The Economic Contribution of University/Nonprofit Inventions in the United States: 1996–2010

Prepared for the Biotechnology Industry Organization

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Project Team: Lori Pressman, David Roessner, Jennifer Bond, Sumiye Okubo & Mark Planting

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The Economic Contribution of University/Nonprofit Inventions in the United States: 1996-2010:

Measures of Economic Impact of Licensed Inventions Commercialized by Licensees of U.S. Respondents to the AUTM Survey 1996-2010

Prepared for the Biotechnology Industry Organization

by Lori Pressman, David Roessner, Jennifer Bond, Sumiye Okubo, and Mark Planting

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Revised Figure 2 provided March 4, 2015

Contents:

Summary:

Using an input output "I-O" approach to estimating the economic impact of academic licensing, and summing over the 15 years of available data for academic U.S. AUTM Survey respondents, the total contribution of these academic licensors to gross industry output ranges from $199B to $836B, in 2005 $US Dollars; contributions to GDP range from $86B to $338B, in 2005 $US 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 900,000 to over 3 million over the 15 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. The rationale for including impacts from hospital and research institutes together with those of universities is presented. Better information on i) royalty rates and royalty bases, ii) where in the world the academic licensors produce their products and where the intermediate inputs used to produce their products are produced, iii) whether the royalty generating products are manufactured items or services, and iv) whether the purchaser is the final purchaser will lead to more accurate estimates.

Introduction:

This report, on measures of economic impact of U.S. academic licensing activity, updates a previous report and model[1] developed by David Roessner, Jennifer Bond, Sumiye Okubo, and Mark Planting, for estimating the economic impact of U.S. university licensing activity. As in the previous report, input-output [I-O] coefficients are used to estimate i) gross industry output, ii) effects on GDP and iii) person- years of employment supported by academic licensing. As in the previous report, license income data, in particular License Income Received[2] and Running Royalties[3] are two key inputs.

The 2009 report used twelve years of AUTM Licensing Survey data, from 1996 – 2007. This report, and the Research Policy paper (footnote 1), use 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 report uses license data from U.S. Hospital and Research Institute "HRI" respondents as well as U.S. university respondents. In this report, the jobs estimate has also been updated to include person years of employment associated with sales of products by licensees. Previously, it had been calculated based only on employment associated with license income received by the universities.

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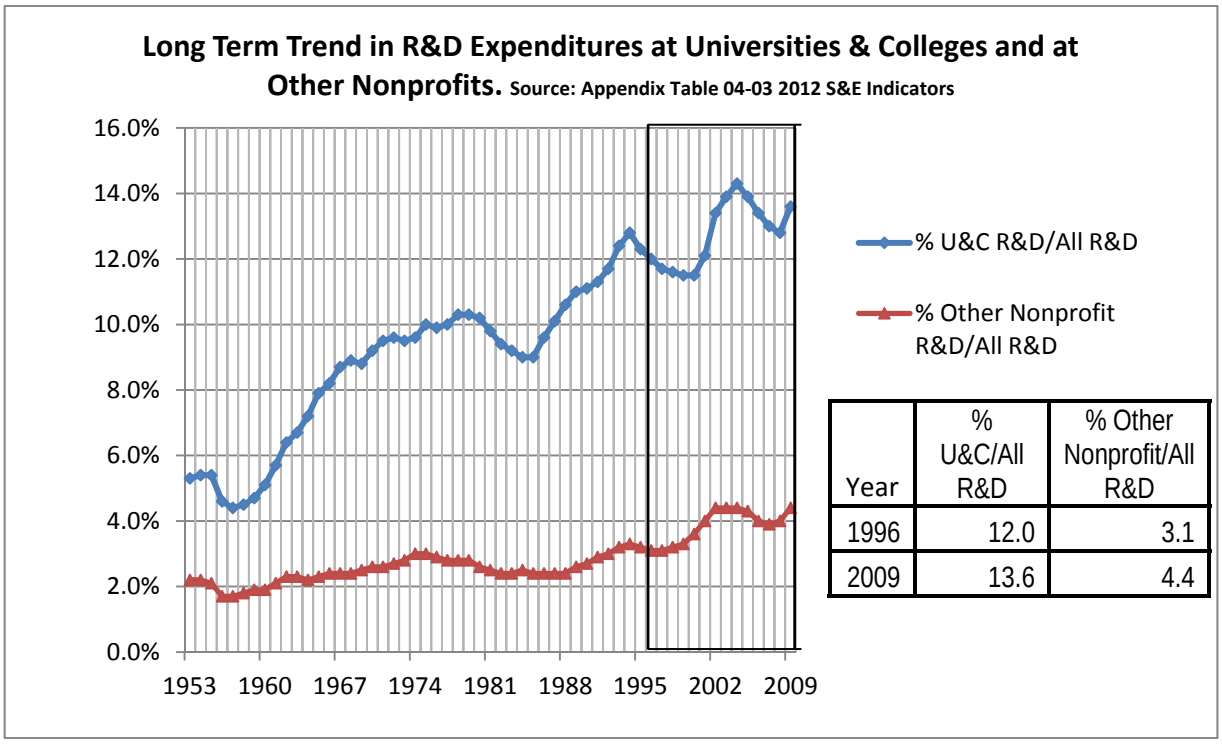
[1] David Roessner, Jennifer Bond, Sumiye Okubo, Mark Planting, "The Economic Impact of Licensed Commercialized Inventions Originating in University Research" Research Policy, May 26, 2012. 10.1016/j.respol.2012.04.015 . See also "The Economic Impact of Licensed Commercialized Inventions Originating 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 May 1, 2012.

[2] From Instructions and Definitions of Survey: LICENSE INCOME RECEIVED 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 enduser 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.

[3] 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.

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 organizations[4] as performers of U.S. R&D.[5] The Data Brief lists the "Top 10 nonprofit organization respondents by amount of intramural R&D expenditures, fiscal years 1996-1997" by name.[6] AUTM HRI Respondents include five, and six, respectively of the top ten for 1996,[7] and 1997.[8] 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 2009 grew from 5.3% to 13.6% of total U.S. R&D, while the fraction of R&D performed by other nonprofits grew from 2.2% to 4.4 % .[9] Data available for the period of this economic impact analysis, between 1996 and 2009, show that U.S. R&D performed at colleges and universities increased from 12.0 % to 13.6% of U.S. R&D , and that research performed at other nonprofits increased from 3.1% to 4.4% of U.S. R&D.



Year	% U&C/All R&D	% Other Nonprofit/All R&D
1996	12.0	3.1
2009	13.6	4.4

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 institutions may be similar to that done at universities and colleges. Hospitals and Research Institutes often have close ties to

[4] Nonprofit organizations other than universities and federal laboratories

[5] See NSF 01-318, February 15, 2001 by Mary V. Burke "Nonprofit Sector's R&D Grows over Past Quarter Century."

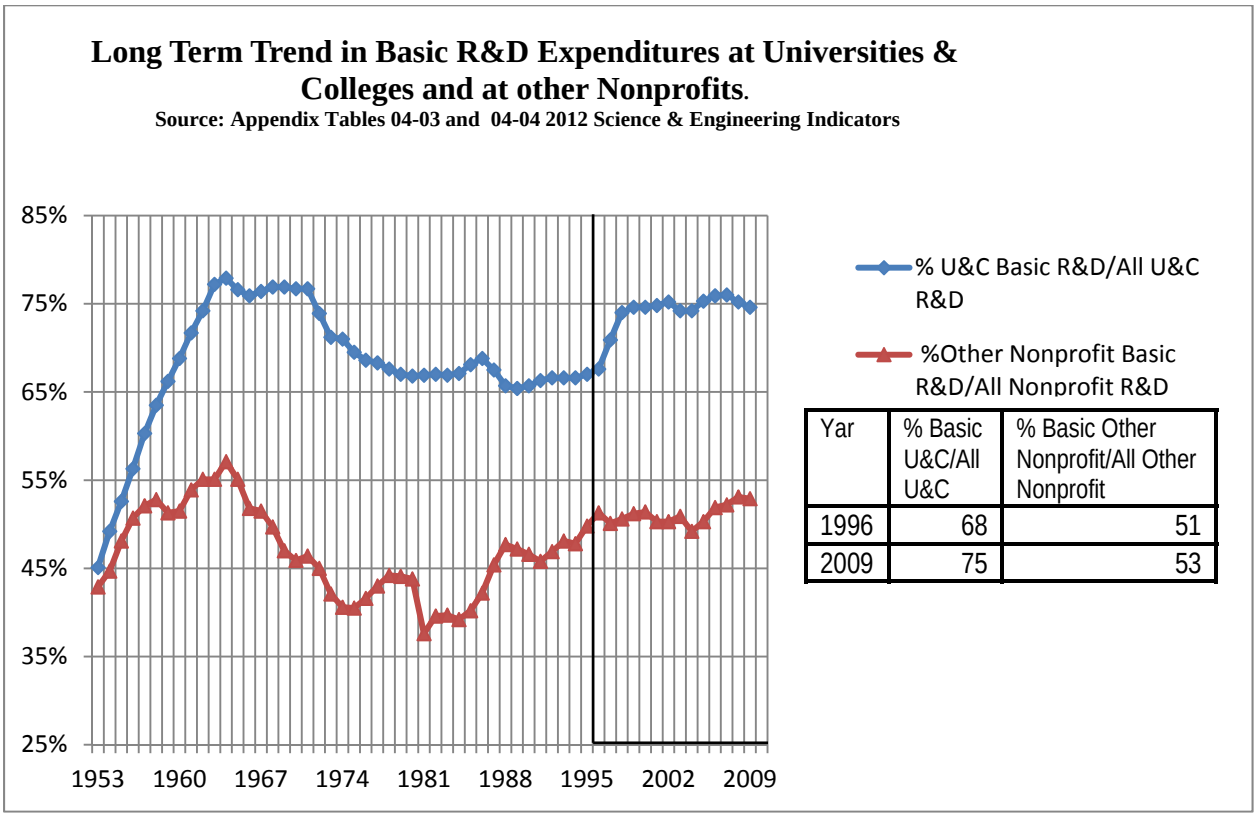
[6] Howard Hughes Medical Institute, Mayo Foundation, SRI International, Memorial Sloan Kettering, Research Triangle Institute, Fred Hutchinson Cancer Research Center , SEMATECH, Inc., Dana-Farber Cancer Institute, Brigham and Women's Hospital, Beth Israel Deaconess Medical Center, Inc.

[7] Mayo, SRI, Sloan Kettering, Fred Hutchinson, and Brigham and Women's Hospital

[8] Mayo, Sloan Kettering, Fred Hutchinson, Dana-Farber Cancer Institute, and Brigham and Women's Hospital, Beth Israel Deaconess Medical Center, Inc,

[9] See Appendix Table 04-03 of 2012 Science & Engineering Indicators.

universities, and share personnel.[10] S&E data show that, over the study period, about three quarters of research expenditures at universities were characterized as basic research expenditures while roughly half of research expenditures at other nonprofits was characterized as a basic research expenditure. [11]



Yar	% Basic U&C/All U&C	% Basic Other Nonprofit/All Other Nonprofit
1996	68	51
2009	75	53

Figure 2.

License Income Received from HRI AUTM Survey respondents over the 15 year period of this report totals $5.47B, approximately 29% of the $18.58B reported by university respondents. Running Royalties reported by HRI AUTM Survey respondents over the 15 year period total $2.27B, approximately 21% of the $13.1B reported by university respondents.

Twenty-six HRI's have responded to the survey in each of 15 years, and 131 to 162 universities responded over the same period. 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.[12] Note that including HRI's also makes this report more heavily weighted toward the economic impact of health technologies, and possibly toward somewhat less basic and more translational research, and could also introduce a bias toward life science and health technology economic impact.

[10] 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.

[11] See Appendix Table 04-04 of 2012 Science & Engineering Indicators.

[12] $5.74B /26~ $221M, versus $18.58B/150~$12.3M

Brief background on economic models based on the national input output accounts:
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.

This section provides definitions and concepts underlying the I-O framework[13] to facilitate understanding 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.

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.

[13] The 1973 Nobel Prize in Economics was awarded "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

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

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[14] of sectors 31-33 "Manufacturing" .

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 statements[15], 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[16]. 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.

[14] The subgroups are: chemical products, plastics and rubber, nonmetallic minerals, fabricated metals, computer and electronics, electrical equipment, transportation equipment, miscellaneous manufacturing and machinery
[15] 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.
[16] 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.

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," $9.4T versus $1.6T). That individuals directly consumed more services ($7.9T) than manufactured goods ($1.7T) in 2007 is another unsurprising observation. The single largest intermediate input to service industries is service (5,030,294) ÷(6,373,425) = 79% , and the single largest intermediate input to manufacturing industries is manufactured commodities (1,609,532) ÷ (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 [3]	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 [5]	**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 non-profits is consumed by persons, and thus is part of GDP. The output of of non-profits is measured as total expenses of the non-profits. 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 non-profits.

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 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 subgroup[17] 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 2005 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.

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

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_{GDP} = (Licensing Income Received in Constant 2005 US Dollars)[18]

B_{GDP} = ((Sales at Licensee[19]) x (Value Added ratio from US I-0 Tables)) x (GDP Deflator to Constant 2005 $US)[20]

Gross Industry Output

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_{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.

$A1_{GO}$ = (Licensing Income Received in Constant 2005 US Dollars)[21]
$A2_{GO}$ = ((Licensing Income Received in Current US Dollars) × (Output Multiplier from U.S. I-O Tables)[22]) x (GDP Deflator to Constant 2005 US$)

B_{GO} = (Sales at Licensee[23])

Employment supported by final purchases associated with academic licensing

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_{YES} = (employment multiplier for academic licensors) x (current License Income Received).

B_{YES} = (employment to output ratio for manufacturing companies) x (Sales at Licensee, calculated using ((Running Royalties[24])÷ (estimated royalty rate))

[18] License Income Received (as reported in the AUTM Survey)
[19] (Running Royalties as Reported in the AUTM Survey) ÷ (Royalty Rate)
[20] The multipliers are applied to current dollar license income. The result is adjusted to constant 2005 US$.
[21] License Income Received (as reported in the AUTM Survey) times a factor which accounts for inflation, and is defined =1 in 2005.
[22] See Appendix B
[23] (Running Royalties as Reported in the AUTM Survey) ÷ (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 report applies no output multiplier to any portion of these sales. This leads to an underestimate.

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. [25] The royalty base itself can be smaller than the commodity sold.[26] These three factors again suggest that using Running Royalties alone underestimates 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" included 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."

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[24] As defined in the AUTM Survey

[25] http://www.sec.gov/Archives/edgar/data/1110803/0001012870-00-001863.txt accessed May 25, 2012

[26] http://www.sec.gov/Archives/edgar/data/1167178/000104746908008964/a2186822zex-10_28.htm#toc_ri44902_1 accessed May 25, 2012.

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."

The model is clearly dependent on the assumed royalty rate. The prior study included this table:

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%

It is difficult to supplement this table with public information. Licensors may be expected to voluntarily publicize higher rates than licensees, and both can be true depending on how the royalty base is defined.

Public information on the royalty that Florida State University received as a result of the Bristol Myers Squibb license to the Holton patents for Taxol synthesis suggests that the rate was approximately 4%. [27] Public material on the Cohen-Boyer patents shows that the rates were under one percent for "end products," and that such products account for the most of $254M in license revenue [28] The paper reports that; "A whopping 90% of the total revenue ($228 million) is from royalty income from product sales."

[27] GAO Report dated June 2003: "NIH-Private Sector Partnership in the Development of Taxol" Footnote 17, page 13.

[28] MaryAnn Feldman, Alessandra Colaianni, and Kang Liu: "Commercializing Cohen-Boyer 1980-1997" DRUID Working Paper No. 05-21accessed April 11 2012

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 Institutions AUTM Survey respondents are in Appendices C and D, respectively. Appendix E is a sum of the impacts estimated in Appendices C and D.

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 producers[29] , ii) the royalty base captures all the relevant 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, and none from service industries, 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.

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

Summing over the 15 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%; the total contribution of this academic licensing, to gross industry output ranges from $199B to $836B, in 2005 $US Dollars and to GDP ranges from $86B to $338B, in 2005 $US 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 900,000 to over 3 million over the 15 year period.

Focusing on the 5% royalty rate column and considering that it captures a blend of conservative and reasonable assumptions: Academic U.S. AUTM member survey respondents' licensing activity contributed $150B to U.S. GDP between 1996 and 2010, supporting 1.5 million person years of employment, and generated $358B in Gross Output.

[29] If all producers are domestic then all sales are domestic even if the buyer takes delivery overseas.

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
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					
	Current Dollar License Income	Current Dollar Running Royalties	Current Dollar License Income	Current Dollar Running Royalties	Value added ratio from U.S. I-O tables[30]	Output multiplier from U.S. I-O tables[31]	Employment multiplier from U.S. I-O tables for Academic Institutions[32]	Employment to output ratio from U.S. I-O tables for Manufacturers (Licensees)[33]	GDP deflator
Year	millions	millions	millions	millions					
1996	$365	$282	$135	$84	0.39	0.71	0.020	0.0048	83.159
1997	$483	$315	$129	$81	0.39	0.71	0.020	0.0048	84.628
1998	$614	$390	$113	$60	0.39	0.71	0.020	0.0048	85.584
1999	$675	$475	$152	$139	0.39	0.69	0.019	0.0046	86.842
2000	$1,100	$559	$132	$111	0.39	0.72	0.018	0.0044	88.723
2001	$868	$637	$171	$131	0.38	0.74	0.018	0.0045	90.727
2002	$998	$787	$259	$151	0.40	0.63	0.017	0.0043	92.196
2003	$1,032	$829	$314	$249	0.40	0.62	0.017	0.0040	94.135
2004	$1,088	$810	$346	$277	0.40	0.59	0.016	0.0037	96.786
2005	$1,775	$856	$346	$278	0.39	0.64	0.015	0.0034	100
2006	$1,512	$969	$653	$198	0.40	0.63	0.015	0.0032	103.231
2007	$2,099	$1,807	$576	$125	0.39	0.64	0.014	0.0030	106.227
2008	$2,397	$1,946	$1,037	$351	0.38	0.69	0.010	0.0029	108.582
2009	$1,782	$1,351	$525	$257	0.42	0.60	0.013	0.0029	109.729
2010	$1,790	$1,092	$587	$276	0.42	0.60	0.013	0.0029	110.992

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

[31] 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)

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

[33] For manufacturers in the subgroup of manufacturers identified previously.

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 *Output Multiplier = 1*, 2% Running Royalties	University Contribution to Gross Output *Output Multiplier = 1*, 5% Running Royalties	University 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	$7,035	$3,078	$1,758	74	34	21	$17,713	$7,536	$4,143
1997	$7,802	$3,463	$2,017	85	40	25	$19,572	$8,414	$4,695
1998	$9,584	$4,264	$2,490	105	49	31	$24,031	$10,349	$5,788
1999	$11,428	$5,038	$2,908	122	56	35	$28,665	$12,255	$6,785
2000	$13,400	$6,104	$3,672	143	69	45	$33,631	$14,731	$8,431
2001	$14,413	$6,339	$3,648	159	73	44	$36,750	$15,702	$8,685
2002	$18,244	$7,947	$4,515	186	85	51	$44,433	$18,833	$10,300
2003	$18,510	$8,062	$4,579	182	83	50	$45,820	$19,392	$10,583
2004	$18,000	$7,875	$4,500	168	78	47	$43,644	$18,532	$10,162
2005	$18,519	$8,473	$5,124	174	86	56	$45,707	$20,028	$11,469
2006	$20,006	$8,881	$5,173	179	85	53	$49,306	$21,158	$11,776
2007	$34,824	$15,115	$8,545	299	137	83	$88,289	$37,258	$20,247
2008	$35,873	$15,674	$8,941	305	136	79	$93,348	$39,578	$21,655
2009	$27,710	$12,059	$6,841	222	103	63	$64,176	$27,233	$14,919
2010	$22,268	$9,875	$5,744	184	88	55	$51,766	$22,258	$12,422
Total	$277,617	$122,245	$70,454	2,586	1,201	739	$686,851	$293,258	$162,060

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	$2,120	$945	$554	23	11	7	$5,311	$2,291	$1,284
1997	$2,022	$901	$527	22	10	6	$5,069	$2,184	$1,223
1998	$1,484	$673	$402	16	8	5	$3,703	$1,616	$921
1999	$3,285	$1,419	$797	35	16	9	$8,282	$3,490	$1,892
2000	$2,558	$1,112	$631	27	12	7	$6,495	$2,752	$1,504
2001	$2,968	$1,300	$744	33	15	9	$7,575	$3,227	$1,778
2002	$3,573	$1,598	$939	37	17	11	$8,644	$3,733	$2,096
2003	$5,567	$2,427	$1,380	55	25	15	$13,778	$5,835	$3,187
2004	$6,129	$2,666	$1,512	57	26	16	$14,883	$6,295	$3,432
2005	$5,775	$2,518	$1,432	53	24	15	$14,444	$6,118	$3,343
2006	$4,425	$2,150	$1,391	42	22	16	$10,629	$4,872	$2,953
2007	$2,821	$1,454	$998	27	16	12	$6,788	$3,248	$2,069
2008	$7,025	$3,383	$2,169	61	30	20	$17,774	$8,078	$4,846
2009	$5,444	$2,465	$1,471	45	22	14	$12,488	$5,455	$3,111
2010	$5,746	$2,616	$1,572	48	24	16	$13,271	$5,817	$3,332
Total	$60,943	$27,625	$16,519	579	279	178	$149,135	$65,012	$36,971

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	$9,155	$4,023	$2,312	97	45	27	$23,024	$9,827	$5,428
1997	$9,824	$4,364	$2,544	107	50	31	$24,640	$10,598	$5,918
1998	$11,068	$4,936	$2,892	122	57	36	$27,734	$11,965	$6,709
1999	$14,713	$6,457	$3,704	156	72	44	$36,948	$15,745	$8,677
2000	$15,957	$7,216	$4,302	169	81	52	$40,127	$17,483	$9,935
2001	$17,381	$7,640	$4,393	192	88	53	$44,326	$18,929	$10,463
2002	$21,817	$9,545	$5,454	223	102	62	$53,077	$22,566	$12,396
2003	$24,077	$10,489	$5,959	237	108	65	$59,598	$25,227	$13,770
2004	$24,128	$10,540	$6,011	225	104	63	$58,527	$24,827	$13,594
2005	$24,295	$10,991	$6,556	227	110	71	$60,151	$26,147	$14,812
2006	$24,431	$11,031	$6,564	220	107	69	$59,935	$26,031	$14,729
2007	$37,645	$16,569	$9,544	325	153	95	$95,077	$40,506	$22,316
2008	$42,898	$19,057	$11,110	366	166	100	$111,121	$47,656	$26,501
2009	$33,154	$14,523	$8,313	267	125	77	$76,664	$32,688	$18,030
2010	$28,015	$12,491	$7,316	232	111	71	$65,037	$28,075	$15,754
Total	$338,560	$149,870	$86,974	3,165	1,480	918	$835,986	$358,270	$199,031