National Economic Impacts from DoD License Agreements with U.S. Industry

2000-2011

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TechLink and Bureau of Business and Economic Research

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PURPOSE OF STUDY

U.S government agencies have a federal legislative mandate to transfer their inventions to the private sector for conversion into new products and services to benefit the nation's economy.[1] This study was undertaken to estimate the contribution to the national economy of license agreements transferring Department of Defense (DoD) inventions to industry. The study's purpose was to determine the extent to which these license agreements have (1) contributed to new economic activity and job creation in the United States, and (2) resulted in the transition of new technology to U.S. military use. The period covered by the study was 2000-2011. This study was commissioned by the Air Force, in cooperation with the Office of the Secretary of Defense.

The study was undertaken in two major phases. First, the research team contacted all companies having active license agreements with DoD during the 2000-2011 period. Companies were asked to divulge the total sales of new products and services directly related to their DoD license agreements. Second, the research team used IMPLAN economic-impact assessment software to estimate the total economic impacts related to these sales. Impacts analyzed included economic output, value added, employment, labor income, and tax revenues.

[1] 15 U.S.C. 3701 and 3710, *inter alia*

RESEARCH TEAM

This economic-impact study was conducted by TechLink, a federally funded technology transfer center at Montana State University, Bozeman, in collaboration with the Bureau of Business and Economic Research (BBER) at the University of Montana, Missoula. Since 1999, TechLink has served as DoD's principal national "partnership intermediary," helping to develop technology transfer partnerships between DoD laboratories and U.S. industry nationwide. TechLink's primary focus is helping DoD labs to transfer their inventions to U.S. companies through license agreements. TechLink currently brokers or facilitates approximately 60 percent of all DoD license agreements with industry. These license agreements enable companies to develop, manufacture, and sell new products and services using DoD inventions. (For more information, see *www.techlinkcenter.org*.)

The BBER has been analyzing local, state, and national economies and providing economic forecasts for more than 50 years (*www.bber.umt.edu*). With TechLink, it has previously conducted two national studies focusing on the economic impacts resulting from DoD technology transfer. The first study, in 2009, examined the economic impacts from all TechLink-facilitated technology transfer agreements during the 2000-2009 period. The second study, conducted in 2012, was an update of the previous study and covered the period from 2000-2011.[2]

The principal authors of this study were Dr. Will Swearingen of TechLink and Dr. Gregg Davis of the BBER.

[2] These studies are available online at *http://techlinkcenter.org/economic-impacts.*

METHODOLOGY

Data Gathering

To undertake this study, TechLink first assembled essential information on all DoD license agreements active during the 2000-2011 period. This information came from two different sources: (1) TechLink itself, for license agreements that it had brokered or facilitated between DoD labs and industry; and (2) DoD labs, for agreements they had established independently of TechLink assistance. A total of 602 license agreements were included in the study. TechLink provided information on 254 of these agreements and the DoD labs on 348 agreements. The study included license agreements from 60 different DoD labs.

The information gathered for each agreement included the name of the company that had licensed the DoD technology, contact information for the company's designated point person, the patent number(s) or a short description of the licensed technology, and the effective dates of the agreement.

A TechLink market research specialist used this information to contact each of the companies involved. A total of 505 companies were contacted by email and telephone about the outcomes of their 602 license agreements with DoD. The number of agreements exceeds the number of companies because a sizeable subset of companies (72, or 14 percent) had two or more license agreements with DoD. Of this group, eleven companies had three or more agreements, including one company with ten different agreements. This data-gathering phase lasted from January to September 2012.

Survey Questions

Companies were asked a series of questions that focused on the economic outcomes and impacts related to their license agreements with DoD. They were assured that their responses would be treated as confidential information and that, in order to conceal their identity, their responses would be aggregated with the responses of other companies and submitted to DoD without any company names. Questions included the following:

1. Did your company develop any new products or services based on the license agreement?

2. What were the total cumulative sales of new products or services related to this license agreement? (Contracts to further develop the technology for specific applications were considered as sales of R&D services and included in the total sales.)

3. Of the total sales, what was the dollar value of sales to the U.S. military, either directly or through a prime contractor?

4. 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)?

5. Prior to this agreement, had your company previously had a technology transfer agreement with DoD?

Response Rate

The company response rate was very high. Only 22 of the 505 companies contacted (slightly over 4 percent) declined to participate in the study, either explicitly or by ignoring repeated telephone calls and email messages. The primary reasons for this high response rate were believed to be the following:

- *Conciseness of the survey.* The survey questions were few in number and relatively easy to answer. This encouraged participation.

- *Clear communication about the purpose and legitimacy of the study*. Companies were informed that the study's purpose was to quantify the extent to which DoD license agreements were having a positive impact on the national economy and U.S. defense mission. Additionally, companies were given contact information for the technology transfer leader at the DoD laboratory from which they had licensed the technology, so they could verify the study's legitimacy.

- *Assurance that company-specific information would be kept confidential*. Most companies consider their sales figures to be confidential, proprietary, or business-sensitive. Without the assurance that all responses would be treated as confidential information, few companies would have been willing to divulge their sales information.

- *Encouragement to participate in the study by high-level DoD officials*. Companies that were reluctant to provide information were sent a letter from the director of the DoD laboratory system explaining the purpose of the study and confirming that company-specific information would kept confidential. In several cases, non-compliant companies were contacted by technology transfer leaders from the Office of the Secretary of Defense or the Air Force.

- *Persistence by the TechLink market research specialist*. Some companies were contacted more than a dozen times by email or telephone in the attempt to get through to the right person and obtain the necessary information.

Besides the companies that declined to participate in the study, several dozen companies could not be contacted because their license agreements had been terminated at some point during the 2000-2011 period and they had ceased to operate as corporate entities. Rigorous efforts were expended to try to track down individuals who might know about the outcomes of these DoD license agreements. In a few cases, these efforts were successful. However, 48 companies (10 percent) had left no traces: They had either gone out of business, changed their names, or been acquired by other companies. With these companies added to those that declined to respond, the effective response rate for the study was around 86 percent, very high for these types of studies.

In several cases involving non-responding companies, the TechLink team was able to get at least partial sales information through Internet searches. Internet searches targeting specific company names enabled the research team to discover press releases and other announcements of contracts awarded to these companies. Further research enabled the research team to determine whether the contracts involved products based on the technology licensed from DoD. In the case of a few large publicly traded companies, Internet searches of annual reports provided an effective way to find sales information for products based on technology licensed from DoD labs.

Web sites that document U.S. government contracts were useful when the licensed technologies were primarily commercialized for sales to the U.S. military or other U.S. government agencies. Government sites consulted included: (1) USAspending.gov, the website of the Office of Management and Budget (OMB), which provides searchable information on all federal contracts awarded (*www.usaspending.gov*); (2) DIBBS, the Defense Logistics Agency (DLA) Internet Bid Board System, which provides information on all DLA awards to industry (*https://www.dibbs.bsm.dla.mil*); and (3) the Federal Procurement Data System, a central repository of information on government-wide contracts maintained by the General Service Administration (*https://www.fpds.gov*).

Commercial sites consulted for U.S. government sales included: (1) Government Contracts Won, which lists awards to thousands of different defense contractors, large and small (*www.governmentcontractswon.com*); (2) BidLink, which enables searches of procurement history by the National Stock Numbers (NSNs) that are used to order specific military products (*www.bidlink.net*); and (3) PartsLogistics, which also allows government contracts to be searched by NSNs (*www.partslogistics.com*). In most cases, searches of several or all of these sites were needed to piece together a history of U.S. government sales related to license agreements.

Verifying Data Accuracy

TechLink undertook an extensive effort to cross-check the accuracy of company sales information to help ensure the overall validity of the study. This effort included consultation with technology transfer personnel in the DoD labs as well as Internet searches involving the sources mentioned above.

Cross-checks with the DoD labs proved to be the least effective means of verifying company sales information. Most DoD license agreements require companies to submit annual royalty reports listing their sales. The research team's initial belief was that it would be straightforward to compare sales figures acquired through the economic-impact survey with those reported to the DoD labs. TechLink randomly selected approximately 10 percent (24) of the 234 companies reporting sales for cross-checks with the DoD labs.

The initial challenge was to conduct these cross-checks without breaching the confidentiality of company sales information acquired through the economic-impact study. TechLink's Partnership Intermediary Agreement with DoD obligates it to not disclose any restricted, business-proprietary, or export-controlled data provided by DoD. This agreement enabled TechLink to receive information from DoD labs about sales related to their license agreements. However, because TechLink was obligated to not divulge the sales figures that it had gathered directly from the companies, it was difficult to resolve discrepancies.

For two reasons, the TechLink and DoD sets of sales figures often varied substantially. *First*, companies usually report only their royalty-bearing sales to the DoD labs. However, the royalty-bearing portion of the sale price of each product or service is often only a small percentage of the full price. For example, a company may license an imaging technology that is an essential component of a medical device—without which the device would not function. However, this component may be only a small portion of the overall device. Depending on how the license agreement is written, the royalty-bearing portion of the total sales price of a product can vary substantially. Furthermore, in many cases, there is ambiguity about the royalty-bearing portion that companies can exploit when calculating their royalties. Because the economic-impact study asked companies to divulge the *total sales* of products and services related to their DoD license agreement, but the DoD labs were informed of only the royalty-bearing sales, there was often a large discrepancy between these two figures. The TechLink figure invariably was larger, because it included the total sales. Unfortunately, there was no practical or legal way to reconcile these discrepancies.

Second, companies generally do not report U.S. government sales to the DoD labs because these sales typically are not royalty-bearing. However, because of DoD's interest in transition of DoD inventions to U.S. military use, the economic-impact study asked companies to divulge their U.S. military sales as a subset of the total. (It did not ask them to separately identify other U.S. government sales, which also would not be royalty-bearing.) As a result, the DoD labs were unable to verify the U.S. military sales data. In short, while cross-checks with DoD labs were instructive, they were often not effective in verifying company sales related to the DoD license agreements.

By contrast, searches of the six different government contract web sites listed above enabled the research team to confirm, with a high degree of accuracy, many of the U.S. military sales that companies had reported. Usually, several or all of these sites were needed to piece together the history of a company's license-related sales to the U.S. military during the 2000-2011 study period.

The most effective method of cross-checking sales information involved examination of company annual reports (posted on the Internet) to determine the sales of products based on licensed technology. These annual reports are audited and, consequently, the sales figures they report are highly accurate. Unfortunately, this method for verifying sales data applied to only a few large publicly traded corporations. Fortunately, the DoD license agreements with these corporations proved to have some of the largest economic impacts.

NAICS Code Assignments

TechLink next assigned each company to the appropriate North American Industry Classification System (NAICS) code for the product or service resulting from its license agreement. This was an essential step for analysis of the overall economic impacts. NAICS codes are one of the most important inputs to the economic-impact model, IMPLAN (described below). 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 a unique code to each industry. Some of the companies in this study with multiple license agreements were assigned to more than one NAICS code, depending on the associated product or service.

In assigning NAICS codes, the TechLink team used the LexisNexis Academic web site (*www.lexisnexis.com*). They also relied on their personal knowledge of the companies/technologies and a commercial NAICS-related website (*www.naics.com*) that provides a convenient system for looking up NAICS codes by industry sectors and subsectors.

As a final step in the data-gathering phase, company sales and NAICS code information were entered by TechLink into a database to facilitate analysis. TechLink subsequently provided a final economic-impact dataset to the Bureau of

Business and Economic Research (BBER) at the University of Montana. The dataset included—for each DoD license agreement that had achieved sales—a code number to identify the agreement and conceal the company's name, the NAICS code for the corresponding product or service, and the total sales figures.

Data Analysis

BBER employed a widely used economic-impact analysis software program, IMPLAN, to estimate the economic contribution effects of the total sales resulting from the DoD license agreements. More than 1,500 entities in academia, the private sector, and government use IMPLAN 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 (*www.implan.com*).

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. This increased demand affects the producer of the product, the producer's employees, the producer's suppliers, the supplier's employees, and others, 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, which also employ 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: (direct effect + indirect effect + induced effect) / 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, based on NAICS codes. Each sector has a unique output multiplier because it 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 license agreements active during the 2000-2011 period. Using IMPLAN, BBER was able to estimate the sum of the direct, indirect, and induced effects of these sales. The overall purpose of this modeling exercise was to estimate the total economic contribution of these sales to the nation's economy, including total economic output, value added, employment, labor income, and tax revenues.

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 relatively higher value of the earlier sales figures due to inflation (e.g., a dollar in 2000 was worth 30.6 percent more than a dollar in 2011.)

RESULTS

Sales from DoD License Agreements

Of the 505 companies contacted, 234 (46 percent) reported that they had sales of products or services directly related to their license agreements with DoD (*see* Table 1). Another 106 companies (21 percent) were still developing or commercializing the inventions that had been licensed from DoD. In short, two-thirds (67 percent) of the companies either were already selling products or services based on the DoD-developed technologies or were continuing to pursue this objective. Approximately a fifth of the companies, a total of 95 (19 percent), had not achieved any sales and had abandoned efforts to commercialize the subject technology. Finally, as previously noted, 22 companies refused to participate in the study and 48 were not contactable because they no longer existed as corporate entities. No information was available on the outcomes of these 70 companies—14 percent of the total.

Eleven of the companies reporting sales had two different license agreements, each involving different technologies. Another 16 companies reporting sales each had multiple license agreements (up to four) for different components of the same technology. As a result, there were a total of 261 license agreements with sales—43 percent of the 602 agreements in the survey.

The total cumulative sales from the DoD license agreements amounted to nearly $13.4 billion ($13,350,688,491). Of this amount, R&D contracts to further develop the technologies licensed from DoD accounted for around $590 million ($592,873,135). Contracts to further develop these technologies for specific applications were considered sales of R&D services and included in the total sales. These R&D contracts came from both the government and private sectors. They accounted for around 4 percent of the total sales.

Table 1. Sales resulting from DoD license agreements, 2000-2011

Companies	Total Number Contacted	Percent of Total	Total Sales ($ millions)	U.S. Military Sales ($ millions)
Survey Results	505	100	13,351	1,321
Companies reporting sales	234	46	13,351	1,321
Large (500+ employees)	36	16	12,012	669
Medium-Sized (100-499 employees)	22	9	506	406
Small (10-99 employees)	120	51	628	158
Very Small (1-9 employees)	56	24	204	88
No results yet because company still developing the technology	106	21	–	–
No results because company abandoned the technology	95	19	–	–
Companies not responding	70	14	–	–

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

Remarkably, a single license agreement accounted for approximately $11 billion of the sales from DoD license agreements—nearly 83 percent. This was a license for a respiratory syncytial virus (RSV) antibody from the Uniformed Services University of the Health Sciences (USUHS). The antibody is used in a top-selling drug, Synagis, to prevent serious lower respiratory tract disease in infants and young children. Without this top-selling drug, total sales were slightly over $2.3 billion. Of this amount, R&D contracts accounted for around 25 percent.

Total sales from the single USUHS license agreement were nearly 20 times larger than those from the second most successful license agreement, which generated approximately $600 million in sales. Only four agreements generated more than $100 million in sales. Thirty-seven agreements had sales of at least $10 million. Notably, 130 license agreements generated sales of at least $1 million—approximately 22 percent.

Including all 602 DoD license agreements in this study, the average agreement generated slightly over $22 million in sales. Excluding sales of Synagis, the average figure was around $3.9 million. Among just the 261 license agreements with sales, the average figure was nearly $9 million (not counting sales of Synagis). The median agreement had sales of approximately $1.1 million.

Military Sales

The survey found that sales to the U.S. military amounted to slightly over $1.3 billion ($1,320,964,625). This was approximately 10 percent of the total sales. However, excluding Synagis, U.S. military sales accounted for nearly 57 percent of total sales. This high percentage is a very positive finding from the DoD perspective. It demonstrates that, via technology transfer, the DoD R&D system is achieving its objective of developing new technology to support the U.S. defense mission.

Some of 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.

Sales by Company Size

A notable survey finding was that large corporations (with 500 or more employees) accounted for only 16 percent of the total companies reporting sales. Small businesses (per the U.S. Small Business Administration definition, those with fewer than 500 employees) accounted for 84 percent of the companies with sales (*see* Table 1). In the small business category there were 22 "medium-sized" companies, with between 100 and 499 employees (9 percent of the total); 120 "small" companies, with 10 to 99 employees (51 percent); and 56 "very small" companies, with fewer than 10 employees (24 percent).

Large corporations accounted for 90 percent of the total sales related to the DoD license agreements. However, if the previously mentioned top-selling drug is excluded, this percentage drops to slightly less than 43 percent, with small businesses accounting for 57 percent of the total sales. Within this latter small business category, "medium-sized" companies accounted for slightly less than 22 percent of the sales, "small" companies for 27 percent, and "very small" companies for nearly 9 percent. With regard to *U.S. military sales*, large corporations accounted for nearly 51 percent of the total, "medium-sized" companies for 31 percent, "small" companies for 12 percent, and "very small" companies for the remaining 7 percent.

Of the 234 companies reporting sales from their license agreements with DoD, only 62 (24 percent) had previously had technology transfer agreements with DoD. The remaining 172 companies (76 percent) had not. This finding confirms the widespread belief in the DoD technology transfer community that the large majority of DoD licensees are new partners with DoD rather than being traditional defense contractors. It also substantiates the argument that DoD technology transfer is helping to diversity and strengthen the U.S. industrial base and supporting the defense mission.

Sales by Technology Source

Figures 1 and 2 present the sales results by the DoD branch from which the licensed technology originated. The difference between the two charts is that Fig. 1 includes sales of Synagis related to the USUHS license agreement while Fig. 2 does not. Sales of technologies licensed from USUHS were approximately $11.034 billion (nearly 83 percent of the total; from the Army, slightly over $1.6 billion (12 percent); from the Navy, $560 million (4 percent); from the Air Force, slightly over $101 million (0.8 percent); and from the National Security Agency (NSA), $37 million (0.3 percent).

When Synagis is excluded, the picture changes significantly (Fig. 2). Sales of technologies licensed from the Army increase to 69 percent of the total; of the Navy, to 24 percent; the Air Force, to over 4 percent; and the NSA to 1.6 percent. The USUHS portion drops from 83 percent to less than 1 percent.

Figure 1. Sales Results by DoD Technology Source

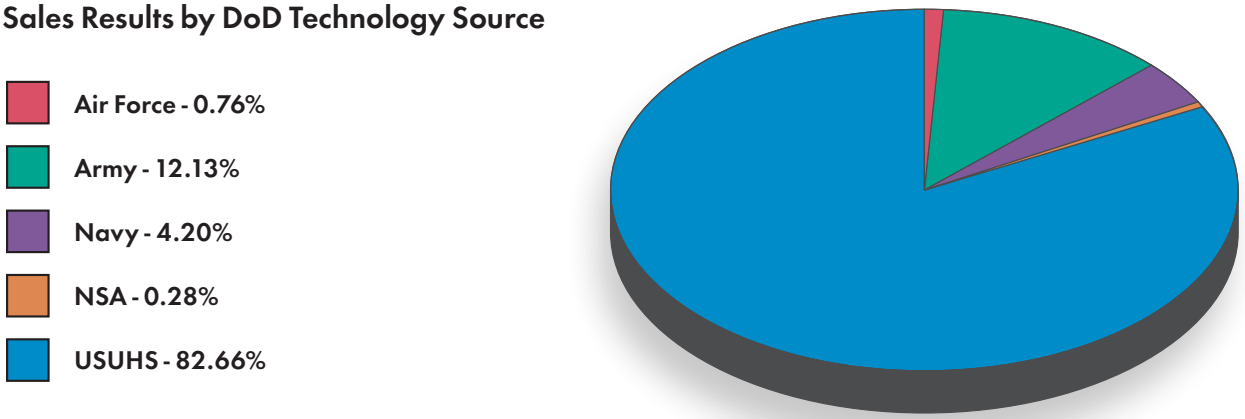
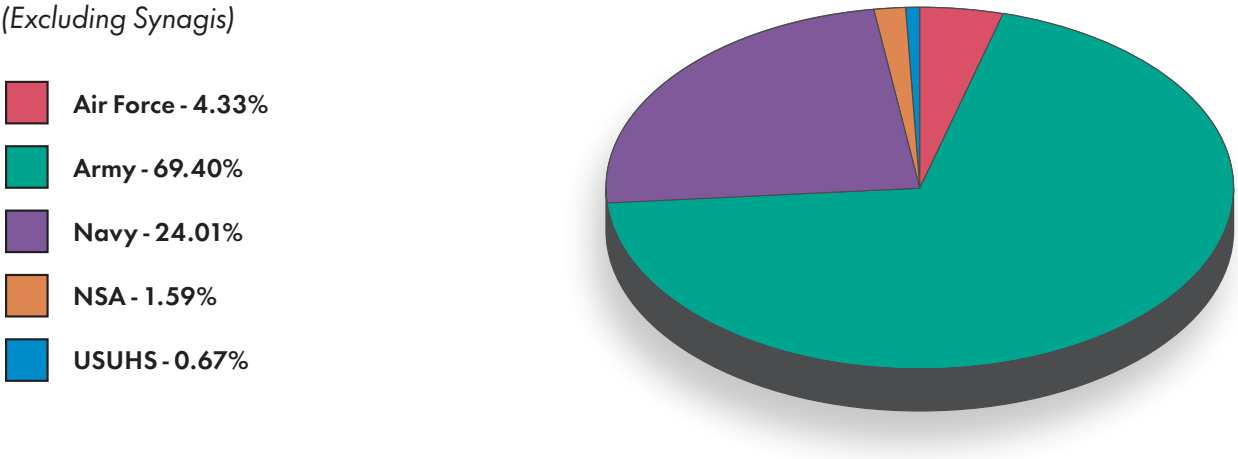


Figure 2. Revised Sales Results by DoD Technology Source
(Excluding Synagis)



Sales by Technology Sector

Fig. 3 presents the sales results by technology sector. It excludes the top-selling drug, Synagis, which otherwise would have caused the Biomedicine sector to dwarf all other sectors. The "Sewn Products" sector accounted for the most sales (nearly 39 percent), and included products such as backpacks and parachutes, which were primarily sold to the U.S. military. This sector was followed by "Biomedicine" (21 percent), which encompassed a wide range of technologies and included preventative and therapeutic vaccines and drugs, diagnostic tests, medical devices, wound care products, antibodies used in research, and medical software. "Software" was the next largest category (nearly 13 percent) and included all software products outside of the medical field. "Mechanical Devices" (10 percent) was the most eclectic sector and included technologies ranging from marine vessel guidance systems to high-security locks. "Advanced Materials" ranged from metal coatings and specialized alloys to bullet-absorbing concrete and nanomaterials and accounted for 9 percent of the total sales. Finally, "Electronics and Optics" technologies ranged from communications equipment and lasers to sensors and accounted for around 8 percent of the total sales.

Verification of Data Quality

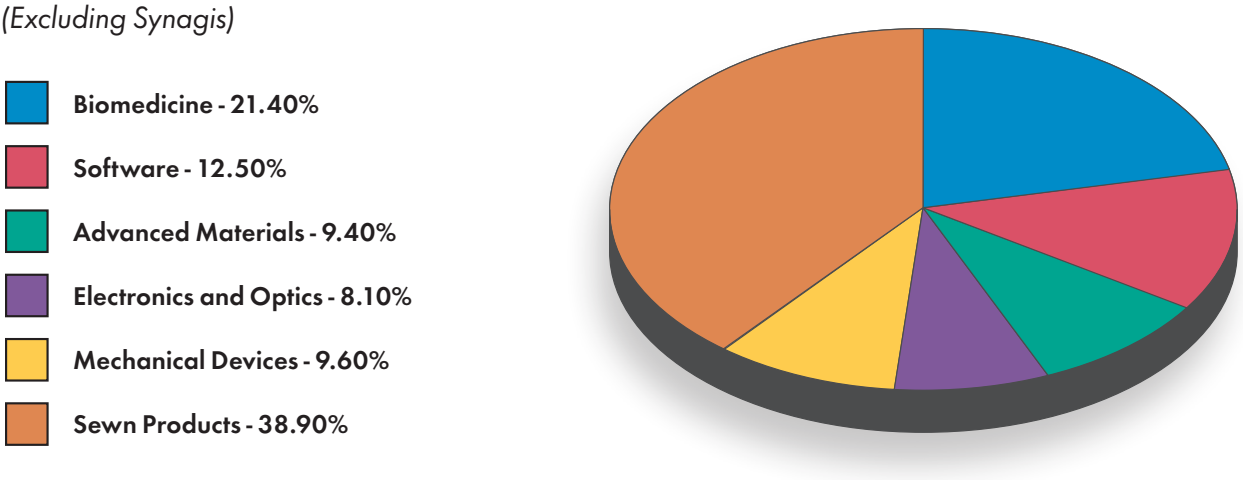
Efforts to verify the accuracy of company sales information proved to be highly successful. These efforts included Internet-based searches of U.S. government contract web sites and company annual reports as well as consultation with DoD technology transfer personnel. Through these cross-checks, the research team was able to verify the accuracy of around $12.5 billion of the $13.4 billion in total sales—93 percent of the total. Excluding Synagis, the team was able to verify the accuracy of 63 percent of the total sales. The remainder of the reported sales were largely unverifiable due to legal and practical constraints.

Sales Figures Understate the Reality

For several reasons, total sales figures obtained by this survey are probably significantly smaller than the actual total sales resulting from DoD license agreements during the 2000-2011 period. Reasons include the following:

- *Non-responding companies*. As previously noted, 70 companies with DoD license agreements active during the 2000-2011 period did not participate in

Figure 3. Revised Sales Results by Technology Sector
(Excluding Synagis)



the study—22 because they declined to participate and another 48 that could not be contacted because they had ceased to operate as corporate entities. Some companies in the first group are known to be making sizeable commercial (non-military) sales of products based on the licensed technologies. For example, one company submitted a royalty check to the Air Force in 2009 for $100,000—without any specific disclosure of its sales. While the research team was able to capture some of the U.S. military sales of these companies from Internet searches, it was unable to learn of any of their commercial sales.

- *Sub-licensee sales.* The total sales figures also underreport the reality because they do not include most of the sub-licensee sales. The TechLink team asked all companies if they had sublicensed the technologies that they had licensed from DoD. Many companies reported that they had. However, most of these companies declined to identify their sublicensees or to divulge what they knew of sublicensee sales. Some claimed that they were prevented from identifying sublicensees by the terms of their sublicensing agreements. Others simply declined to identify these sublicensees. Sublicensee sales of DoD-licensed technologies are probably substantial. For example, in two cases where licensees did report their sublicensee sales, the combined value was $116 million.

- *Licensee underreporting of sales.* Another reason why the total reported sales are believed to be less than the actual sales is that underreporting is common in the licensing world. Historic royalty audit data from the Invotex Group, a well-established accounting and intellectual property management company, reveals that over 80 percent of licensees underreport and underpay royalties to their licensors.[3] There are various reasons why royalties are underreported. However, the Invotex Group found that at least half of the licensees that it examined actually underreported *sales*. Frequently, these involved next-generation products based on the licensed technology.

- *Inflation.* Finally, inflation contributes, in effect, to an underreporting of sales. All sales data are expressed in 2011 dollars as previously discussed. However, some of the company sales date back to the early 2000s and most occurred *prior to* 2011. Use of 2011 as the reference year does not consider the higher value of the earlier sales figures. For example, a dollar in 2000 was worth 30.6 percent more than a dollar in 2011.

For all of the above reasons, the total sales figures reported in this survey are conservative and probably significantly understate the actual total sales resulting from DoD license agreements during the 2000-2011 period.

Economic-Impact Analysis

Upon receiving the company sales and NAICS code 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. According to the national IMPLAN model, the nearly $13.4 billion (2011 $) in direct sales of new products and services reported by companies generated an additional $22.9 billion in sales economy-wide. Of this amount, around $11.6 billion was generated indirectly as the result of inter-industry purchases (firms purchasing from each other), and $11.3 billion was generated from the induced effect, the result of households spending payroll on goods and services economy-wide (see Table 2). The total economy-wide output (the sum of direct, indirect, and induced sales) was $36.3 billion.

[3] D.R. Stewart and J.A. Byrd, "The Significance of Underreported Royalties-2007 Update: The Magnitude and Meaning of Royalty Misreporting," Invotex Group, Baltimore, MD, February 2007, online at: *www.lawseminars.com/materials/07LICIL/licil%20m%20stewart2.pdf;* D.R. Stewart and J.A. Byrd, "89% of Royalty Revenue is Underreported! Top Five Questions You Should Ask Your Licensee to Avoid Becoming a Statistic," Invotex Group, Baltimore, MD, April 2012, online at: *www.invotex.com/assets/2012_Royalty_Audit_Article.pdf.*

Dividing total economy-wide output ($36.3 billion) by the direct output of companies selling products and services related to their license agreements with DoD ($13.4 billion) yielded an output multiplier of 2.7. That is, for every dollar in sales directly attributable to the DoD license agreements, an *additional* $1.70 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 in order 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 U.S. 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 license agreements with DoD. According to the national IMPLAN model, the $13.4 billion (2011 $) in sales reported by companies generated an additional $17.4 billion in value added impact economy-wide. Of this total, $4.5 billion was generated directly, $6.4 billion was generated indirectly, and $6.5 billion was generated from the induced effect (*see* Table 2).

Employment

According to the national IMPLAN model, an estimated 27,128 jobs were directly sustained economy-wide in 2011 by the $13.4 billion in sales. Indirect effects were responsible for an additional 56,728 jobs, and induced effects for 79,210 jobs. The IMPLAN model estimates that, altogether, 163,067 jobs nationwide resulted from the direct, indirect, and induced effects of the DoD license agreements with U.S. industry.

Using the same procedure outlined above to derive the multiplier, an employment multiplier of 6 was calculated. That is, for every job directly attributable to the DoD license agreements, *five additional* jobs were created or retained economy-wide. This relatively large multiplier 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. That is, workers in these well-paying industries pumped more income back into the economy than lower-paid workers in other sectors, resulting in more job creation 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 model estimated that labor income directly associated with the $13.4 billion in sales was $2.7 billion in 2011, or approximately $101,000 per job. This was *almost double* the average U.S. wage in 2011 of $52,000.

The indirect labor income was estimated at $4.2 billion, or approximately $74,000 per job. The induced labor income was estimated to be $3.7 billion, 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 $7.9 billion. The total economy-wide labor income resulting in 2011 from the DoD license agreements was $10.6 billion. The average wage of the approximately 163,000 jobs created or retained as a result of the DoD license agreements was $65,000, approximately 25 percent higher than the average U.S. wage of $52,000 in 2011.

The labor income multiplier was 3.9, indicating that for every dollar in wage and salary income attributable to the DoD license agreements, an *additional* $2.90 was generated nationally in employee compensation and proprietary income.

Tax Revenues

Tax revenues were estimated for the $13.4 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 $3.7 billion. This included slightly over $2.3 billion in federal tax revenues and $1.3 billion in state and local tax revenues. In sum, for every dollar of sales related to the DoD license agreements, an *additional* $0.28 was generated in federal, state, and local tax revenue.

SUMMARY

In summary, this study estimated the economic contribution to the U.S. economy of Department of Defense (DoD) license agreements in effect during the 2000-2011 period. Its purpose was to determine the extent to which these license agreements (1) contributed to new economic activity and job creation in the United States, and (2) resulted in the transition of new technology to U.S. military use.

The research team contacted 505 companies having license agreements with DoD during the 2000-2011 period. A total of 602 license agreements were included in the study because some companies had multiple agreements. Companies were asked to divulge the total sales of new products and services directly related to their DoD license agreements. They were also asked about their license-related sales to the U.S. military, either directly or through a defense contractor. Nearly half of the companies—234 out of 505—reported sales. Collectively, they reported slightly over $13.4 billion in total sales and $1.3 billion in military sales (in 2011 dollars).

IMPLAN economic-impact assessment software was used to estimate the total economic impacts related to these sales. Impacts analyzed included economic output, value added, employment, labor income, and tax revenues. Total economy-wide sales, as measured by output, were estimated at $36.3 billion. Value added was estimated at $17.4 billion, representing new wealth creation in the economy. Employment impacts included 163,067 jobs with an average wage of $65,000. Labor income in 2011 was estimated at $10.6 billion. The $13.4 billion in sales and its economy-wide effects generated approximately $2.3 billion in federal tax revenues and over $1.3 billion in state and local tax revenues. Table 2 summarizes the total economic contribution of the DoD license agreements with U.S. industry.

Table 2. Nationwide Economic Impacts from DoD License Agreements, 2000-2011

	Output ($ billions)	Employment (Jobs created or retained)	Value Added ($ billions)	Labor Income ($ billions)	Tax Revenue ($ billions)	Average Wage (US = $52,000)
Direct Impact	13.4	27,128	4.5	2.7		100,926
Indirect Impact	11.6	56,728	6.4	4.2		74,339
Induced Impact	11.3	79,210	6.5	3.7		46,093
Federal Tax Revenues					2.3	
State and Local Tax Revenues					1.3	
Total Economy-Wide Impact	**36.3**	**163,067**	**17.4**	**10.6**	**3.7**	**65,041**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDICES

The following appendices provide a more focused look at the economic impacts resulting from DoD licenses during the 2000-2011 period. They estimate the economic impacts for selected DoD components from which the licensed technologies originated. These include the three DoD services (Army, Navy, Air Force), the National Security Agency, USUHS, and several major DoD commands and laboratories. Breakouts for smaller DoD labs are not included for two reasons. First, the total sales related to their license agreements were too small and geographically concentrated to be legitimately analyzed by the national IMPLAN model. Second, revealing the outcomes of the limited number of license agreements from these labs could enable fairly accurate guesses about the sales of specific companies, violating the need to keep company sales information confidential. For explanation of the economic terms used in the appendices, please refer to the main text of the report.

1. **Air Force**
2. **Air Force Research Laboratory (AFRL)**
3. **Army**
4. **Army Corps of Engineers, Engineer Research and Development Center (ERDC)**
5. **Army Medical Research and Materiel Command (USAMRMC)**
6. **Army Medical Materiel Development Activity (USAMMDA)**
7. **Army Medical Research Institute of Infectious Diseases (USAMRIID)**
8. **Walter Reed Army Institute of Research (WRAIR)**
9. **Army Natick Soldier Research, Development and Engineering Center (NSRDEC)**
10. **Army Research Laboratory (ARL)**
11. **National Security Agency (NSA)**
12. **Navy**
13. **Naval Air Warfare Center, Aircraft Division (NAWCAD)**
14. **Naval Research Laboratory (NRL)**
15. **Uniformed Services University of the Health Sciences (USUHS)**

APPENDIX 1

Nationwide Economic Impacts from Air Force License Agreements, 2000-2011

	Output *($ Millions)*	Employment *(Number of Jobs created or retained)*	Value Added *($ Millions)*	Labor Income *($ Millions)*	Tax Revenue *($ Millions)*
Direct Impact	99.6	692	58.1	50.3	
Indirect Impact	58.6	403	33.9	22.2	
Induced Impact	117.6	828	68.2	38.1	
Federal Tax Revenues					22.7
State and Local Tax Revenues					12.8
Total Economy-Wide Impact	**275.7**	**1,923**	**160.2**	**110.7**	**35.5**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 2

Nationwide Economic Impacts from Air Force Research Laboratory (AFRL) License Agreements, 2000-2011

	Output *($ Millions)*	Employment *(Number of Jobs created or retained)*	Value Added *($ Millions)*	Labor Income *($ Millions)*	Tax Revenue *($ Millions)*
Direct Impact	90.4	661	52.6	47.1	
Indirect Impact	52.8	362	30.4	20.0	
Induced Impact	108.8	765	63.1	35.3	
Federal Tax Revenues					20.8
State and Local Tax Revenues					11.9
Total Economy-Wide Impact	**252.0**	**1,788**	**146.1**	**102.4**	**32.7**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 3

Nationwide Economic Impacts from Army License Agreements, 2000-2011

	Output *($ Millions)*	Employment *(Number of Jobs created or retained)*	Value Added *($ Millions)*	Labor Income *($ Millions)*	Tax Revenue *($ Millions)*
Direct Impact	1,603.7	9,274	703.6	518.4	
Indirect Impact	1,338.4	6,423	658.6	413.7	
Induced Impact	1,510.1	10,611	875.1	489.3	
Federal Tax Revenues					308.8
State and Local Tax Revenues					165.1
Total Economy-Wide Impact	**4,452.3**	**26,307**	**2,237.3**	**1,421.4**	**473.9**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 4

Nationwide Economic Impacts from Army Corps of Engineers-Engineer Research and Development Center (ERDC) License Agreements, 2000-2011

	Output *($ Millions)*	Employment *(Number of Jobs created or retained)*	Value Added *($ Millions)*	Labor Income *($ Millions)*	Tax Revenue *($ Millions)*
Direct Impact	96.7	665	49.2	38.1	
Indirect Impact	70.8	398	38.0	23.4	
Induced Impact	99.7	701	57.8	32.3	
Federal Tax Revenues					20.1
State and Local Tax Revenues					11.1
Total Economy-Wide Impact	**267.2**	**1,764**	**145.0**	**93.8**	**31.2**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 5

Nationwide Economic Impacts from Army Medical Research and Materiel Command (USAMRMC) License Agreements, 2000-2011

	Output *($ Millions)*	Employment *(Number of Jobs created or retained)*	Value Added *($ Millions)*	Labor Income *($ Millions)*	Tax Revenue *($ Millions)*
Direct Impact	448.4	1,244	174.9	127.7	
Indirect Impact	359.0	1,882	200.5	131.0	
Induced Impact	419.2	2,948	243.0	135.8	
Federal Tax Revenues					84.3
State and Local Tax Revenues					45.4
Total Economy-Wide Impact	**1,226.5**	**6,074**	**618.5**	**394.6**	**129.7**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 6

Nationwide Economic Impacts from Army Medical Materiel Development Activity (USAMMDA) License Agreements, 2000-2011

	Output *($ Millions)*	Employment *(Number of Jobs created or retained)*	Value Added *($ Millions)*	Labor Income *($ Millions)*	Tax Revenue *($ Millions)*
Direct Impact	70.4	209	27.3	15.1	
Indirect Impact	51.3	259	27.7	18.4	
Induced Impact	54.2	381	31.4	17.6	
Federal Tax Revenues					11.4
State and Local Tax Revenues					6.1
Total Economy-Wide Impact	**176.0**	**849**	**86.5**	**51.1**	**17.5**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 7

Nationwide Economic Impacts from Army Medical Research Institute of Infectious Diseases (USAMRIID) License Agreements, 2000-2011

	Output *($ Millions)*	Employment *(Number of Jobs created or retained)*	Value Added *($ Millions)*	Labor Income *($ Millions)*	Tax Revenue *($ Millions)*
Direct Impact	236.8	474	82.6	57.0	
Indirect Impact	203.6	1,029	114.5	75.2	
Induced Impact	214.3	1,507	124.2	69.4	
Federal Tax Revenues					43.6
State and Local Tax Revenues					24.1
Total Economy-Wide Impact	**654.7**	**3,009**	**321.3**	**201.7**	**67.7**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 8

Nationwide Economic Impacts from Walter Reed Army Institute of Research (WRAIR) License Agreements, 2000-2011

	Output *($ Millions)*	Employment *(Number of Jobs created or retained)*	Value Added *($ Millions)*	Labor Income *($ Millions)*	Tax Revenue *($ Millions)*
Direct Impact	123.8	468	55.4	46.1	
Indirect Impact	93.2	522	52,0	33.6	
Induced Impact	129.1	909	74.9	41.9	
Federal Tax Revenues					25.2
State and Local Tax Revenues					13.2
Total Economy-Wide Impact	**346.1**	**1,899**	**182.3**	**121.6**	**38.4**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 9

Nationwide Economic Impacts from Army Natick Soldier Research, Development and Engineering Center (NSRDEC) License Agreements, 2000-2011

	Output ($ Millions)	Employment (Number of Jobs created or retained)	Value Added ($ Millions)	Labor Income ($ Millions)	Tax Revenue ($ Millions)
Direct Impact	937.6	6,764	425.8	304.7	
Indirect Impact	806.0	3,623	364.4	224.4	
Induced Impact	857.1	6,019	496.6	277.6	
Federal Tax Revenues					177.7
State and Local Tax Revenues					93.9
Total Economy-Wide Impact	**2,600.7**	**16,406**	**1,286.7**	**806.8**	**271.6**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 10

Nationwide Economic Impacts from Army Research Laboratory (ARL) License Agreements, 2000-2011

	Output ($ Millions)	Employment (Number of Jobs created or retained)	Value Added ($ Millions)	Labor Income ($ Millions)	Tax Revenue ($ Millions)
Direct Impact	90.4	442	39.0	34.1	
Indirect Impact	78.9	392	42.4	26.9	
Induced Impact	98.9	695	57.3	32.0	
Federal Tax Revenues					19.8
State and Local Tax Revenues					10.7
Total Economy-Wide Impact	**268.2**	**1,529**	**138.7**	**93.1**	**30.5**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 11

Nationwide Economic Impacts from National Security Agency (NSA) License Agreements, 2000-2011

	Output ($ Millions)	Employment (Number of Jobs created or retained)	Value Added ($ Millions)	Labor Income ($ Millions)	Tax Revenue ($ Millions)
Direct Impact	36.9	333	22.8	31.5	
Indirect Impact	19.2	136	11.9	6.8	
Induced Impact	62.0	437	36.0	20.1	
Federal Tax Revenues					10.8
State and Local Tax Revenues					5.9
Total Economy-Wide Impact	**118.0**	**905**	**70.6**	**58.4**	**16.7**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 12

Nationwide Economic Impacts from Navy License Agreements, 2000-2011

	Output ($ Millions)	Employment (Number of Jobs created or retained)	Value Added ($ Millions)	Labor Income ($ Millions)	Tax Revenue ($ Millions)
Direct Impact	560.0	2,392	255.2	216.0	
Indirect Impact	429.6	2,349	238.2	150.0	
Induced Impact	593.2	4,171	343.8	192.2	
Federal Tax Revenues					117.2
State and Local Tax Revenues					61.2
Total Economy-Wide Impact	**1,582.7**	**8,911**	**837.3**	**558.1**	**178.4**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 13

Nationwide Economic Impacts from Naval Air Warfare Center-Aircraft Division (NAWCAD) License Agreements, 2000-2011

	Output ($ Millions)	Employment (Number of Jobs created or retained)	Value Added ($ Millions)	Labor Income ($ Millions)	Tax Revenue ($ Millions)
Direct Impact	102.7	239	37.9	28.1	
Indirect Impact	94.1	451	49.9	32.1	
Induced Impact	97.5	685	56.5	31.6	
Federal Tax Revenues					20.0
State and Local Tax Revenues					10.6
Total Economy-Wide Impact	**294.3**	**1,375**	**144.3**	**91.7**	**30.6**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 14

Nationwide Economic Impacts from Naval Research Laboratory (NRL) License Agreements, 2000-2011

	Output ($ Millions)	Employment (Number of Jobs created or retained)	Value Added ($ Millions)	Labor Income ($ Millions)	Tax Revenue ($ Millions)
Direct Impact	261.0	1,037	116.8	99.4	
Indirect Impact	201.7	1,093	112.2	71.2	
Induced Impact	276.5	1,943	160.2	89.6	
Federal Tax Revenues					54.7
State and Local Tax Revenues					28.8
Total Economy-Wide Impact	**739.2**	**4,073**	**389.2**	**260.2**	**83.5**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

APPENDIX 15

Nationwide Economic Impacts from Uniformed Services University of the Health Sciences (USUHS) License Agreements, 2000-2011

	Output *($ Millions)*	Employment *(Number of Jobs created or retained)*	Value Added *($ Millions)*	Labor Income *($ Millions)*	Tax Revenue *($ Millions)*
Direct Impact	11,033.9	14,504	3,466.6	1,926.8	
Indirect Impact	9,759.4	47,621	5,446.0	3,639.4	
Induced Impact	9,016.8	63,393	5,226.0	2,921.8	
Federal Tax Revenues					1,889.9
State and Local Tax Revenues					1,071.5
Total Economy-Wide Impact	**29,810.1**	**125,518**	**14,138.6**	**8,488.1**	**2,961.4**

Source: BBER, University of Montana; IMPLAN
Note: Totals may not tally due to rounding

National Economic Impacts from DoD License Agreements with U.S. Industry

2000-2011

TechLink and Bureau of Business and Economic Research