The Economic Impact of the University of Florida's Clinical and Translational Science Institute

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This report summarizes the results to date of an assessment of the economic impact of the University of Florida's (UF) Clinical and Translational Science Institute (CTSI) conducted by the Economic Analysis Program of the Bureau of Economic and Business Research at UF and funded by the CTSI. While the analysis represents the best professional judgment of the authors, it does not necessarily represent the views of the CTSI or UF.

Executive Summary

The mission of the Clinical and Translational Science Institute (CTSI) at the University of Florida (UF) is to improve human health by accelerating the translation of scientific discoveries into practical applications and practices for the diagnosis, treatment, prevention and cure of human diseases. The activities of the CTSI span many departments and continue to expand. The number of investigators associated with the CTSI grew from 49 in 2009 to 711 in 2012. This report, prepared by UF's Bureau of Economic and Business Research (BEBR) addresses the impact of the CTSI on research productivity and regional economic activity.

Productivity Impact

BEBR compared the records of CTSI investigators before and after their association with CTSI on external funding, patent filings, and the number and quality of publications, controlling for annual shocks to the productivity of all UF researchers and shifts in the average productivity of each academic unit. The following are the main findings of that analysis:

- Status as a CTSI investigator is associated with a 310% increase in external funding.
- Patent filings increase 38% following association with the CTSI.
- Publications in top 100 journals increase 41% following association with the CTSI, with no change in total publications.

Whether these findings arise from activities of the CTSI that enhance productivity, the tendency of investigators pursuing larger grants or working on more important problems to be more likely to need resources and services provided by the CTSI, or a combination of the two, the magnitude of these productivity increases indicate a strong return on the investment in the CTSI.

Regional Economic Impact

Regional economic impact studies typically apply multipliers to an initial expenditure to calculate the total amount of regional economic activity related to the initial expenditure. The analysis reported here also accounts for the impact of external funding attracted by investigators related to their association with the CTSI. The main results are as follows (dollar amounts are in constant 2012 4th quarter dollars):

- On average, $1 of the CTSI's operating expenditure supported $11 in additional external funding, so $41 million in CTSI expenditures supported a $462 million increase in external funding.
- On average, $1 million in CTSI operating funding supports 122 jobs in Alachua County and 203 in Florida.
- CTSI's operations supported 5,012 person years of employment in Alachua County and 8,351 in Florida over the 2008 through 2012 grant years.
- CTSI's operations supported $807 million in economic activity in Alachua County and $1,108 million in Florida over the 2008 through 2012 grant years.

Introduction

In 2009, the University of Florida (UF) received a $26 million Clinical and Translational Science Award from the National Institutes of Health. The purpose of the award is to help UF's Clinical and Translational Science Institute (CTSI), founded in 2008, in its mission to improve human health by accelerating the translation of scientific discoveries into practical applications and practices for the diagnosis, treatment, prevention and cure of human diseases. The activities of the CTSI are diverse and extensive, spanning many departments. From 2009 to 2012, the number of investigators associated with the CTSI grew from 49 to 711. In 2013 the CTSI will move into a new facility on the UF campus.

The CTSI engaged UF's Bureau of Economic and Business Research (BEBR) to prepare an analysis of CTSI's economic impacts. These impacts can be divided into three areas: 1) the effect of CTSI's activities on research productivity; 2) the impact of expenditures associated with CTSI on the level and pattern of regional economic activity; and 3) the health cost savings and other benefits associated with the outcomes of research directly or indirectly supported by the CTSI. This report addresses the first two areas.

Research Productivity

The CTSI engages in many activities that enhance the efficiency of health research and translational science across the university and beyond. The following are examples:

- The Regulatory Knowledge and Research Support Program helps investigators improve the efficiency and timeliness of research protocol submissions.
- The Biomedical Informatics Program is implementing an integrated data repository (IDR) combining data from clinical practice and the research enterprise. Through the Consent2Share initiative, patients can consent to be contacted about future health research studies for which they might be eligible and/or to allow UF to store tissue leftover from their health-care visits for future use in research. Data and tissue samples from this initiative are securely managed and made available to researchers through the IDR and CTSI Biorepository.
- The Pilot and Collaborative Projects Program provides seed money to promote research deemed to have a potentially high near-future impact.
- The Community Engagement and Research Program builds relationships with community partners, and identifies and optimizes opportunities for individuals to participate in UF research studies.
- One of the core goals of the Tracking and Evaluation Program is to "help each program utilize its data in a way that integrates its performance with other elements of the CTSI to enhance its performance beyond a simple sum of parts."

Initiatives such as these capitalize on opportunities for economies of scale or scope (e.g. utilizing resources more intensively, creating positive network effects, or realizing synergies from coordinating related activities). Measuring the extent of such efficiencies directly would require extremely detailed data from the time period before CTSI was established through the present, which is not available. However, evidence of CTSI's association with increased productivity may be clearly seen in three traditional measures of the productivity of research universities: external funding, patent filings, and publications.

Data on external funding awards to UF Principal Investigators (PI) is taken from a database maintained by UF's Division of Sponsored Research. UF's Office of Technology Licensing provided data on patent filings—associated with the researcher whose name appears first on the filing. Data on publications was extracted from VIVO. Data on the academic units and hiring and termination dates of UF investigators was provided by UF Enterprise Systems. The data span all academic units. For external funding and patent filings the analysis focuses on researchers employed continuously at UF over the 2005-2012 grant years. For external funding the analysis focuses on PIs with at least one award of $10,000 or more during the 2005-2008 grant years. For patents, the analysis focuses on researchers with at least one filing in the 2005-2008 grant years. Publications data is available only for 2008 through 2012 and all continuously employed researchers whose name appears in the list of authors for a publication listed in VIVO at any time during that period are included.

Table 1 summarizes the results of the analyses. In the case of external funding, results are reported for total external funding and for Federal funding not associated with the American Reinvestment and Recovery Act (ARRA). The panel in the middle of the table reports average annual values for employees in the Health Sciences Center (HSC) by CTSI investigator status for 2009-2012. A given investigator is counted as non-CTSI before their first appearance on the CTSI investigator roster and as a CTSI investigator after that time. CTSI investigators received average annual awards of $506,562, compared to $342,026 for other HSC researchers. Focusing on Federal Non-ARRA funding, the figures are $268,783 and $144,393, respectively.

Table 1: CTSI, External Funding, Patent Filings, and Publications

Productivity Measure		2009-12 HSC Researcher Annual Average[a] Non-CTSI	CTSI	CTSI Effect[b]	*p*[c]
External Funding	Total	342,026	506,562	4.10	<0.001
	Fed Non ARRA	144,393	268,783	2.71	0.021
Patent Filings		0.719	1.277	1.38	0.034
Publications	Total	1.866	4.001	-0.02	0.448
	Top 100	0.048	0.181	1.41	0.025

[a] Researchers are identified as a CTSI investigator when first listed on the CTSI roster and every year thereafter.
[b] The CTSI effect is expressed as the ratio of the predicted value for an individual researcher if associated with the CTSI relative to the value predicted for the same individual if not.
[c] *p*-value for a two-tailed test of the null hypothesis of no effect.

So far, this only shows that researchers who are associated with CTSI bring in more funding in an average year than those who are not—it says nothing about whether becoming associated with CTSI is associated with an increase in external funding. To address that question a regression analysis is employed that focuses on the change in productivity for individual researchers following their association with CTSI, as opposed to the difference in external funding between CTSI and non-CTSI researchers. The analysis controls for academic unit specific productivity differentials between the period before the 2009 grant year and the period after. This is to prevent a change in productivity for a particular academic unit that happened to coincide with the founding of the CTSI from being confounded with a CTSI effect.[1] What is

[1] A Tobit regression with conditional investigator fixed effects is used—specifically the pantob routine for STATA available from Honoré at http://www.princeton.edu/~honore/stata/. The dependent variable is the log of the total

labeled the "CTSI Effect" in Table 1 is the result of this analysis. Expected annual total external funding for a given researcher is 310% higher after association with CTSI (p<0.001). Expected annual Federal Non-ARRA funding is 171% higher (p=0.021). Effects on both ARRA funding and nonfederal funding are also strong and statistically significant, but smaller than the effect for all funding. Focusing on only one type of funding at a time apparently leads to something akin to simple attenuation. Even if CTSI status is associated with higher productivity for all award types, CTSI investigators may be unlikely to receive more of all three types in any given year due to capacity constraints on investigator time. Analyzing any individual award type thus reveals a smaller effect than focusing on the total, meaning the estimate for total funding is the more accurate reflection of the productivity differential.

From 2009 to 2012 HSC CTSI investigators were listed first on 1.277 patents annually on average, compared to 0.719 for those not associated with CTSI. This does not address the question of whether researchers become more productive after their association with CTSI. To examine that question, an analysis mirroring the one conducted for external funding was performed. The results of this analysis show CTSI investigator status is associated with 38% higher expected patent filings (p=0.034) than for the same researcher absent such status.[2]

Table 1 also lists results for publications in total and in the top 100 journals ranked by impact factor. From 2009 through 2012, HSC CTSI investigators names appeared in the author list of 4.001 publications per year on average, compared to 1.866 for those not associated with CTSI. For top 100 publications, the numbers are 0.181 and 0.048. While publications in top 100 journals are rare, the advantage for CTSI investigators is nearly twice as large for top 100 publications as for all publications. To address whether CTSI status is associated with an increase in productivity, as opposed to the simple association between CTSI status and average productivity, regression analyses mirroring those used for external funding and patents were used.[3] CTSI status was not associated with the overall publication count. However, focusing on publications in top 100 journals (which results in a smaller sample as those who never published in such a journal are excluded) reveals a 41% increase associated with CTSI status (p=0.25). The results are nearly identical if the top 100 journals in the natural science rankings and the top 100 in the social science rankings are used instead of just the top 100 journals overall, though the slightly larger sample yields slightly greater statistical significance. This pattern indicates researchers do not publish more or less prolifically overall when they become associated with CTSI, but their publications are more likely to appear in journals with higher impact factors.

Taken altogether, the evidence summarized in Table 1 indicates CTSI researchers are more productive on average and that their productivity increases relative to what would have been otherwise expected following their initial association with CTSI, at least as measured by the traditional metrics of external funding, patent filings, and publications. These findings are extremely robust to alternative empirical specifications.[4] This association may reflect that CTSI

award, and control variables include year specific indicator variables and indicator variables for each academic unit in the post 2008 grant year period.

[2] Rather than Tobit regression, a negative binomial regression was used to accommodate the count nature of the data. The dependent variable is the number of patents filed. Over-dispersion of patent filings indicated negative binomial regression to be a better approach than Poisson regression.

[3] Again, negative binomial regression is used to account for the fact that the dependent variables, the counts of total publications and top 100 publications, are counts and exhibit over dispersion.

[4] Alternatives ran as robustness checks include: running OLS versions of the regressions; running versions excluding observations above the 90th percentile, the 95th percentile, and the 99th percentile; running the Tobit regression with

directly enhances productivity, that CTSI provides services needed and valued by researchers whose productivity is increasing, or some combination of the two.

Regional Economic Activity

Expenditures associated with the CTSI impact the level and pattern of economic activity in the Gainesville area (taken as Alachua County) and in Florida more broadly. The simplest and most common way to analyze the impact of a given expenditure on economic activity within a region is with a multiplier analysis based on an input-output (I-O) model. BEBR used RIMS II (Regional Input-Output Modeling System) multipliers from the U.S. Bureau of Economic Analysis. Multipliers are available for Gross Output, Value Added, Earnings, and Employment. Gross output refers to the total value of economic activity within the region. Value added is gross output less the cost of intermediate goods, or the increase in regional gross domestic product. To estimate the impact of a given expenditure on final demand, the total expenditure is allocated across industries according to how it was or will be spent, industry level expenditures are multiplied by industry specific multipliers, and then the resulting products are summed.[5]

To aid with the interpretation of the multipliers, consider the employment multiplier and suppose half of expenditures in industries in the economic base—those that produce things for sale or consumption outside the local region—are on wages and salaries and the other half on materials, supplies, space, labor costs other than wages and salaries, etc. This is approximately true of the CTSI's expenditures and also more generally. Further suppose the salary for the typical job created is $50,000—slightly above the average earnings per non-farm wage and salary job in Florida. Then $1 million in expenditure means $500,000 in expenditure on wages and salaries, supporting 10 jobs. Finally, suppose one service worker (for example physicians, construction contractors, retail clerks, food service workers, etc.) on average provides the local goods and services needed to support three workers—two in the economic base and themselves. Then 10 workers in the economic base create a demand for an additional 5 workers in local service industries. The employment multiplier would be 15 jobs per $1 million of expenditure. While this is a rough illustration with round numbers to make it easier to follow, hopefully it serves to make the logic of the multipliers easy to follow.

The results provide an estimate of the increase in final demand in the region created by the initial expenditure. Such results are useful in assessing the importance of a given firm, industry, expenditure, or event to a regional economy. In particular, they indicate the size of the hole that would be left in a regional economy were the firm, industry, or event removed. These models were largely developed with this type of planning purpose in mind—e.g. assessing the near term local impact of a military base closure. Further interpretation of the results is complex and depends on many factors outside the model and beyond the scope of a typical input-output multiplier analysis. This is best illustrated with an example. Consider an exogenous expenditure resulting in an increase in labor demand equivalent to 1,000 jobs. If there are enough suitable unemployed workers in the region, the demand may be filled largely by putting them to work. If there are few suitable unemployed workers in the region, but many in other regions that are free

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alternative cut points and for the award amount not transformed to its natural log; and running Poisson versions of the patent and publications regressions.

[5] The multipliers are derived from the national input-output accounts for 62 aggregate and 406 detailed industries and reflect the direct, indirect, and induced impact of a dollar of exogenous spending on demand within the region. More detail is in the user's guide available at http://www.bea.gov/regional/pdf/rims/RIMSII_User_Guide.pdf.

to move, the demand may be met largely by in-migration and additional commuting from nearby areas. If the regional economy and the national economy are at more or less full employment, the demand will put upward pressure on regional wages and prices until the demand for workers from other sources is reduced by 1,000, freeing up the workers needed to fill this new demand (referred to as crowding out), whether they were initially in the region or move to it as a result.

Operating Expenditures

CTSI's quarterly operating expenditures from 2008 through 2012 were obtained for 86 spending categories used by UF's Office of Finance and Accounting. All expenditures were adjusted to Q4 2012 dollars using the Bureau of Labor Statistics' (BLS) Consumer Price Index (CPI). Expenditures in each of these 86 categories were then matched to industry specific multipliers according to which industry each category best fit. In some cases, a category was allocated across several industries. Relevant summary information for multipliers is provided in Table 2. For purposes of illustration, expenditure categories are aggregated into seven broad categories. Spending reflects actual expenditures cumulative through the third quarter of the 2012 grant year (December 2012) adjusted to constant 2012 4th quarter dollars. Weighted average multipliers for all four economic measures for both Alachua County (AL) and Florida (FL) are shown in the remainder of the table. To aggregate the multipliers from the many industry categories to the summary categories, each industry specific multiplier is weighted by its share of the total category expenditures.

Multipliers for Gross Output, Earnings, and Value Added indicate the final dollar value change resulting from a one dollar spending increase. Employment multipliers are the number of full time equivalent jobs created per one million dollars of expenditure. Multipliers for Florida are larger than those for Alachua because a larger share of CTSI expenditure occurs within the entire state of Florida than occurs within Alachua County. To illustrate the nature of the analysis, $1 million spent on Salaries and Wages supports $1.82 million of gross output and 7.66 jobs in Alachua County and $2.28 million of gross output in the state of Florida along with 12.36 jobs. Given the overall pattern of expenditures, a typical $1 million of CTSI expenditure supports $1.70 million of gross output and 9.24 jobs in Alachua County and $2.23 million of gross output in the state of Florida along with 15.09 jobs.

Table 2: Expenditures and Weighted Average Multipliers by Broad Expenditure Category

Expenditure Category	Spending[a]	Weighted Average Multipliers: Gross Output[b] AL	Gross Output[b] FL	Earnings[b] AL	Earnings[b] FL	Value Added[b] AL	Value Added[b] FL	Employment[c] AL	Employment[c] FL
Salaries & Wages	19.51	1.82	2.28	1.18	1.35	1.50	1.77	7.66	12.36
Contractual Expenses	10.15	1.60	2.20	0.53	0.79	0.95	1.32	10.26	16.94
Supplies, Repair & Maintenance	1.09	1.37	1.98	0.35	0.65	0.70	1.17	6.99	14.05
Sponsored Research & Travel	1.10	1.59	2.18	0.51	0.77	0.95	1.31	11.28	18.14
Capital Asset Purchases	1.25	1.37	1.83	0.29	0.50	0.71	0.98	7.09	12.12
Facilities and Administration	3.73	1.60	2.27	0.57	0.88	1.00	1.42	14.31	23.01
Other	1.21	1.56	2.14	0.45	0.72	0.89	1.25	12.83	20.49
Average CTSI Expenditure	38.05	1.70	2.23	0.85	1.07	1.22	1.54	9.24	15.09
Additional External Funding[d]	420.96	1.61	2.22	0.53	0.80	0.95	1.32	10.09	16.83

[a] Spending is actual spending through the third quarter of the 2012 grant year (December 2012) in constant 2012 4th quarter dollars. Accordingly, the totals do not match those in Table 3, for which a projection for the fourth quarter of the 2012 grant year has been added.

[b] Multipliers for Gross Output, Earnings, and Value added indicate the final per $1 change in initial spending.

[c] Employment multipliers are person years of employment created by an initial $1 million expenditure

[d] To match CTSI expenditures, additional external funding is actual funding through the third quarter of the 2012 grant year (December 2012) in constant 2012 4th quarter dollars. Accordingly, the totals do not match those in Table 3, for which a projection for the fourth quarter of the 2012 grant year has been added.

To evaluate the economic impact of CTSI on the regional economy, an appropriate portion of the external funding attracted by CTSI investigators should also be included. It was shown above that status as a CTSI investigator is associated with a 310% increase in external funding. That implies approximately three quarters of the external funding attracted by CTSI investigators should be included—after removing any external funding already accounted for in CTSI expenditures.[6] Lacking a detailed breakdown of how this money is spent, the multipliers for the Scientific Research and Development Services industry are applied. An alternative method for conducting this analysis would have been to apply these multipliers to CTSI expenditures as well, rather than matching components of CTSI expenditures to the specific industries in which they were spent. Comparing the multipliers for Additional External Funding and CTSI Expenditures shows the approaches would yield similar results. However, breaking expenditures down in detail provides a more accurate estimate of the regional economic impact.

Table 3 presents estimates of the regional economic impact of CTSI's ongoing activities. CTSI expenditures, the addition to external funding, and total spending (the sum of CTSI expenditures and additional external funding) showed strong growth over time. Employment by year is in FTE jobs. Total employment is in job years—so one person employed five years or five people employed one year both count as five person-years of employment. The $41 million of CTSI expenditure supported $503 million in total expenditures once increased external funding is accounted for. This in turn supported $807 million in total economic activity and 5,012 person years of employment in Alachua County and $1,108 million of economic activity and 8,351 person years of employment in Florida.

[6] Funding for establishing and operating the CTSI was removed from the data for the productivity analysis report in the previous section as well. The portion of remaining funding associated with CTSI is then 3.1/4.1, or 75.6%.

Table 3: Impact of UF's CTSI on the Level and Pattern Regional Economic Activity

		Grant Year						
		2008	2009	2010	2011	2012[b]	Total[b]	Total / CTSI Exp
CTSI Expenditures		5.3	7.8	8.2	9.9	9.9	41.1	
Additional External Funding		0.0	26.3	125.6	145.0	165.1	461.9	11.3
Total Spending		5.3	34.1	133.8	154.9	175.0	503.0	12.3
Earnings[a]	Alachua	4.6	20.6	73.8	85.3	93.6	277.9	6.8
	Florida	5.7	29.4	108.9	125.9	138.9	408.8	10.0
Value Added[a]	Alachua	6.5	34.5	129.3	149.5	165.1	485.1	11.8
	Florida	8.2	46.9	178.7	206.7	228.8	669.2	16.3
Gross Output[a]	Alachua	9.0	55.5	215.8	249.6	277.0	807.0	19.7
	Florida	11.7	75.6	296.6	343.0	381.1	1,108.0	27.0
Employment[a]	Alachua	46.9	338.0	1,343.6	1,552.9	1,730.3	5,011.7	122.1
	Florida	76.7	561.6	2,239.1	2,588.6	2,884.5	8,350.5	203.4

[a] Dollar values are in millions of constant 2012 4th quarter dollars and employment is in person years.

[b] Data on CTSI expenditures and external funding was available only through the third quarter of the 2012 grant year. Expenditures and external funding are projected for the fourth quarter of 2012 using the average of the ratio of the annual total to the total of the first three quarters for 2009, 2010, and 2011. As a result, the totals do not match the totals through the third quarter of the 2012 grant year in Table 2.

The last column of Table 3 divides the totals by CTSI expenditures. Each dollar of CTSI spending is associated with $12 of total funding, or each dollar of base funding is leveraged to raise an additional $11. Each $10,000 of base funding supports $68,000 of local earnings and $100,000 in earnings in Florida. Each million dollars of annual base CTSI funding supports 122 jobs in Alachua County and 203 in Florida. The large magnitude of these regional economic impacts is driven by the large increase in external funding associated with CTSI—that is, by higher productivity of the faculty and staff related to status as CTSI investigators.

Construction Expenditures

Construction projects were undertaken on the UF main campus and at Lake Nona to provide office space for CTSI employees. The most important difference between the regional economic impact of operating and construction expenditures is that the construction impact is a one-time impact rather than a recurring impact. As of the end of fiscal year 2011-2012, UF's construction commitments supported an estimated 2,069 jobs in Alachua and 3,559 jobs in Florida—each amounting to roughly 60% and 1% of the respective regions' total construction employment. In the same year, the two buildings in which CTSI would ultimately occupy space accounted for nearly 53% of UF's outstanding construction commitments, although neither of these facilities will be entirely occupied by CTSI.

Table 4 shows the economic activity generated by construction spending for space intended for CTSI occupancy for two methods. The detailed method involves breaking expenditures into categories which can be matched to multipliers for detailed industries, as was done for the analysis of operating expenditures. The aggregated method involves simply taking the product of the total amount spent on behalf of CTSI and the multiplier for the aggregate construction industry. The aggregated method generates a larger impact in every case. This is because the detailed method uncovered leakages from the region not captured in the less refined

approach, providing a more accurate estimate. The difference between the two methods is proportionally smaller for Florida as there are fewer leakages from the larger region.

Table 4: Construction Impact (Millions of 2012 4th Quarter Dollars)

		Facility					
		CTRB		Lake Nona		Total	
		Aggregate	Detailed	Aggregate	Detailed	Aggregate	Detailed
Expenditures		29.8	29.8	3.2	3.2	33.0	33.0
Earnings	Alachua	12.6	6.8	0	0	12.6	6.8
	Florida	21.7	16.6	2.4	2.1	24.1	18.7
Value Added	Alachua	24.9	14.7	0	0	24.9	14.7
	Florida	35.4	30.3	3.8	3.7	39.2	34.0
Gross Output	Alachua	46.6	38.7	0	0	46.6	38.7
	Florida	64.3	58.1	7.0	6.7	71.3	64.8
Employment	Alachua	338	174	0	0	338	174
	Florida	581	418	63	55	644	473

Conclusion

The expenditures of the CTSI and associated increases in external funding support a large volume of employment and economic activity. The additional multiplier effect arising from the leveraging of $1 of CTSI operating expenditures to bring in an additional $11 of external funding essentially increases the multipliers for employment and economic activity by a factor of 12. This means each dollar invested in the CTSI supports many times more employment and economic activity than the typical dollar of funding originating from outside the region—12 times as much, but for modest differences in the multipliers resulting from differences in expenditure patterns. One million dollars of CTSI operating funding supports 122 person years of employment in Alachua County and 203 in Florida.

The findings regarding productivity demonstrate the return on the investment in the CTSI is high. Whether the reported findings arise from activities of the CTSI that enhance productivity, the tendency of those investigators going after larger grants or working on more important problems to be more likely to need resources and services provided by the CTSI, or some combination of the two, the magnitude of the productivity differentials are large. Moreover, it is possible that as the CTSI matures, its impact on productivity may grow further. The ultimate return on investment will be realized over the longer run in improved quality of healthcare delivery and health cost savings—but the initial results regarding research productivity are very promising.