

THE ECONOMIC CONTRIBUTION OF UNIVERSITY/NONPROFIT INVENTIONS IN THE UNITED STATES: 1996-2013

PREPARED FOR
THE BIOTECHNOLOGY INDUSTRY ORGANIZATION
BY LORI PRESSMAN, DAVID ROESSNER, JENNIFER BOND,
SUMIYE OKUBO AND MARK PLANTING, MARCH 2015

MARCH 17, 2015



Biotechnology
Industry
Organization

The Economic Contribution of University/Nonprofit Inventions in the United States: 1996-2013.

Prepared for the Biotechnology Industry Organization by Lori Pressman, David Roessner,
Jennifer Bond, Sumiye Okubo and Mark Planting, March 2015¹

Team: Lori Pressman is an independent business development, licensing and strategy consultant in Cambridge, MA, a former Assistant Director at the MIT Technology Licensing Office and a former Chair of the AUTM Survey Statistics and Metrics Committee. Dr. David Roessner is Professor of Public Policy Emeritus, Georgia Institute of Technology and Senior Fellow, Science and Technology Policy Program, SRI International. Ms. Jennifer Bond is Senior Advisor for International Affairs for the Council on Competitiveness and former Director of the Science & Engineering Indicators Program at the National Science Foundation. Dr. Sumiye Okubo is former Associate Director for Industry Accounts at the Commerce Department's Bureau of Economic Analysis. Mr. Mark Planting is former Chief of Research on the use and development of U.S. input-output accounts at the Bureau of Economic Analysis

Acknowledgements: The project team gratefully acknowledges the financial support, interest, and encouragement of the Biotechnology Industry Organization. We are also appreciative of AUTM for providing updated data and Rick Colman's valuable time and insights. We thank AUTM survey respondents for providing the data used in this report. Special thanks to Joe Allen for championing the project.

¹ An update to *The Economic Contribution of University/Nonprofit Inventions in the United States: 1996-2010: Measures of Economic Impact of U.S. Respondents to the AUTM Survey 1996-2010*. Prepared for Biotechnology Industry Organization June 2012 by Lori Pressman, David Roessner, Jennifer Bond, Sumiye Okubo, and Mark Planting.

Contents:

Team:	1
Acknowledgements:.....	1
Summary:.....	3
Introduction and Background:	3
Inclusion of Hospitals and Research Institutes that respond to the AUTM Survey:.....	4
Brief Background on Economic Models Based on the National Input Output Accounts:.....	6
Assumptions used in Applying the I-O Model to Measurements of Economic Impact of U.S. academic licensing: See also Appendix A:	9
General:.....	9
For the GDP Calculation:.....	9
For the Gross Output Calculation:	9
The Economic Impact Model using AUTM Data and I-O Coefficients:.....	9
GDP:	9
Gross Industry Output:.....	10
Employment Supported by Final Purchases Associated with Academic Licensing:.....	10
Comments on Assumptions and Caveats on Accuracy of Estimates:.....	10
Updated Public Information on AUTM Member Royalty Rates:	11
AUTM Data, I-O Coefficients, and Results:.....	12
Trends and Observations:	14
Appendix A: Assumptions and their Effects.....	18
Appendix B: AUTM Data and I-O Multipliers.....	19
Appendix C: GDP, Employment and Gross Output Calculations for U.S. University AUTM Survey Respondents,	21
Appendix D: GDP, Employment and Gross Output Calculation for U.S. Hospital and Research Institute AUTM Survey Respondents	22
Appendix E: Sum of University and HRI AUTM Survey Respondent contribution to GDP, Employment and Gross Output	23
Supplementary Tables and Figures:	24

Summary:

Using an input-output “I-O” approach to estimating the economic impact of academic licensing and summing over 18 years of available data for academic U.S. AUTM Survey respondents, the total contribution of these academic licensors to gross industry output ranges from \$282B to \$1.18T, in 2009 \$U.S. Dollars; and contributions to GDP range from \$130B to \$518B, in 2009 \$U.S. Dollars. Estimates of the total number of person years of employment supported by U.S. universities’ and hospitals’ and research institutes’ licensed-product sales range from 1,130,000 million to over 3,824,000 million over the 18 year period. An explanation of the I-O approach is provided, and the assumptions used and the potential effects of the assumptions on the estimates are discussed. Recent public information on AUTM licensee average royalty rates is presented. AUTM associated contributions to GDP, calculated using the I-O approach, are compared with U.S. GDP as a whole, and to selected industry, as defined by NAICS code, contributions to GDP. Factors affecting the AUTM contributions to GDP appear to differ from those affecting U.S. GDP as a whole, as well as from those affecting selected NAICS industry contributions to GDP.

Introduction and Background:

This report, on measures of economic impact of U.S. academic licensing activity, is the 2015 update of a 2009 report² and model developed and described³ by David Roessner, Jennifer Bond, Sumiye Okubo, and Mark Planting for estimating the economic impact of U.S. academic licensing activity. There was also a 2012 update⁴. As in the previous reports, the Leontief input-output “I-O” coefficients⁵ are used to estimate i) gross industry output “GO”, ii) effects on GDP and iii) person- years of employment supported by academic licensing. As in the previous reports, license income data, in particular License Income Received⁶ and Running Royalties⁷, are two key inputs.

The 2009 report used twelve years of AUTM Licensing Survey data, from 1996 – 2007. The 2012 report, and the Research Policy paper (ft 3), used 15 years of AUTM Survey data, from 1996-2010. The 2009 report, and the Research Policy paper, use license data only from U.S. university respondents to the AUTM Survey. This 2015 report includes, as did the 2012 report, license data from U.S. Hospital and Research Institute “HRI” respondents as well as U.S. university

² “The Economic Impact of Licensed Commercialized Inventions Originating in University Research” 1996-2007, September 3, 2009, by David Roessner, Jennifer Bond, Sumiye Okubo, Mark Planting, accessed http://www.bio.org/sites/default/files/BIO_final_report_9_3_09_rev_2_0.pdf February 24, 2015

³ David Roessner, Jennifer Bond, Sumiye Okubo, Mark Planting, “The Economic Impact of Licensed Commercialized Inventions Originating in University Research” Research Policy, May 26, 2012. 10.1016/j.respol.2012.04.015 .

⁴ “The Economic Contribution of University/Nonprofit Inventions in the United States: 1996-2010” June 20, 2012, by Lori Pressman, David Roessner, Jennifer Bond, Sumiye Okubo, and Mark Planting, accessed <https://www.bio.org/sites/default/files/BIOEconomicImpact2012June20.pdf> February 24, 2015

⁵ The Nobel Prize was awarded to Wassily Leontief in 1973 “for the development of the input-output method and for its application to important economic problems.” http://www.nobelprize.org/nobel_prizes/economics/laureates/1973/press.html

⁶ From Instructions and Definitions of Survey: LICENSE INCOME RECEIVED, AUTM Survey reference “LIRECD”, includes: license issue fees, payments under options, annual minimums, running royalties, termination payments, the amount of equity received when cashed-in, and software and biological material end user license fees equal to \$1,000 or more, but not research funding, patent expense reimbursement, a valuation of equity not cashed-in, software and biological material end user license fees less than \$1,000, or trademark licensing royalties from university insignia. License Income also does not include income received in support of the cost to make and transfer materials under Material Transfer Agreements.

⁷ From Instructions and Definitions of Survey: For the purposes of this Survey, RUNNING ROYALTIES are defined as royalties earned on and tied to the sale of products. Excluded from this number are license issue fees, payments under options, termination payments, and the amount of annual minimums not supported by sales. Also excluded from this amount is CASHED-INEQUITY, which should be reported separately. The AUTM Survey reference is “LIRUNR”.

respondents. In this 2015 report, as well as the 2012 report, the jobs estimate includes person-years of employment “Jobs” associated with sales of products by licensees. Previously, it had been calculated based only on employment associated with license income received by the universities.

This report provides estimates in 2009 dollars; the earlier reports and paper used 2005 dollars. Supplementary table S-1 displays the 2012 figures for GO, GDP and Jobs, in both 2005 and 2009 dollars, and these updated 2015 figures. On a rolling fifteen year basis, GO and GDP increased 21% and 20%, respectively, and the number of jobs supported increased 11%.

Inclusion of Hospitals and Research Institutes that respond to the AUTM Survey:

In 2001, the NSF issued a Data Brief highlighting the role of nonprofit research organizations⁸ as performers of U.S. R&D.⁹ The Data Brief lists the “Top 10 nonprofit organization respondents by amount of intramural R&D expenditures, fiscal years 1996-1997” by name.¹⁰ AUTM HRI respondents include five, and six, respectively of the top ten for 1996,¹¹ and 1997.¹² A long term trend, seen in Figure 1, is that other nonprofits, as well as universities, are performing a larger share of total U.S. R&D. U.S. R&D performed by universities and colleges from 1953 through 2011 grew from 5.3% to 14.9% of total U.S. R&D, while the fraction of R&D performed by other nonprofits grew from 2.2% to 4.2 %.¹³ Data available for the period of this economic impact analysis, between 1996 and 2011, show that U.S. R&D performed at colleges and universities increased from 12.0 % to 14.9% of U.S R&D, and that research performed at other nonprofits increased from 3.1% to 4.2% of U.S. R&D.

⁸ Nonprofit organizations other than universities and federal laboratories

⁹ See NSF 01-318, February 15, 2001 by Mary V. Burke “Nonprofit Sector’s R&D Grows over Past Quarter Century.”

¹⁰ Howard Hughes Medical Institute, Mayo Foundation, SRI International, Memorial Sloan Kettering, Research Triangle Institute, Fred Hutchinson Cancer Research Center , SEMATECH, Inc., Dana-Farber Cancer Institute, Brigham and Women’s Hospital, Beth Israel Deaconess Medical Center, Inc.

¹¹ Mayo, SRI, Sloan Kettering, Fred Hutchinson, and Brigham and Women’s Hospital

¹² Mayo, Sloan Kettering, Fred Hutchinson, Dana-Farber Cancer Institute, and Brigham and Women’s Hospital, Beth Israel Deaconess Medical Center, Inc,

¹³ See Appendix Tables 04-02 and 04-03 of the 2014 Science & Engineering Indicators.

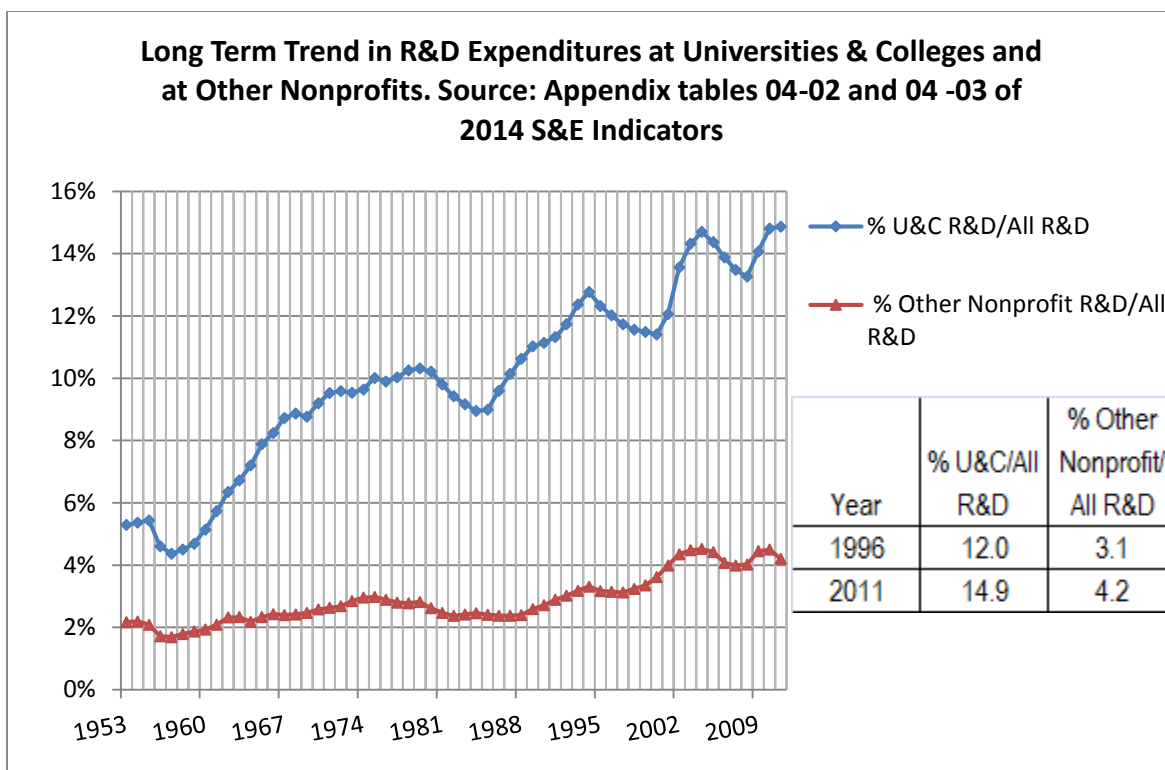


Figure 1.

Another factor contributing to the decision to apply the model to Hospitals and Research Institutes is evidence suggesting that the character of the work performed in research institutes may be similar to that done at universities and colleges. Hospitals and Research Institutes often have close ties to universities and share personnel.¹⁴ S&E data show that, between 1996 and 2011, an average of 72% of the research expenditures at Universities and Colleges was characterized as Basic R&D and an average of 52% of expenditures at other nonprofit research institutes was characterized as Basic Research expenditures.¹⁵ This is a correction to the figures provided in the 2012 report, where the fraction of research that was basic research at both Universities and Colleges and Other Nonprofits was incorrectly given as about half. Figure 2 may suggest that the character of work at Hospitals and Research Institutes is more applied or “translational” than that occurring at universities.

¹⁴ For example, all investigators at the Whitehead Institute, -which responds to the AUTM survey in the “HRI” category, hold joint appointments in the MIT Department of Biology. Many investigators at the Fred Hutchinson Cancer Research Center, another Hospital and Research Institute which responds to the AUTM survey hold a joint appointment at the University of Washington.

¹⁵ See Appendix Tables 04-02 and 04-03 of the 2014 Science & Engineering Indicators.

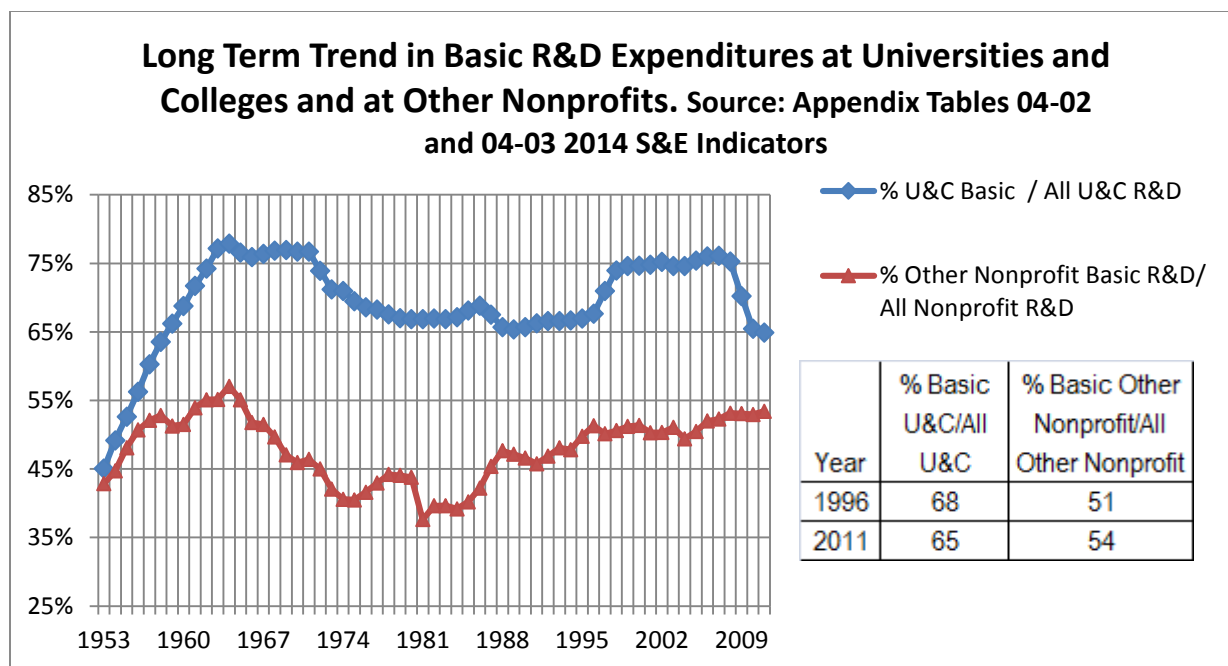


Figure 2.

License Income Received from HRI AUTM Survey respondents over the 18 year period of this report totals \$7.36 B, approximately 30% of the \$24.44B reported by university respondents. Running Royalties reported by HRI AUTM Survey respondents over the 18 year period total \$4.2B, approximately 25% of the \$16.9B reported by university respondents.

Twenty-six HRI's have responded to the survey in each of 15 years between 1996 and 2010, 28, 32, and 30 responded in 2011, 2012, and 2013, respectively. Between 131 to 164 universities responded between 1996 and 2013. Thus, among institutions that chose to respond to the AUTM Survey, Hospitals and Research Institutions report, on average, more License Income Received and Running Royalties than universities do.¹⁶ Note that including HRI's also makes this report more heavily weighted toward the economic impact of health technologies, and could introduce a bias toward life science and health technology economic impact.

Brief Background on Economic Models Based on the National Input Output Accounts:

This section provides definitions and concepts underlying the I-O framework¹⁷ to facilitate understanding the assumptions used when applying it to model the economic impact of academic technology licensing. Several paragraphs and sentences, but not all paragraphs and sentences, in this section are taken verbatim from the above noted references. As always, the primary source is the preferred reference.

¹⁶ \$7.36B / 30~ \$245M, versus \$24.44B/150~\$16.3M. Current, not constant dollars were used for this estimate.

¹⁷ See BEA (Bureau of Economic Analysis, U.S. Department of Commerce) BRIEFING: A Primer on BEA's Industry Accounts , accessible at http://www.bea.gov/scb/pdf/2009/06%20June/0609_indyaccts_primer_a.pdf : By Mary L. Streitwieser and "Concepts and Methods of the Input-Output Accounts," accessible at http://www.bea.gov/papers/pdf/IOmanual_092906.pdf : By Karen J. Horowitz and Mark A. Planting. Chapter 12 discusses Input-Output modeling and applications.

The terms “input” and “output,” and not “cost” and “revenue” are apt, as the same economic transaction is “output” to one party, the seller, and “input” to the other, the buyer. When the buyer is the last buyer, they are the “final user” in I-O parlance. The sum of all purchases by “final users” is “final demand.” When the buyer uses that input to produce its own, or his or her own, output, then such input is called “intermediate input.” Output multipliers can only be applied to final demand.

The word “commodity” in BEA explanatory material aligns with its use in economics as any marketable item, whether goods or services, which is the subject of a transaction. The everyday meaning of “commodity” means goods which are supplied without differentiation such as salt or copper. Thus, it is useful to keep in mind the economic meaning, not the everyday meaning, of “commodity” while reading about I-O models.

The largest single source of U.S. I-O data is the Economic Census, which is conducted once every 5 years by the U.S. Bureau of the Census. The models start with two basic tables, the “make” and “use” table. A make table shows the value of each I-O commodity produced by each industry in a given year. Before such tables can be produced, classifications are needed for “commodities” and “industries.”

For the I-O accounts, BEA uses a classification system that is based on the North American Industry Classification System (NAICS). The I-O classification system is consistent with that used by the principal agencies that provide the source data used in the I-O accounts and by the preparers of the national accounts and other economic series that are used for analysis in conjunction with the I-O accounts. In I-O accounting, each industry is associated with a commodity that is considered the primary product of that industry. The 20 major sectors and their two-digit NAICS codes are found in Table S-2.

The coefficients used in this report assume that License Income for academic licensors, both universities and HRI’s, is in sector 61 “Educational Services,” and that the outputs of the technology licensees are in a subgroup of sectors 31-33 “Manufacturing.” The subgroups are: chemical products (325), plastics and rubber products (326), nonmetallic mineral products, (327), fabricated metal products (332), machinery (333), computer and electronic products (334), electrical equipment appliances and components (335), other transportation equipment (2264OT), and miscellaneous manufacturing (339).

The use table shows the uses of commodities by industries as intermediate inputs and by final users. “Use of commodities by industries as intermediate inputs,” is roughly analogous, for manufacturers, to COGS in financial statements¹⁸, and the “use by final users” would be understood in everyday parlance as the sum of purchases by persons, government and business investment, and exports less imports.¹⁹ For the economy as a whole, the total of all final uses of commodities equals the sum of all value added by all industries, or GDP.

Table B from the BEA Primer is copied below to illustrate that some observations are consistent with intuition or at least not intuitively surprising. First, it supports the often heard truism that “The U.S. is a service economy,” more of the GDP is characterized as “service” than “manufacturing,” That individuals directly consumed more services (\$7.9T)

¹⁸ The analogy fails for wholesalers and retailers in the I-O accounts, where “intermediate input” is equivalent to the cost of running the retail or wholesale operation excluding labor.

¹⁹ The word “investment” is used in a manufacturing context, not a financial one, and refers to investment in new fixed assets or inventories, or for replacing depreciated fixed assets. It does not mean venture investment or stock purchases. Imports are used in the United States but produced abroad.

than manufactured goods (\$1.7T) in 2007 is another unsurprising observation. The single largest intermediate input to service industries is service $(5,030,294) \div (6,373,425) = 79\%$, and the single largest intermediate input to manufacturing industries is manufactured commodities $(1,609,532) \div (3,417,099) = 47\%$.

**Table B. The Use of Commodities by Industries,
2007 [Millions of Dollars]**

Commodities/industries	Agriculture, mining, and construction ¹	Manufacturing		Services ²	Government ³	Total intermediate use	Personal consumption expenditures	Private fixed investment	Change in private inventories ⁴	Net trade	Government consumption expenditures and gross investment ⁵	Total final uses (GDP)	Total commodity output
		Total	Computer and electronic products										
Agriculture, mining, and construction ¹	154,402	595,776	944	248,419	89,143	1,087,739	59,605	1,011,206	11,099	-271,109	293,340	1,104,141	2,191,880
Manufacturing.....	415,614	1,609,532	105,397	929,547	317,079	3,271,773	1,681,597	689,338	34,532	-779,107	114,238	1,740,597	5,012,370
Computer and electronic products	4,401	108,822	66,881	79,778	26,520	219,521	73,990	186,349	2,938	-148,523	40,576	155,331	374,852
Services ²	464,515	1,135,150	123,225	5,030,294	720,891	7,350,850	7,904,854	527,305	10,205	441,528	53,167	8,937,059	16,287,909
Total intermediate inputs ⁶	1,038,805	3,417,099	241,727	6,374,425	1,171,034	84,454							2,362,541
Compensation of employees	549,340	969,412	139,114	4,823,282	1,477,338	12,001,363							
Taxes on production and imports less subsidies	28,529	57,178	4,483	893,320	-15,874	7,819,371							
Gross operating surplus	475,893	590,236	2,697	3,677,424	281,462	963,153							
Total industry output.....	2,092,567	5,033,925	388,021	15,768,450	2,913,960	5,025,015	9,710,168	2,133,993	-3,642	-707,810	2,674,830		

1. Agriculture consists of agriculture, forestry, fishing and hunting.
2. Consists of utilities; wholesale trade; retail trade; transportation and warehousing; information; finance, insurance, real estate, rental, and leasing; professional and business services; educational services, health care, and social assistance; arts, entertainment, recreation, accommodation, and food services; and other services, except government.
3. Consists of federal, state, and local governments.
4. Includes inventory valuation adjustment.
5. Includes noncomparable imports; inventory valuation adjustment; rest-of-the-world, and scrap, used and secondhand goods.

Note that “total value added” is a measure of the value of factors of production – in textbook economics, land, labor and capital. It is not the same as profit. It includes compensation to employees, taxes on production and imports minus subsidies, and gross operating surplus. This surplus can be used, in the case of industries, to build more capacity, to pay shareholders or owners, for income taxes, or for their own R&D. By definition, this study assumes that all academic license income contributes to GDP. Within the national accounts, all of the output of nonprofits is consumed by persons, and thus is part of GDP. The output of nonprofits is measured as total expenses of the nonprofits. Finally, in this study we assume that the license income revenues are used to fund expenses and all of the revenue adds to output of nonprofits.

Four “requirements” tables are derived from the make and use tables. These are used to relate final demand to Gross Output. If final demand is known, for example, or there is a change in final demand, then the requirements tables can be used to show the inputs required by an industry to produce a given output. When only the direct requirements are considered (the inputs needed to produce the inputs are not included), the table is called a “direct requirement” table. When all inputs needed to make the inputs are considered, then the table is called the “total requirements table.” The total requirements table accounts for all interactions required by industries to support a given level of final demand. Note that output multipliers can only be used when final demand is known.

Thus, an output multiplier *is* applied to license income received at the academic licensors, since all of their output is consumed by persons, and thus considered, by definition, final demand. In contrast, since there is no information on the

fraction of sales of the licensees which is purchased by final users, and thus satisfies a final demand, *no* output multiplier on their sales is applied.

Assumptions used in Applying the I-O Model to Measurements of Economic Impact of U.S. academic licensing: See also Appendix A:

General:

- i) The academic licensors are in industry class “61,” educational services, and their licensees are in a subgroup²⁰ of industry classes 31-33: “Manufacturing.”
- ii) The value added ratio, the output multiplier, and the employment to output ratio are all applied to current dollars. GDP and Gross Output are then normalized to constant 2009 dollars.
- iii) Sales of the licensee’s products are estimated using the AUTM reported Running Royalties (earned royalties on product sales) divided by an assumed royalty rate.
- iv) All relevant sales are captured by the royalty base.

For the GDP Calculation:

- i) 100% of academic institution expenditures contribute to GDP.
- ii) 100% of licensee’s sales are by domestic producers.

For the Gross Output Calculation:

- i) The license revenue (income) received by U.S. academic licensors is all spent in the U.S., and is treated as consumption expenditures. The effect of this revenue on gross output is increased by one iteration of purchases of intermediate inputs, so called “direct requirements.”
- ii) 100% of licensees’ sales are by domestic producers and 100% of the intermediate inputs for this production are also domestic.
- iii) Since the fraction of the licensee’s sales that are final sales is unknown, no output multipliers are applied. Gross output is simply total licensees’ sales.
- iv) Though sponsored research to the academic licensors is a result of licensing activity, some licenses include an obligation to fund research as a condition of keeping the license. Since there are no systematic data, it is omitted entirely.

The Economic Impact Model using AUTM Data and I-O Coefficients:

GDP:

A: A portion associated with the License Income Received at academic licensors	+	B: A portion associated with the business activity associated with the technology license at the licensees
---	----------	---

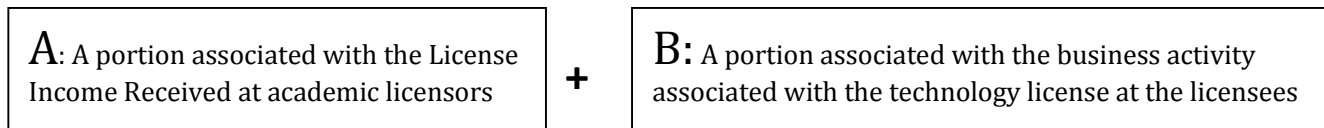
$$A_{\text{GDP}} = (\text{Licensing Income Received in Constant 2009 U.S. Dollars})^{21}$$

²⁰ The subgroups are: chemical products, plastics and rubber, nonmetallic minerals, fabricated metals, computer and electronics, electrical equipment, transportation equipment, miscellaneous manufacturing and machinery

²¹ License Income Received (as reported in the AUTM Survey)

$$B_{GDP} = ((\text{Sales at Licensee}^{22}) \times (\text{Value Added ratio from U.S. I-O Tables})) \times (\text{GDP Deflator to Constant 2009 \$U.S.})^{23}$$

Gross Industry Output:



A_{GO} is made up of two parts, and $= A1_{go} + A2_{go}$

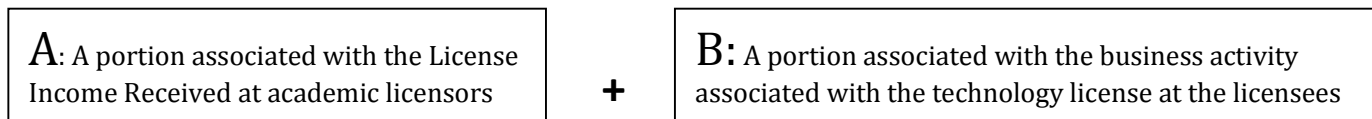
$A1_{go}$: the effect of the License Income Received at the academic licensor, and $A2_{go}$: the effect outside the licensor when the licensor spends that income.

$$A1_{go} = (\text{Licensing Income Received in Constant 2009 U.S. Dollars})^{24}$$

$$A2_{go} = ((\text{Licensing Income Received in Current U.S. Dollars}) \times (\text{Output Multiplier from U.S. I-O Tables})^{25}) \times (\text{GDP Deflator to Constant 2009 U.S.\$})$$

$$B_{go} = (\text{Sales at Licensee}^{26})$$

Employment Supported by Final Purchases Associated with Academic Licensing:



$$A_{YES} = (\text{employment multiplier for academic licensors}) \times (\text{current License Income Received})$$

$$B_{YES} = (\text{employment to output ratio for manufacturing companies}) \times (\text{Sales at Licensee, calculated using ((Running Royalties}^{27}) \div (\text{estimated royalty rate}))$$

Comments on Assumptions and Caveats on Accuracy of Estimates:

This report assumes that all of the licensees' sales are commodities produced by domestic producers, and that all intermediate inputs are also domestically produced. These assumptions, in isolation, lead to overestimates; imports are not taken into account.

This report assumes that all sales result from manufacturing activity. To the extent that some important academic licensees are in the service business (Google, for example) this assumption, in isolation leads to an underestimate.

Because the fraction of licensees' sales that are final sales is unknown, this model applies no output multiplier to any portion of these sales. This leads to an underestimate.

²² (Running Royalties as Reported in the AUTM Survey) \div (Royalty Rate)

²³ The multipliers are applied to current dollar license income. The result is adjusted to constant 2009 U.S.\$.

²⁴ License Income Received (as reported in the AUTM Survey) times a factor which accounts for inflation, and is defined =1 in 2009.

²⁵ See Appendix B

²⁶ (Running Royalties as Reported in the AUTM Survey) \div (Royalty Rate)

²⁷ As defined in the AUTM Survey

Not all licenses contain royalty terms. The license exhibit Google filed with its S-1, for example, contains an equity provision for Stanford, but no apparent running royalty. This phenomenon means that using Running Royalties in isolation, even with an accurate royalty rate, underestimates licensees' sales. Some licenses contain royalties on products, but not on services.²⁸ The royalty base itself can be smaller than the commodity sold.²⁹ Royalty offsets (ft 29) and combination product language (ft 28), through reducing the royalty base, contribute to an effective royalty rate lower than the one apparently specified in the license contract. These factors suggest that estimating licensees' sales by using (Running Royalties as reported in the AUTM Survey) ÷ (an assumed Royalty Rate) may underestimate licensees' relevant sales, and thus GDP, gross output, and employment.

Patent reimbursement is reported separately from License Income in the AUTM Survey. Review of the data shows patent reimbursement is about 5% of total license income. Adding patent reimbursement would thus increase economic impact estimates, but modestly. License Income Paid to Other Institutions was also not considered and appears also to be roughly 5% of total license income. However, until recently "License Income Paid to Other Institutions" was included in License Income paid to any institution, even one which did not respond to the AUTM Survey. Thus, it is not clear that removing it removes only double counting. Including "License Income Paid to Other Institutions" would subtract from economic impact estimates. These two omissions likely off set each other, and are likely not as large a factor in the accuracy of the overall estimate as other assumptions listed in Appendix A.

It has been suggested that an assumed product substitution rate should be used to reduce overall estimates. There is not sufficient information to estimate substitution, but to the extent that substitution maintains or increases U.S. domestic production, or use of U.S. intermediate inputs, then it is not a subtraction.

Companies highlight their new products, and sometimes they depend on such "substitution" to ensure growth. Frederick J. Palensky, 3M's chief technology officer, was interviewed in the January 9, 2012 Chemical & Engineering News: "New products—five years old or less—accounted for 31% of sales in 2010, and when 2011's new products are included in the tally, they are likely to account for 33% of sales, Palensky says. 3M's goal is for new products to reach 40% of sales. The company's businesses won't grow at all if new product sales don't reach at least 25%, he says, so a high-functioning R&D organization is critical for survival."

Since economies grow through renewal and replacement, though to assure growth, renewal and replacement must exceed loss, the caveat on product substitution is written as assuming "no detrimental product substitution effects."

Updated Public Information on AUTM Member Royalty Rates:

The model is clearly dependent on the assumed royalty rate. Licensors may be expected to voluntarily publicize higher rates than licensees, and both can be true depending on how the royalty base is defined. The 2009 and 2012 report and 2012 Research Policy paper³⁰ included this table:

²⁸ <http://www.sec.gov/Archives/edgar/data/1110803/0001012870-00-001863.txt> accessed March 15, 2015

²⁹ http://www.sec.gov/Archives/edgar/data/1167178/000104746908008964/a2186822zex-10_28.htm#toc_ri44902_1 accessed March 15, 2015.

³⁰ To develop information about "typical" royalty rates charged by universities on which to base our impact estimates, we enlisted the aid of a number of individual university technology transfer officers from various regions of the country, and current and former members of the AUTM Public Policy Committee. With their help, we obtained royalty rate information from 12 research universities

Royalty Rates Used by Selected U.S. Research Universities

University	Life Sciences	Software	Other	Overall
A	4-6%	10-20%	0.5-3%	
B	10%+		.25%	Processes 1-3% composition of matter 4-6%
C				2-3%
D	Devices 5% Therapeutics 1-2%			
E	Devices 4-5% Therapeutics 1-2%	“higher”		
F				8% (health plus IT)
G	4%			3-4% (mostly medical devices)
H				4-5% (mostly life sciences)
I				1-2%
J				About 5%
K				4 .4%
L				5-8%

Yet, the FY 2012 AUTM Survey reported an average royalty rate of 1.7% in FY2011 and 1.8% in FY2012.³¹ These rates were calculated by asking respondents to report the product sales their licensees provided in royalty reports to AUTM member licensors and the earned royalties AUTM members received³²:

“Further, these organizations said that 3,014 licensees reported \$36.8 billion in sales, implying average sales of \$12.2 million per license and paid \$657.7 million in royalties, implying an average royalty rate of 1.8 percent. In contrast, FY2011 data indicated that 2,281 licensees achieved \$36.9 billion in product sales, implying average sales of \$16.2 million per license, and paid \$661.6 million in royalties, implying an average royalty rate of 1.7 percent.”

The table and the FY2012 AUTM Survey numbers may be internally consistent when combined with royalty offsets and debundling provisions described above, examples of which can be found in template AUTM member license agreements and in numerically, but not structurally, redacted SEC filings.

AUTM Data, I-O Coefficients, and Results:

The AUTM respondent data and I-O coefficients are in Appendix B. The GDP, Employment and Gross Output calculations for University AUTM Survey respondents and Hospital and Research Institutes AUTM Survey respondents are in Appendices C and D, respectively. Appendix E is a sum of the impacts estimated in Appendices C and D³³.

Since the royalty rate is clearly a key input, the calculations were run for three assumed royalties; 2%, 5%, and 10%. The assumptions that i) all sales are made by domestic producers³⁴, ii) the royalty base captures all the relevant

representing a range of sizes, types (public and private), and geo-graphic locations. The following [Table 1](#) summarizes the results of this effort.

³¹ Page 40 FY2012 AUTM Survey

³² These data apply to the subset of all AUTM Survey Respondents, including patent management firms and Canadian Respondents, not only U.S. Universities and U.S. Hospitals and Research Institutes, that responded to the question on their licensees’ net sales.

³³ The data are calculated to many more significant places than shown in the Appendix Tables. For example, employment supported by University licensing activities from 1996-2013 for a 2% royalty rate is calculated as 3,058,413 jobs. This explains why summing the data in the U table and the HRI table is not always exactly equal to the U+HRI Table.

³⁴ If all producers are domestic then all sales are domestic even if the buyer takes delivery overseas.

sales of the academic licensees, iii) none of the licensees' sales are to final users, iv) the intermediate inputs to the licensees' sales are all produced domestically, and v) all of the licensee's sales are from manufacturing industries captured by NAICS codes 31-33, and not from other sectors, are likely the next largest unknowns which affect the estimates.

Appendix A shows how these and other assumptions affect the estimates, in some cases, leading to overestimates, and in an equal number of cases, leading to underestimates.

Assumptions on whether new products i) displace, and remove from the U.S. economy products which would have been sold absent the new product, or ii) replace existing products, and keep products in the U.S. economy which would otherwise have been lost had not the new product been available to replace a soon-to-be-obsolete product, clearly influence these estimates. Whatever the assumptions on displacement versus replacement, it is known that royalty generating products will evolve away from reportability and visibility under AUTM licenses, as i) market changes remove demand, or ii) the product changes technically so it no longer reads on the licensed intellectual property, or finally, iii) the patent expires.

Since not all sales are captured in the royalty base thereby effectively lowers the royalty rate, and since licensors naturally report higher rates than licensees, estimates at the lower end of the range (2%) are likely more realistic, especially on a weighted average basis.

Summing over the 18 years of available data for academic U.S. AUTM Survey respondents, both U.S. universities and hospitals and research institutes, assuming no detrimental product substitution effects, and all the assumptions listed in Appendix A, then for royalty rates ranging from 2% to 10%, and due to the fact that the impacts are inversely proportional to the estimated average royalty rate; the total contribution of this academic licensing, to gross industry output ranges from \$1.18T to \$282B in 2009 \$U.S. Dollars and to GDP it ranges from \$531B to \$130B, in 2009 \$U.S. Dollars.

Estimates of the total number of person years of employment supported by U.S. universities' and hospitals' and research institutes' licensed-product sales range from 3,824,000 to 1,130,000 over the 18 year period.

Trends and Observations:

Figure 3 below (data are in table S-3) shows the normalized, relative to itself in 1996, i) I-O model calculated increase in AUTM respondent contribution to GDP and ii) increase in U.S. GDP.

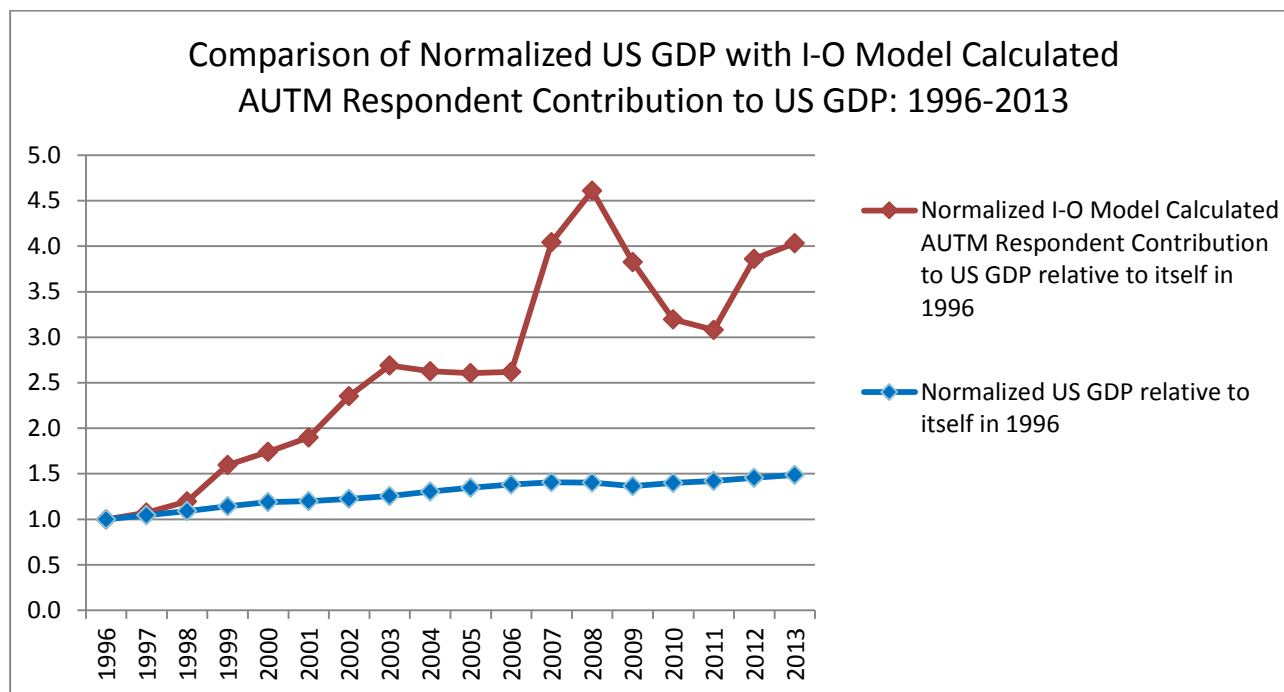


Figure 3.

Figure 3 suggests that factors different in kind, strength or timing from those that influence U.S. GDP influence AUTM respondent contributions to GDP. Over an eighteen year period, U.S. GDP increased by approximately 50% while AUTM respondent's reported contributions to GDP, as estimated using this model, apparently may have quadrupled over the same eighteen year period. Note however, that the absolute I-O calculated AUTM respondent contribution to U.S. GDP is very small. In 1996, it would be roughly a tenth of one percent (\$10.8B, assuming a 2% royalty rate, out of \$10.6T), and in 2013, three tenths of a percent (\$43.5B, assuming a 2% royalty rate, out of \$15.7T).

The BEA also provides GDP by Industry.³⁵ Consistent data are available for 1997-2013. Figure 4 below (data are in tables S-4 and S-5) shows the normalized, relative to itself in 1997, i) I-O model calculated AUTM respondent contribution to GDP, ii) increase in U.S. GDP for the industry sectors identified by NAICS codes used as the basis of the I-O coefficients in Appendix B³⁶, and iii) the increase in U.S. GDP as a whole.

³⁵ http://www.bea.gov/industry/gdpbyind_data.htm

³⁶ 325 (chemical products), 326 (plastics and rubber products), 327 (nonmetallic mineral products), 332 (fabricated metal products), 333 (machinery), 334 (computer and electronic products), 335 (electrical equipment, appliances, and components), 2264OT (other transportation equipment) 339 (miscellaneous manufacturing), and 61 (educational services).

Over the seventeen year period, the selected NAICS sectors' contribution to GDP increased by 57%, U.S. GDP as a whole by 42% and AUTM respondents' I-O calculated contributions to GDP increased by a factor of 3.75.

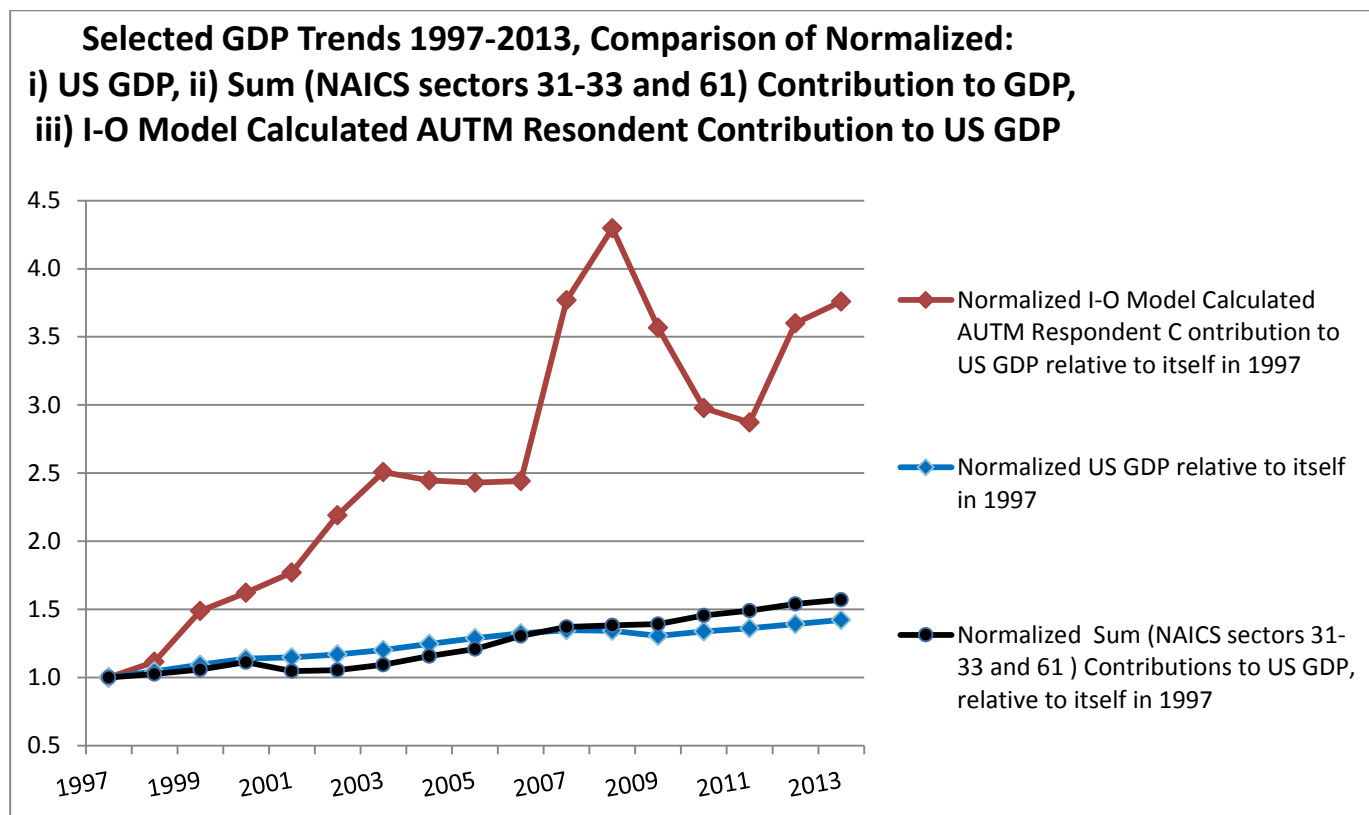


Figure 4.

The comparisons in Figure 4 above suggest that from 1997-2013, factors different in kind, strength or timing from those that influence this selected portion of U.S. GDP influence I-O calculated AUTM respondent contributions to U.S. GDP .

AUTM tracks many measures of academic licensing activity, including total research expenditures “TOTEXP”, new licenses executed “LICEX”, cumulative total of active licenses “ACTLI”, cumulative total of licenses generating license income “LIGNLI”, and cumulative total of licenses generating running royalties “LCGNRR”, as well as license income received in a given year “LIRECD” and total running royalties received in a given year “LIRUNR”. (LIRECD and LIRUNR are shown in Appendix B, separately for U.S. Universities and Hospitals and Research Institutes). Data on the cumulative number of licenses generating running royalties “LCGNRR” are available only starting in 1999.

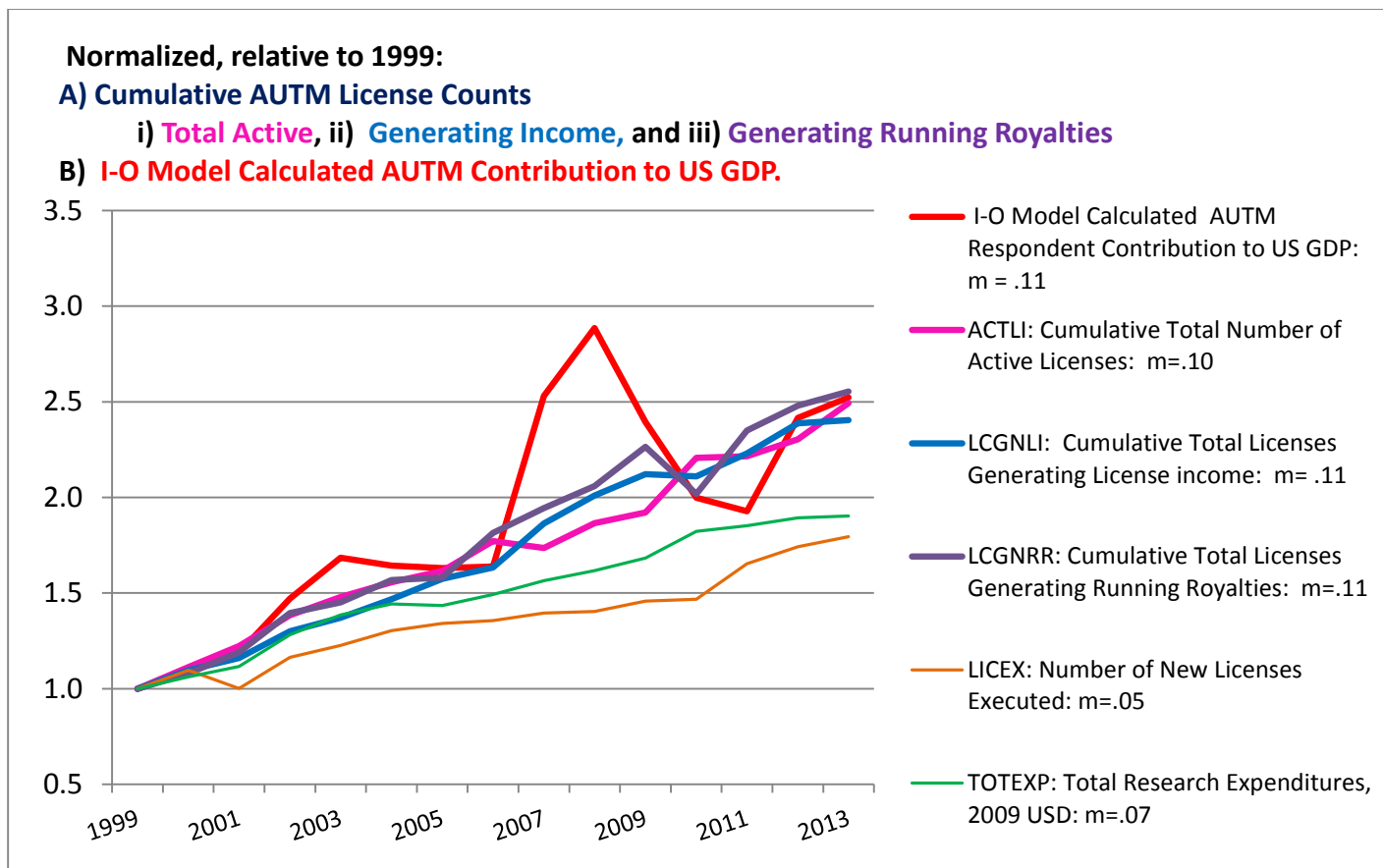


Figure 5.

Figure 5 (data are in table S-6), above, shows the normalized I-O model derived AUTM respondent contribution to GDP of figure 4 compared with the normalized growth in various AUTM metrics from 1999-2013. Data table S-6 also provides a slope and correlation coefficient for a linear curve fit, not shown, to the 15 years of normalized data, and displays the actual (not normalized) data values.

It is interesting to observe, by eye and by calculated slope and correlation coefficients, that cumulative active license agreements and cumulative license agreements generating running royalties track well with a best fit line to I-O calculated AUTM respondent U.S. GDP contributions. Perhaps because they are by definition cumulative, and thus time averaged, they appear to track more consistently than the single year metrics, such as the number of New Licenses Executed “LICEX”, or Total Research Expenditures “TOTEXP”. Sales today are associated with earlier license agreements and even earlier research.

The cumulative license agreement numbers are the result of an inflow and outflow of active license agreements and the subset of active license agreements generating running royalties. Agreements are added as new licenses are signed, or new products start to generate running royalties. Agreements are subtracted as licenses terminate or end for any number of reasons, from i) a discovery that there is no or an inadequate market for the anticipated product, to ii) the product evolving away technically from the patent claims, to iii) patent expiration.

By definition, royalties payable when a product reads on a patent claim end upon patent expiration. Thus, AUTM respondent running royalties are associated with newer or younger products or newer or younger parts of products than U.S. products as a whole. These data support the proposition that new products drive growth.

For the time period 1999-2013, these data indicate a net addition of active license agreements and license agreements associated with running royalties. It will be interesting to watch these trends as academic licensing continues to mature, patent life is effectively shortened in a now almost 20 year post GATT world, patent laws continue to evolve, and data and databases, both public and private, play an increasing role in society and the economy.

Appendix A: Assumptions and their Effects

Assumption	Effect of Assumption: + means results in an over estimate relative to the estimates in this report – means results in an under estimate relative to the estimate in this report	Future Work
(Relevant) Sales = (Running Royalties) ÷ Royalty Rate	+ or - Total impact is a function of royalty rate - Since not all sales generate Running Royalties, this assumption leads to an underestimate. Impact overall would increase if this could be adjusted accurately.	Acquire data
The licensees' production of Running Royalty generating commodities occurs entirely in the U.S.	+ Impact overall would decrease.	Characterize locations of licensees' production.
None of the licensees' sales are final sales.	- Gross Output: If a fraction of the licensees' sales are final sales, then it is appropriate to apply an output multiplier to that fraction, thus increasing the Gross Output estimate. - Employment: If Gross Output increases, then Employment Increases.	Characterize products
All of the intermediate inputs to Gross Output are domestic.	+ Gross Output: If a fraction of the intermediate inputs to production are not domestically produced, then Gross Output should be reduced. + Employment: If Gross Output is reduced, then Employment is reduced	Characterize the geographic origin of intermediate inputs
Licensees are in a subgroup (chemical products, plastics and rubber, nonmetallic minerals, fabricated metals, computer and electronics, electrical equipment, transportation equipment, miscellaneous manufacturing and machinery) of industry classes 31-33: "Manufacturing."	- GDP: Value added ratios are generally higher for service providers than for manufacturers, so the GDP estimate would increase. -Employment: Employment multipliers are generally higher for service providers than for manufacturers, so the employment estimate would increase. + Gross Output: The output multipliers for service providers are generally lower than for manufacturers. The Gross Output estimate would decrease.	Characterize industries of licensees
Sponsored Research to the academic licensor associated with the license = 0	- Impact would increase. The assumption was forced, since there are no reliable data	Acquire data
Substitution Effects	+ To the extent a new product actually displaces a current product, unaccounted for substitution effect will result in an overestimate. To the extent it keeps in the U.S. economy activity which would otherwise have been lost, then not a factor	Case by case considerations
Impact ends when Running Royalty payments end.	- Likely results in an underestimate of impact.	Studies of product lifetimes, relative to license duration.

No Patent Reimbursement and no License Income paid to other Institutions	Likely cancel each other out	Look at in more detail
--	------------------------------	------------------------

Appendix B: AUTM Data and I-O Multipliers

	University Total License Income	University Running Royalties	HRI Total License Income	HRI Running Royalties					
Year	Current Dollar License Income millions	Current Dollar Running Royalties millions	Current Dollar License Income millions	Current Dollar Running Royalties millions	Value added ratio from U.S. I-O tables ³⁷	Output multiplier from U.S. I-O tables ³⁸	Employment multiplier from U.S. I-O tables for Academic Institutions ³⁹	Employment to output ratio from U.S. I-O tables for Manufacturers (Licensees) ⁴⁰	GDP deflator
1996	\$365	\$282	\$135	\$84	0.43	0.73	0.020	0.0046	76.767
1997	\$483	\$315	\$129	\$81	0.43	0.73	0.020	0.0046	78.088
1998	\$614	\$390	\$113	\$60	0.42	0.76	0.020	0.0046	78.935
1999	\$675	\$475	\$152	\$139	0.42	0.77	0.019	0.0045	80.065
2000	\$1,100	\$559	\$132	\$111	0.42	0.81	0.018	0.0043	81.89
2001	\$868	\$637	\$171	\$131	0.42	0.81	0.018	0.0044	83.755
2002	\$998	\$787	\$259	\$151	0.43	0.76	0.017	0.0041	85.04
2003	\$1,032	\$829	\$314	\$249	0.44	0.74	0.016	0.0039	86.735
2004	\$1,088	\$810	\$346	\$277	0.44	0.69	0.016	0.0036	89.118
2005	\$1,775	\$856	\$346	\$278	0.42	0.74	0.015	0.0033	91.985
2006	\$1,512	\$969	\$653	\$198	0.42	0.75	0.015	0.0031	94.812
2007	\$2,099	\$1,807	\$576	\$125	0.41	0.75	0.014	0.0029	97.34
2008	\$2,397	\$1,946	\$1,037	\$351	0.41	0.77	0.013	0.0028	99.218
2009	\$1,782	\$1,351	\$525	\$257	0.48	0.68	0.013	0.0029	100
2010	\$1,790	\$1,092	\$587	\$276	0.47	0.74	0.012	0.0027	101.226

³⁷ This applies to the licensees' sales only. Recall that 100% of license income received by the academic licensors contributes to GDP.

³⁸ This is applied to the license income received by the academic licensors only, and is effectively (1+.71, etc). It was deemed reasonable to look at one level of intermediate inputs since all of nonprofit expenses by definition are consumed by persons, and thus, are final demand. There is NO output multiplier applied to the licensees' sales. Gross Output = 1 x (licensees' sales)

³⁹ The number of employees required in all industries to meet the university level of final demand.

⁴⁰ For manufacturers in the subgroup of manufacturers identified previously.

2011	\$1,814	\$1,097	\$620	\$333	0.45	0.76	0.012	0.0025	103.315
2012	\$1,955	\$1,306	\$638	\$555	0.44	0.77	0.012	0.0025	105.174
2013	\$2,090	\$1,426	\$627	\$554	0.44	0.80	0.012	0.0024	106.73

Appendix C: GDP, Employment and Gross Output Calculations for U.S. University AUTM Survey Respondents,

	University Contribution to GDP, 2% Running Royalties	University Contribution to GDP, 5% Running Royalties	University Contribution to GDP, 10 % Running Royalties	University Contribution to Person Years of Employment Supported , 2% Running Royalties	University Contribution to Person Years of Employment Supported, 5% Running Royalties	University Contribution to Person Years of Employment Supported, 10 % Running Royalties	University Contribution to Gross Output, <i>Output Multiplier = 1,</i> 2% Running Royalties	University Contribution to Gross Output, <i>Output Multiplier = 1,</i> 5% Running Royalties	University Contribution to Gross Output, <i>Output Multiplier = 1,</i> 10 % Running Royalties)
	Constant Dollars	Constant Dollars	Constant Dollars	Person Yrs of Employment	Person Yrs of Employment	Person Yrs of Employment	Constant Dollars	Constant Dollars	Constant Dollars
Year	millions	millions	millions	thousands	thousands	thousands	millions	millions	millions
1996	\$8,291	\$3,602	\$2,039	73	33	20	\$19,196	\$8,172	\$4,497
1997	\$9,191	\$4,047	\$2,333	83	39	24	\$21,222	\$9,130	\$5,099
1998	\$11,182	\$4,939	\$2,858	103	48	30	\$26,095	\$11,261	\$6,316
1999	\$13,388	\$5,862	\$3,353	119	55	34	\$31,156	\$13,357	\$7,423
2000	\$15,759	\$7,110	\$4,226	139	68	44	\$36,560	\$16,083	\$9,257
2001	\$16,986	\$7,417	\$4,227	154	71	43	\$39,882	\$17,081	\$9,481
2002	\$21,217	\$9,191	\$5,182	180	82	50	\$48,323	\$20,568	\$11,317
2003	\$22,317	\$9,641	\$5,415	177	81	49	\$49,872	\$21,190	\$11,629
2004	\$21,132	\$9,185	\$5,203	163	75	46	\$47,522	\$20,250	\$11,159
2005	\$21,423	\$9,727	\$5,828	169	83	55	\$49,877	\$21,961	\$12,656
2006	\$23,161	\$10,221	\$5,908	173	82	52	\$53,866	\$23,219	\$13,003
2007	\$40,379	\$17,445	\$9,801	288	133	81	\$96,580	\$40,890	\$22,326
2008	\$42,113	\$18,003	\$9,966	305	141	87	\$102,354	\$43,510	\$23,896
2009	\$34,351	\$14,697	\$8,146	222	102	63	\$70,555	\$30,018	\$16,505
2010	\$27,476	\$12,284	\$7,220	167	80	51	\$56,996	\$24,641	\$13,856
2011	\$25,439	\$11,229	\$6,492	161	77	50	\$56,175	\$24,323	\$13,706
2012	\$29,349	\$12,855	\$7,357	186	88	56	\$65,378	\$28,129	\$15,713
2013	\$31,446	\$13,753	\$7,856	198	94	59	\$70,349	\$30,253	\$16,888
Total	\$414,602	\$181,208	\$103,410	3,058	1,435	894	\$941,959	\$404,035	\$224,726

Appendix D: GDP, Employment and Gross Output Calculation for U.S. Hospital and Research Institute AUTM Survey Respondents

	HRI Contribution to GDP, 2% Running Royalties	HRI Contribution to GDP, 5% Running Royalties	HRI Contribution to GDP, 10 % Running Royalties or	HRI Contribution to Person Years of Employment Supported , 2% Running Royalties	HRI Contribution to Person Years of Employment Supported, 5% Running Royalties	HRI Contribution to Person Years of Employment Supported, 10 % Running Royalties	HRI Contribution to Gross Output, Output Multiplier = 1, 2% Running Royalties	HRI Contribution to Gross Output, Output Multiplier = 1, 5% Running Royalties	HRI Contribution to Gross Output, Output Multiplier = 1, 10 % Running Royalties
	Constant Dollars	Constant Dollars	Constant Dollars	Person Yrs of Employment	Person Yrs of Employment	Person Yrs of Employment	Constant Dollars	Constant Dollars	Constant Dollars
Year	millions	millions	millions	thousands	thousands	thousands	millions	millions	millions
1996	\$2,495	\$1,104	\$640	22	10	7	\$5,756	\$2,485	\$1,394
1997	\$2,382	\$1,052	\$609	21	10	6	\$5,496	\$2,370	\$1,328
1998	\$1,730	\$777	\$460	16	8	5	\$4,023	\$1,760	\$1,006
1999	\$3,853	\$1,655	\$922	34	15	9	\$8,998	\$3,800	\$2,067
2000	\$3,017	\$1,304	\$732	26	12	7	\$7,052	\$2,996	\$1,644
2001	\$3,499	\$1,522	\$863	32	15	9	\$8,220	\$3,510	\$1,940
2002	\$4,150	\$1,843	\$1,074	36	17	11	\$9,410	\$4,086	\$2,311
2003	\$6,712	\$2,902	\$1,632	53	24	15	\$14,997	\$6,376	\$3,503
2004	\$7,197	\$3,112	\$1,750	55	25	15	\$16,202	\$6,875	\$3,766
2005	\$6,697	\$2,905	\$1,641	51	24	14	\$15,739	\$6,688	\$3,671
2006	\$5,100	\$2,453	\$1,571	40	22	16	\$11,651	\$5,383	\$3,294
2007	\$3,243	\$1,653	\$1,122	26	15	12	\$7,471	\$3,608	\$2,321
2008	\$7,622	\$3,275	\$1,826	63	34	24	\$19,536	\$8,925	\$5,388
2009	\$6,925	\$3,183	\$1,936	45	22	14	\$13,743	\$6,026	\$3,453
2010	\$6,988	\$3,151	\$1,871	44	22	15	\$14,629	\$6,455	\$3,731
2011	\$7,782	\$3,473	\$2,037	50	24	16	\$17,155	\$7,496	\$4,276
2012	\$12,295	\$5,282	\$2,945	77	35	21	\$27,473	\$11,635	\$6,355
2013	\$12,047	\$5,172	\$2,880	75	34	21	\$27,027	\$11,445	\$6,251
Total	\$103,735	\$45,816	\$26,510	765	368	236	\$234,579	\$101,920	\$57,701

Appendix E: Sum of University and HRI AUTM Survey Respondent contribution to GDP, Employment and Gross Output

	U +HRI Contribution to GDP, 2% Running Royalties	U + HRI Contribution to GDP, 5% Running Royalties	U+ HRI Contribution to GDP, 10 % Running Royalties	U + HRI Contribution to Person Years of Employment Supported , 2% Running Royalties	U + HRI Contribution to Person Years of Employment Supported, 5% Running Royalties	U + HRI Contribution to Person Years of Employment Supported, 10 % Running Royalties	U + HRI Contribution to Gross Output, Output Multiplier = 1, 2% Running Royalties	U + HRI Contribution to Gross Output, Output Multiplier = 1, 5% Running Royalties	U+ HRI Contribution to Gross Output, Output Multiplier = 1, 10 % Running Royalties
	Constant Dollars	Constant Dollars	Constant Dollars	Person Yrs of Employment	Person Yrs of Employment	Person Yrs of Employment	Constant Dollars	Constant Dollars	Constant Dollars
Year	millions	millions	millions	thousands	Thousands	Thousands	millions	millions	millions
1996	\$10,786	\$4,706	\$2,679	95	44	27	\$24,953	\$10,657	\$5,891
1997	\$11,572	\$5,099	\$2,942	104	49	31	\$26,718	\$11,500	\$6,427
1998	\$12,912	\$5,717	\$3,318	119	56	35	\$30,118	\$13,021	\$7,321
1999	\$17,241	\$7,516	\$4,275	153	71	43	\$40,154	\$17,156	\$9,491
2000	\$18,776	\$8,413	\$4,959	165	80	51	\$43,612	\$19,079	\$10,901
2001	\$20,485	\$8,939	\$5,090	186	86	52	\$48,102	\$20,591	\$11,421
2002	\$25,366	\$11,033	\$6,256	216	99	60	\$57,733	\$24,654	\$13,628
2003	\$29,029	\$12,543	\$7,047	230	105	64	\$64,870	\$27,566	\$15,132
2004	\$28,329	\$12,297	\$6,953	218	101	62	\$63,724	\$27,125	\$14,925
2005	\$28,120	\$12,632	\$7,469	220	107	70	\$65,616	\$28,649	\$16,327
2006	\$28,261	\$12,674	\$7,479	213	104	68	\$65,517	\$28,602	\$16,297
2007	\$43,622	\$19,098	\$10,923	314	148	92	\$104,051	\$44,498	\$24,647
2008	\$49,736	\$21,278	\$11,792	368	175	110	\$121,890	\$52,436	\$29,284
2009	\$41,276	\$17,880	\$10,082	266	124	77	\$84,298	\$36,044	\$19,959
2010	\$34,464	\$15,435	\$9,091	211	102	66	\$71,625	\$31,096	\$17,587
2011	\$33,221	\$14,702	\$8,529	210	102	66	\$73,330	\$31,819	\$17,982
2012	\$41,644	\$18,137	\$10,302	262	123	77	\$92,850	\$39,764	\$22,068
2013	\$43,494	\$18,925	\$10,735	273	128	80	\$97,376	\$41,698	\$23,139
Total	\$518,337	\$227,024	\$129,920	3,824	1,803	1,130	\$1,176,538	\$505,955	\$282,427

Supplementary Tables and Figures:

Table S-1

Year of Report Years of data Year of currency value	GDP U	GDP HRI	GDP U + HRI	Gross Output U	Gross Output HRI	Gross Output U + HRI	Jobs: Person years of employ ment supported U	Jobs: Person years of employ ment supported HRI	Jobs: Person years of employ ment Supported U + HRI
2012 15 years of AUTM data 1996-2010 In 2005 dollars	\$278B	\$61B	\$339B	\$687B	\$149B	\$836B	2,586,000	579,000	3,165,000
2012 15 years of AUTM data 1996-2010 GO and GDP In 2009 dollars	\$328B	\$72B	\$400B	\$750B	\$162B	\$913B	Same as above since employment to output calculations are done in current dollars.		
2015 18 years of AUTM data 1996-2013 In 2009 dollars	\$414B	\$103B	\$518B	\$942B	\$235B	\$1,177B	3,058,000	765,000	3,824,000
2015 15 years of AUTM data 1999-2013 In 2009 dollars	\$385B	\$97B	\$483B	\$875B	\$219B	\$1,095B	2,801,000	706,000	3,506,000
Percent Increase from 1996-2010 period to 1999-2013 period	A= 17%	B = 35%	C = 21%	D= 17%	E= 35%	F = 20%	G = 8.3%	H= 22%	I = 11%

Cumulative GO, GDP and Employment calculations for 18 years from 1996-2013

Rolling 15 year comparison, between the first data set, 1996-2010, and a 15 year subset of the second data set 1999-2013.

$$A = (385-328)/328 = 17\%$$

$$B = (97-72)/72 = 35\%$$

$$C = (483-400)/400 = 21\%$$

$$D = (875-750)/750 = 17\%$$

$$E = (219-162)/162 = 35\%$$

$$F = (1095-913)/913 = 20\%$$

$$G = (2,801,000-2,586,000)/2,586,000 = 8.3\%$$

$$H = (706,000-579,000)/579,000 = 22\%$$

$$I = (3,506,000-3,165,000)/(3,165,000) = 11\%$$

Table S-2

The following is a list of the 20 major sectors and their two-digit NAICS codes.

11	Agriculture, forestry, fishing and hunting
21	Mining
22	Utilities
23	Construction
31-33	Manufacturing
42	Wholesale trade
44-45	Retail trade
48-49	Transportation and warehousing
51	Information
52	Finance and insurance
53	Real estate and rental and leasing
54	Professional, scientific, and technical services
55	Management of companies and enterprises
56	Administrative and support and waste management and remediation services
61	Educational services
62	Health care and social assistance
71	Arts, entertainment, and recreation
72	Accommodation and food services
81	Other services (except public administration)
92	Public administration

Table S-3

Year	U +HRI Contribution to GDP, 2% Running Royalties , in millions of 2009 dollars	Normalized AUTM contribution to GDP relative to itself in 1996	BEA Table 1.1.6. Real Gross Domestic Product, billions of Chained Dollars	Normalized U.S. GDP relative to itself in 1996
1996	10,786	1.00	10,561	1.00
1997	11,572	1.07	11,035	1.04
1998	12,912	1.20	11,526	1.09
1999	17,241	1.60	12,066	1.14
2000	18,776	1.74	12,560	1.19
2001	20,485	1.90	12,682	1.20
2002	25,366	2.35	12,909	1.22
2003	29,029	2.69	13,271	1.26
2004	28,329	2.63	13,774	1.30
2005	28,120	2.61	14,234	1.35
2006	28,261	2.62	14,614	1.38
2007	43,622	4.04	14,874	1.41
2008	49,736	4.61	14,830	1.40
2009	41,276	3.83	14,419	1.37
2010	34,464	3.20	14,784	1.40
2011	33,221	3.08	15,021	1.42
2012	41,644	3.86	15,369	1.46
2013	43,494	4.03	15,710	1.49

Table S-4

Year	U +HRI Contribution to GDP, 2% Running Royalties	AUTM Normalized contribution to GDP relative to itself in 1997 in constant 2009 dollars	Table 1.1.6. Real Gross Domestic Product, Chained Dollars	Normalized U.S. GDP relative to itself in 1997	Normalized NAICS sectors 31- 33 and 61 contributions to U.S. GDP, relative to itself in 1997
1997	11,572	1.0000	11,035	1.00	1.00
1998	12,912	1.1157	11,526	1.04	1.03
1999	17,241	1.4899	12,066	1.09	1.06
2000	18,776	1.6225	12,560	1.14	1.11
2001	20,485	1.7702	12,682	1.15	1.05
2002	25,366	2.1920	12,909	1.17	1.06
2003	29,029	2.5085	13,271	1.20	1.10
2004	28,329	2.4480	13,774	1.25	1.16
2005	28,120	2.4300	14,234	1.29	1.21
2006	28,261	2.4421	14,614	1.32	1.31
2007	43,622	3.7695	14,874	1.35	1.37
2008	49,736	4.2978	14,830	1.34	1.38
2009	41,276	3.5668	14,419	1.31	1.39
2010	34,464	2.9782	14,784	1.34	1.46
2011	33,221	2.8707	15,021	1.36	1.49
2012	41,644	3.5986	15,369	1.39	1.54
2013	43,494	3.7584	15,710	1.42	1.57

Table S-5

Value Added by Industry (GDP by Industry)																		
[Billions of dollars]																		
Bureau of Economic Analysis																		
Release Date: November 13, 2014																		
NAICS Code		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
327	Nonmetallic mineral products	40	40.9	43.3	42.7	41.5	42	42.2	45.6	49.1	50.6	50.3	43.8	37.3	36.2	36.1	38.8	40.3
332	Fabricated metal products	110.5	112	116.4	121.7	111.5	106.6	109	115.3	122.9	127.1	135.1	133	117.9	120.3	127.4	137.6	139.9
333	Machinery	102.6	114	111.3	113.3	105.8	99.3	97.8	104.7	114.9	122.3	129.7	129.7	115.6	122.1	136.7	143.6	144.6
334	Computer and electronic products	196.3	192.2	186.9	225.9	173	172.4	193.3	201.5	211	223.4	227.2	234.1	228.9	249	248.9	252.6	255.1
335	Electrical equipment, appliances, and components	47.1	40.6	44.7	45.8	44.3	43.7	45.6	42.1	43.2	51.4	50.2	55.1	50.2	50	47.4	49.1	50.6
3364OT	Other transportation equipment	62.7	66.9	74	71.2	77	73	72.7	76	89.9	96.3	114	111.6	111.9	112.2	115.4	117	123.2
339	Miscellaneous manufacturing	52.5	55.4	57.8	59.4	57.5	61	62.1	63.9	66.2	70.2	71.9	74.9	80.2	81.2	78.1	78.6	82.5
325	Chemical products	174.9	182	189.8	189	193.4	207.1	211.5	230.1	227.3	260.6	276.4	280.1	310.3	330.8	337.2	341.5	345.7
326	Plastics and rubber products	58	62.1	66.3	65.9	64.1	63.5	63.3	64.4	63.5	64.4	63.7	56.3	61.5	63.3	64.6	71.1	73.4
61	Educational services	71.8	74.5	80.4	86.1	91.7	98.6	106.5	116.7	121	129.9	138.7	149.3	163	169.3	175.5	181.2	184.6
	total	916.4	940.6	970.9	1021	959.8	967.2	1004	1060.3	1109	1196.2	1257.2	1267.9	1276.8	1334.4	1367.3	1411.1	1439.9
	Normalized, relative to itself in 1997	1	1.03	1.06	1.11	1.05	1.06	1.10	1.16	1.21	1.31	1.37	1.38	1.39	1.46	1.49	1.54	1.57

Table S-6.

Year	LICFTE	N LICFTE: Number of Licensing Full Time Equivalents, normalized to 1999, Not related	TOT EXP : Total Research Expenditures in Constant 2009 \$B	N TOT EXP: Constant 2009 \$, Normalized to 1999	LICEX	N LICEX: Number of New Licenses Executed, normalized to 1999	ACTLI	N ACTLI: Cumulative Total Number of Active Licenses, normalized to 1999	LCGNLI	N LCGNLI: Cumulative Total Licenses generating license income, normalized	LCGNRR	N LCGNRR: Cumulative Total Licenses Generating Running Royalties,	LIRECD: License Income Received by year, Constant 2009 \$M	N LIRECD: Constant 2009\$, normalized to 1999	LIRUNR : License Income Received by year, Characterized as Running Royalties, Constant 2009 \$M	N LIRUNR: Constant 2009 \$, normalized to 1999	U +HRI Contribution to GDP, 2% Running Royalties \$B 2009 USD	I-O Model Calculated AUTM contribution to U.S. GDP normalized to 1999
1999	494	1.00	32.07	1.00	3650	1.00	17370	1.00	7620	1.00	3878	1.00	1033	1.00	767	1.00	17,241	1.00
2000	629	1.12	34.04	1.06	4004	1.10	19337	1.11	8352	1.10	4188	1.08	1505	1.46	818	1.07	18,776	1.09
2001	734	1.27	35.77	1.12	3657	1.00	21236	1.22	8839	1.16	4614	1.19	1241	1.20	917	1.20	20,485	1.19
2002	794	1.48	41.12	1.28	4247	1.16	24034	1.38	9906	1.30	5412	1.40	1478	1.43	1103	1.44	25,366	1.47
2003	833	1.61	44.42	1.39	4473	1.23	25694	1.48	10442	1.37	5627	1.45	1551	1.50	1243	1.62	29,029	1.68
2004	847	1.69	46.28	1.44	4758	1.30	27025	1.56	11181	1.47	6080	1.57	1609	1.56	1220	1.59	28,329	1.64
2005	911	1.71	45.99	1.43	4897	1.34	28049	1.61	11998	1.57	6130	1.58	2306	2.23	1232	1.61	28,120	1.63
2006	968	1.84	47.85	1.49	4947	1.36	30777	1.77	12452	1.63	7037	1.81	2283	2.21	1231	1.61	28,261	1.64
2007	1039	1.96	50.18	1.56	5094	1.40	30132	1.73	14194	1.86	7541	1.94	2748	2.66	1985	2.59	43,622	2.53
2008	1050	2.10	51.87	1.62	5123	1.40	32399	1.87	15316	2.01	7982	2.06	3461	3.35	2315	3.02	49,736	2.88
2009	1041	2.12	53.95	1.68	5321	1.46	33381	1.92	16162	2.12	8782	2.26	2307	2.23	1608	2.10	41,276	2.39
2010	1033	2.11	58.42	1.82	5356	1.47	38328	2.21	16080	2.11	7828	2.02	2348	2.27	1351	1.76	34,464	2.00

2011	1080	2.09	59.39	1.85	6037	1.65	3847 7	2.22	1699 7	2.23	9113	2.35	2356	2.28	1384	1.81	33,22 1	1.93
2012	1095	2.19	60.72	1.89	6360	1.74	4000 6	2.30	1818 9	2.39	9613	2.48	2466	2.39	1770	2.31	41,64 4	2.42
2013	494	2.22	61.01	1.90	6549	1.79	4329 5	2.49	1831 8	2.40	9901	2.55	2546	2.46	1856	2.42	43,49 4	2.52
2013/ 1999	2.22		1.90		1.79		2.49		2.40		2.55		2.46		2.42		2.52	

Table S-5. continued

Year	LICFTE	N LICFTE: Number of Licensing Full Time Equivalents, normalized to 1999. Not plotted	TOT EXP in \$B	N TOT EXP: Total Research Expenditures, Normalized to 1999	LICEX	N LICEX: Number of New Licenses Executed, normalized to 1999	ACTLI	N ACTLI: Cumulative Total Number of Active Licenses, normalized to 1999	LCGNLI	N LCGNLI: Cumulative Total Licenses generating license income, normalized to 1999	LCGNRR	N LCGNRR: Cumulative Total Licenses Generating Running Royalties, normalized to 1999	LIRECD \$M	N LIRECD: License Income Received by year, normalized to 1999	LIRUNR \$M	N LIRUNR: License Income Received by year, LIRUNR : License Income Received by year, U +HRI Contribution to GDP, 2% Running Royalties \$B 2009 USD	I-O Model Calculated AUTM contribution to U.S. GDP normalized to 1999
Slope		0.09		0.07		0.05		0.10		0.11		0.11		0.11		0.10	0.11
rsq		0.92		0.98		0.95		0.98		0.99		0.98		0.60		0.56	0.69

Most consistent multiyear tracking to a linear fit to I-O mode calculated GDP growth, by eye, slope and r^2 :

Slope = m in a $y = mx + b$ in a linear model

Rsq = Pearson's correlation coefficient.