial change in demand.

For example, Company X licenses a patented laser invention from the Air Force Research Laboratory. It then develops an improved barcode scanner using this technology, which it manufactures and sells nationwide. This requires Company X to hire factory workers, who spend their payroll checks on groceries and other goods. In addition, Company X has to purchase components and raw materials from other companies, employing workers who purchase groceries and other goods, and so on.

In this example, direct effects are the sales of the new barcode scanner based on the Air Force technology. Indirect effects are the inter-industry purchases of components and raw materials needed to manufacture the barcode scanner. Induced effects are the household expenditures as workers spend their payroll checks on goods and services across a wide spectrum of the economy. Economic impacts are the sum of direct effects, indirect effects, and induced effects.

Multipliers are the ratio of the overall economic impact to the initial change and are typically derived from the following equation: $(\text{direct effect} + \text{indirect effect} + \text{induced effect}) / (\text{direct effect})$. Multipliers are very specific to industry sectors and regions. IMPLAN distinguishes between 509 industry sectors recognized by the U.S. Department of Commerce and classified through the North American Industry Classification System (NAICS). Each NAICS sector has a unique output multiplier, because each industry sector has a different pattern of purchases from firms inside and outside of the regional economy. Each year, IMPLAN is updated using data collected by various federal government agencies.

In this study, the BBER applied the national-level IMPLAN model to the total sales figures reported by the companies surveyed. As previously indicated, these figures represented all sales of products and services related to the DoD technology transfer agreements brokered or facilitated by TechLink during the 2000-2011 period.

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Using IMPLAN, BBER was able to estimate the total economic impacts (including direct, indirect, and induced effects) on the nation's economy from these sales. The overall purpose of this modeling exercise was to determine the total economic contribution and the jobs created or retained as a result of these sales.

Data presented are for the year 2011 accounting period and expressed in 2011 dollars. The large majority of the company sales occurred prior to 2011 and some date back to the early 2000s. However, most of these sales are ongoing and there was a need to standardize the year. Use of 2011 as the reference year represents a conservative approach because it does not consider the increase in value of the earlier sales figures resulting from inflation (e.g., a dollar in 2003 was worth more than a dollar in 2011).

RESULTS

Of the 361 companies contacted, 178 (49 percent) reported that they had sales of products or services related to the technology transfer agreements with DoD that TechLink had facilitated (see Table 1). The total cumulative sales reported by these 178 companies amounted to slightly over \$1 billion (\$1,032,669,174). Of the remaining companies, 65 (18 percent) were still developing or commercializing the technology that had been licensed from DoD, co-developed with this agency, or funded by DoD. In short, two-thirds of the companies either were already selling the DoD-related technologies or were continuing to pursue this objective. Approximately a third of the companies, a total of 116 (32 percent), had not achieved any sales and had abandoned efforts to commercialize the subject technology.

Table 1:
Sales resulting from DoD technology transfer agreements facilitated by TechLink, 2000-2011

Companies	Total Number Contacted	Percent of Total	Total Sales	U.S. Military Sales
Survey Results	361	100%	\$1,033 Million	\$568 Million
No results because company abandoned the technology	116	32%	0	0
No results yet because company still developing the technology	65	18%	0	0
Reporting sales	178	49%	\$1,033 Million	\$568 Million
Large (500+ employees)	8	5%	\$15 Million	\$2 Million
Medium-Sized (100-499 employees)	12	7%	\$382 Million	\$359 Million
Small (10-99 employees)	83	47%	\$436 Million	\$133 Million
Very Small (1-9 employees)	75	42%	\$199 Million	\$74 Million

Source: Results reported by companies, January-April 2012; TechLink, Montana State University

Note: Totals do not equal 100 percent due to rounding

The survey found that, of the total cumulative sales, sales to the U.S. military amounted to \$568,132,199, or 55 percent of the total. This high percentage is a very positive finding from the DoD perspective because it demonstrates that the DoD R&D system is successfully achieving its objective of developing innovative new technology that DoD subsequently procures from industry to help achieve its defense mission. Some of



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the companies surveyed had primarily military sales. While companies do not need license agreements to manufacture products based on DoD-patented inventions for U.S. government use, they obtain licenses because they expect to eventually make commercial or foreign military sales. It is ideal when there are both commercial and military markets for new technologies because DoD benefits from production economies of scale that help reduce the cost of new defense-related products. In addition, the commercial marketplace helps ensure the ongoing development of the new technologies and also sustains production in between the spikes of military demand.

A notable survey finding was that small businesses accounted for 95 percent of the companies reporting sales (per the U.S. Small Business Administration criteria that small businesses are those with fewer than 500 employees). Furthermore, these small businesses accounted for nearly 99 percent of the total sales. Large businesses, which made up only 5 percent of the companies reporting sales, accounted for only around 1.5 percent of the total sales and a mere 0.32 percent of the U.S. military sales.

Of the small businesses, only 12 (7 percent) had between 100 and 499 employees, which is commonly considered “medium-sized.” However, these medium-sized companies accounted for 37 percent of the total sales and 63 percent of the U.S. military sales. Close to 90 percent of the companies reporting sales had fewer than 100 employees. Fully 42 percent were in the “very small” category, with fewer than 10 employees. The “small” and “very small” companies accounted for around 61 percent of the total sales and 36 percent of the U.S. military sales.

Another interesting finding concerned companies’ prior experience with DoD technology transfer. Of the 178 companies reporting sales, only 45 (25 percent) had previous technology-transfer agreements with DoD; 133 companies (75 percent) had not previously engaged in technology transfer with DoD prior to TechLink’s involvement.

Upon receiving the company data from TechLink, the BBER employed IMPLAN to determine the economic contribution effects of the total sales figures. Results below are presented for output, value added, employment, labor income, and tax revenues. As previously noted, all dollar figures are reported in 2011 dollars.

OUTPUT

Output is the total value of purchases by intermediate and final consumers and can be thought of as sales, plus or minus inventory adjustments. According to the national IMPLAN model, the \$1.033 billion (2011 \$) in sales of new products or services reported by companies generated an additional \$1.907 billion in sales economy-wide. Of this \$1.907 billion, \$792.4 million was generated indirectly as the result of inter-industry purchases (basically firms purchasing from each other), and \$1.114 billion was generated from the induced effect, or the result of households spending payroll on goods and services economy-wide (see Table 2). The larger induced effect was mainly due to the relatively high-paying jobs associated with high-tech and technology-based industries, which accounted for the majority of the companies involved.

Dividing total economy-wide output (\$2.935 billion) by the direct output of companies selling products or services related to their technology transfer agreements with DoD (\$1.032 billion) yielded an output multiplier of 2.85. That is, for every dollar in sales directly attributable to the DoD technology transfer agreements, an additional \$1.85 in sales was generated economy-wide.



VALUE ADDED

Value added is the difference between an industry's or company's output and the cost of intermediate inputs. Expressed differently, it is the difference between a product's sale price and its production cost. This measure recognizes that companies buy goods and services from other companies and remanufacture these goods and services to create products of greater value than the sum of the goods and services used to make these products. This increase in value resulting from the production process is the "value added." As estimated by IMPLAN, value added is equal to the total sales (plus or minus inventory adjustments) minus the cost of the goods and services purchased to produce the products sold.

The main difference between output and value added is that output includes the value of intermediate goods and services, while value added does not. Many economists prefer value added as an economic measure because, at the macroeconomic scale, output multiple-counts the value of inputs. For example, in the previously cited case of Company X, which sells an improved barcode scanner based on an Air Force laser invention: Company X purchases laser rods, electronic components, optical components, and various raw materials to make the barcode scanner. The value of Company X's sales incorporates the value of these laser rods and other inputs. Further, each of the companies from which Company X purchases its inputs incorporates the value of their respective inputs from other companies. By combining and aggregating the values of intermediate and final products, output overstates the size of the US economy by a factor of roughly 2. For this reason, Gross Domestic Product (GDP), a measure of value added, is used to track the size of the U.S. economy because it is a non-duplicative aggregation of production across all industries in the United States.

In the current study, value added measures the real contribution that each of the DoD technology transfer partners made to the national economy as a result of their technology transfer agreements with DoD. According to the national IMPLAN model, the \$1.033 billion (2011 \$) in sales reported by companies generated an additional \$1.553 billion in value added economy-wide. Of this total, \$509.5 million was generated directly, \$397.5 million was generated indirectly, and \$646 million was generated from the induced effect (see Table 2).

EMPLOYMENT

According to the national IMPLAN model, approximately 5,768 jobs were directly sustained economy-wide in 2011 by the \$1.032 billion in sales. Indirectly, 4,211 jobs were added to the economy, and an additional 7,839 jobs were generated via the induced effects of household spending. Altogether, nearly 18,000 jobs (17,818) nationwide are estimated to have resulted from the direct, indirect, and induced effects of the TechLink-facilitated agreements between DoD labs and companies.

Using the same procedure outlined above to derive the multiplier, an employment multiplier of 3.09 was calculated. That is, for every job directly attributable to the DoD technology transfer agreements, an additional 2.09 jobs were created economy-wide.

LABOR INCOME

Labor income consists of employee compensation (wage and salary payments, including benefits), paid to workers as well as proprietary income (income received by self-employed individuals). The national IMPLAN



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model estimated that labor income directly associated with the \$1.032 billion in sales was \$439.2 million in 2011, or approximately \$76,000 per job. This was substantially above the average U.S. wage in 2011 of \$52,000.

The indirect labor income was estimated at \$248.1 million, or approximately \$59,000 per job. The induced labor income was estimated to be \$361.2 million, or \$46,000 per job. Average wages for the indirect and induced jobs were substantially lower than the average wage for the jobs directly created or retained because many of these jobs were in lower-paid manufacturing and service sectors. Together, the indirect and induced labor income amounted to \$609.3 million. The total economy-wide labor income resulting in 2011 from the DoD technology transfer agreements brokered by TechLink was \$1.049 billion. The average wage of the nearly 18,000 jobs created or retained as a result of the DoD technology transfer agreements was \$59,000, approximately 13 percent higher than the average U.S. wage of \$52,000 in 2011.

The labor income multiplier was 2.39, indicating that for every dollar in wage and salary income attributable to DoD technology transfer agreements, an additional \$1.39 was generated nationally in employee compensation and proprietary income.

TAX REVENUES

Tax revenues were estimated for the \$1.033 billion in sales and their economy-wide indirect and induced effects. These tax revenues included social insurance taxes (paid by employers, employees, and the self-employed), personal income taxes, motor vehicle licenses, property taxes, corporate profits taxes and dividends, and indirect business taxes (comprised mainly of excise and property taxes, fees, licenses, and sales taxes). Total taxes collected by federal, state, and local government entities were estimated at \$331 million. This included \$217 million in federal tax revenues and \$114 million in state and local tax revenues. In sum, for every dollar of sales related to the technology transfer agreements brokered by TechLink, an additional \$0.33 was generated in federal, state, and local tax revenue.

SUMMARY

In summary, this study estimates the economic contribution to the U.S. economy of Department of Defense (DoD) technology transfer agreements brokered or facilitated by TechLink from 2000-2011. Its purpose was to determine the degree to which these agreements have contributed to new economic activity and job creation in the United States. Because TechLink facilitated approximately 40 percent of DoD's license agreements with industry during the period analyzed, the study represents a substantial case study of the economic outcomes and impacts resulting from Department of Defense technology transfer.

The study team conducted a survey to determine the total sales of new products and services resulting from the TechLink-brokered agreements. This survey found that the 178 companies reporting sales collectively had generated over \$1 billion in sales (2011 dollars). The team applied IMPLAN economic-impact assessment software to estimate the economic ripple effects of these sales nationwide. Specific objectives were to estimate the gross changes in economic output, value added, employment, labor income, and tax revenues related to these total sales.

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The total economy-wide contribution combines the direct, indirect, and induced impacts. Total economy-wide sales, as measured by output, are estimated at \$2.935 billion. Value added is estimated at \$1.553 billion, representing new wealth creation in the economy. Employment impacts include 17,818 jobs with an average wage of \$59,000. Labor income in 2011 is estimated at \$1.049 billion. The \$1 billion in sales and its economy-wide effects generated (in 2011) approximately \$217 million in federal tax revenues and over \$114 million in state and local tax revenues. Table 2 summarizes the total economic contribution of the technology transfer agreements brokered by TechLink between DoD labs and U.S. industry.

Table 2:
Nationwide economic contribution resulting from DoD technology transfer agreements facilitated by TechLink, 2000-2011 (2011 dollars)

	Output	Employment (Jobs created or retained)	Value Added	Labor Income	Tax Revenue	Average Wage (US = \$52,000)
Direct Impact	\$1,033 Million	5,768 jobs	\$510 Million	\$439 Million		\$76,000
Indirect Impact	\$792 Million	4,211 jobs	\$398 Million	\$248 Million		\$59,000
Induced Impact	\$1,114 Million	7,839 jobs	\$646 Million	\$361 Million		\$46,000
Federal Tax Revenues					\$217 Million	
State and Local Tax Revenues					\$114 Million	
Total Economy- Wide Impact	\$2,935 Million	17,818 jobs	\$1,553 Million	\$1,049 Million	\$331 Million	\$59,000

Source: BBER, University of Montana; IMPLAN

Note: Totals may not tally due to rounding