The Economic Impact of Bioscience Connecticut

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CONNECTICUT CENTER OF ECONOMIC ANALYSIS

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What Bioscience Connecticut Achieves:

Bioscience Connecticut accelerates the build-out of the foundation for continuing economic development and job growth, creating, attracting, and expanding biomedical and bioscience firms; in contrast PA10-104, while addressing effectively the essential challenges of UCHC, focused on expanding clinical services, an approach whose economic benefits would plateau after full implementation. The list below enumerates the core benefits of Bioscience Connecticut:

- Delivers significant new tax revenues to the state as a result of the construction, subsequent operation of the University of Connecticut Health Center and John Dempsey Hospital and commercialization of intellectual property (IP) from Bioscience Connecticut. Over the twenty years (2018 to 2037) following completion of construction, Bioscience Connecticut will yield the state gross revenues equivalent to $916M (Fixed 2008$), after subtracting additional state expenditures, the result is $823M in net new revenues (based on a discount of future revenue in 2017 at 5%). That $823M return from implementing Bioscience Connecticut entirely covers the $592M in state financing for this investment—and thus delivers a net fiscal bonus of $231M during the bonding period and another $142M during construction, a total of $373M in revenue over and above the full costs of implementation. As part of the economic modeling, the start-up costs of $281M have been offset by the state raising funds from other sources.
- Driven first by construction and coincident operational expansion from 2011 to 2018, Bioscience Connecticut quickly generates 3,100 direct, indirect, and induced jobs annually in 2013 and 2014. Over the 2011-2018 timeframe, this initiative will deliver in aggregate 18,300 jobs.[1] This short-term impact is of special importance given the current unemployment in the state. After completion of construction, net new permanent jobs above the base case steadily rise from 2,170 in 2019 to 16,400 in 2037. This initiative responds effectively to emerging public healthcare challenges which result from Connecticut's aging population and retirement of medical practitioners from the baby boom era while stimulating economic growth flowing from innovation and invention in the biosciences.
- Bioscience Connecticut is particularly valuable because it delivers good-paying jobs, raising Connecticut's annual personal income steadily, up $4.6 billion (current dollars) in 2037.
- Net of personal taxes, Connecticut's households coincidentally enjoy $3.7 billion more in disposable income that is most valuable as it delivers freedom of choice for the state's citizens.
- Bioscience Connecticut builds a powerful foundation for establishing a bioscience industry cluster, fueled by new firms and external investments; it will be a powerful magnet to retain and attract firms.
- The projection of payoffs from implementation of Bioscience Connecticut excludes significant additional benefits, in particular, those of better health care for Connecticut's citizens. Combined with the additional biomedical and biotech potential resulting from partnering with other Connecticut hospitals to expand financially rewarding clinical trials (a main operating driver underpinning the PA10-104 investment), Bioscience Connecticut dramatically outperforms the PA10-104 stand alone investment in job creation and revenue generation.

[1] This reference is to the cumulative number of jobs in those years.

Bioscience Connecticut for Connecticut Bio-Health Care: The Economic Impacts

Introduction

This economic analysis demonstrates the substantial benefits Connecticut enjoys from implementing Bioscience Connecticut; these benefits flow from construction, subsequent operations, and the generation and transfer of Intellectual Property (IP) to Connecticut start-ups and existing companies over the eight years of construction and initial twenty years of operations. The analysis covers: design and construction, recruitment of new personnel, expansion of research and development (R&D), establishment and expansion of stage one through to stage four clinical trials, expansions in both medical and dentistry enrollments resulting in establishment of practices by these new Connecticut graduates, and the economic impacts of spin-offs and transfers arising from the incremental biotechnology scientific base. In this manner, the analysis captures the impacts from fifty additional, higher-earning med-surgical beds, of which ten are net gains in beds to John Dempsey Hospital (JDH), after transferring forty neo-natal beds to the Children's Hospital. This study also captures future revenues that will flow from expanded clinical trials and intellectual capital in biomedicine and bioscience the new clinical and research staff create, independent of additional industry spin-offs.

This study conservatively attributes new research productivity only to new staff. As a result, the overall analysis underestimates both the role existing faculty will play through their participation on new innovative research teams and in collaborative efforts with other regional biotech entities. Research productivity and thus licensing has strong linkages to the size of the research team. As the number of researchers expands, synergistic/network opportunities among team members increase exponentially, not linearly.[2] No account is taken of this dynamic.

Other than benefits flowing from direct transfers of IP, this analysis does not include the impact that expanded research productivity will have on creating, retaining, and attracting biomedical firms to the region. While developmental expenditures of the UConn Health Network are included under PA10-104 and in this study, this analysis is limited to the activities at UCHC's campus envisioned in Bioscience Connecticut and related commercial opportunities based on IP transfers, discussed in detail later. Finally, this study does not incorporate amenity benefits such as the enhanced delivery of medical services and improved health benefits flowing from research-based innovations. Excluding these benefits from the analysis—benefits historical experience clearly reveals this initiative will generate but ones which are difficult to quantify before the fact—clearly results in a significant understatement of the total benefits that the citizens of the state will enjoy in terms of health, new jobs, rising incomes, economic growth, and new tax revenues.[3]

It is useful for policy makers, stakeholders, and others interested in evaluating Bioscience Connecticut to see how its economic impacts differ from those the project Governor Rell initiated and PA10-104

[2] Pressman, L., Guterman, S., Abrams, I., Geist D., and L. Nelsen. 1995. "Pre-Production Investment and Jobs Induced by MIT Exclusive Patent Licenses: A Preliminary Model to Measure the Economic Impact of University Licensing." *Journal of the Association of University Technology Managers*, 7: 77-90. Steve Johnson, *Where Good Ideas Come From: The Natural History of Innovation* (Penguin, 2010), offers a broader discussion of this phenomenon.

[3] For further details on these benefits see: Families USA Foundation, *In Your Own Backyard: How NIH Funding Helps Your State's Economy 2008*.

incorporated; Table 1 below summarizes those differences. The comparison holds constant all basic assumptions and analytical techniques, based on the REMI dynamic model of the state's economy and CCEA's algorithm for state fiscal analysis. The numbers reported here differ from those Governor Rell announced in her initiative. The enacted legislation eliminated some major components and added new elements that were not included in the proposal that CCEA analyzed at the request of University of Connecticut President Hogan, an analysis from which the Governor drew her impact numbers. For the comparison in this assessment, CCEA re-evaluated PA10-104 to prepare an analysis that is strictly comparable with the elements of Bioscience Connecticut.

Table 1: Stimulus Biosciences Connecticut in Contrast to the PA10-104 Investment

Stimulus	**Bioscience Connecticut**	**PA10-104**	**Advantages of Bioscience Connecticut**
Investment	$864M: Start-up costs for attracting faculty included & offset by tax revenues	$365M	2015: major construction completed 2018: renovations completed. Bioscience Connecticut stimulates construction at a critical time for Connecticut's economy
Research	Key to future intellectual property revenues	Related only to clinical trials	Opportunity to build synergistic, well-managed R&D teams to upgrade the status of the program and quality of graduates.
Beds	50, net gain of 10 after transferring 40 the Children's	50, net gain of 10 after transfer of 40 to Children's Hospital	No change: strengthens the clinical base for both instruction and research
New Revenues from Patents	$194 M by 2036	0	Bioscience Connecticut catalyzes intellectual property growth and revenues
Expanded Medical School Class heavily recruited from Connecticut	Medicine: 12 in 2014 and 25 thereafter above current levels for 4 years	5 starting in 2017 + hiring to expand Stage 3 & 4 trials	Redresses critical shortages resulting from an aging general population and aging of current practitioners
Expanded Dental School Class	Dental: 6 in 2014 and 12 thereafter above current levels for 4 years	0	Redress critical shortages arising from the aging general population and aging of current practitioners
Direct New Employment on Campus	683 by 2017 including 50 clinicians, 40 clinician-scientists, and 10 eminent researchers, plus additional research assistants and healthcare staff	50 new clinicians + support staff a year 2017 to 2020	Bioscience Connecticut expands faculty to strength educational programs and research initiatives to create a biomedical and bioscience cluster catalyst. Hospital personnel capped at 350 in both cases while an additional 233 are included to staff the new Ambulatory Care Center within Bioscience Connecticut.
Staffing of Graduate's Offices	60% expected to stay in Connecticut due to higher shares recruited in state, expanded opportunities, and financial incentives	50% expected to stay due to lack of opportunities for the School to retain them	Redress critical shortages arising from an aging general population and aging of current practitioners by recruiting from Connecticut, expanding classes, increasing incentives to stay, and providing continuous life-long learning
Spin-offs	Eight for every 100 commercially successful patents	Excluded	Leads to 15 new startups by 2037 with initial average staffs on average doubling every four years from the time of the IP transfer.
Transfers of IP to extant CT firms	16 for every 100 commercially successful patents	Excluded	Leads to 31 IP transfers by 2037, with initial average staffs on average doubling every four years from the time of the IP transfer.

Table 2: Impact of Biosciences Connecticut in Contrast to the PA10-104 Investment

Impacts	**Bioscience Connecticut**	**PA10-104**	**Advantages of Bioscience Connecticut**
Incremental Direct, Indirect and Induced Jobs During Construction	2011-2018: 18,300 2013 & 2014: 3,100 annually	2012 up 410 2014 up 1,070	Bioscience Connecticut puts more people back to work sooner in greater numbers than PA10-104 investment: both cases exclude collaborative clinical trials.
Incremental Direct, Indirect and Induced Jobs During Operation	Grows from 2,200 in 2019 to 16,400 in 2037	Maximum of 2,400 in 2037	Bioscience Connecticut puts Connecticut back at work sooner in greater numbers than the PA10-104. Critically, Bioscience Connecticut does not plateau, but generates sustained job growth.
Personal Income (Current Million $)	2012 up $89 2014 up $216 2037 up $4,582	2012 up $30 2015 up $ 76 2037 up $730	Bioscience Connecticut generates more and higher incomes than PA10-104, aside from staffing up for and undertaking medical trials.
Fiscal Considerations (M $	Bonding sought: $592 Generated by Const 142 Net bonding $ 450 NPV 20 yr Surplus $823 NPV[1] UConn NPV Patent Revenues $ 246 NPV Mark-up on medical trials $218	$265 $053 $212 $251 0 $218	Bioscience Connecticut bonding being sought from state is $592M, of which $338M received prior approval. There are four offsetting revenue sources: State surpluses arising from the construction and initial hiring phase to 2018 ($142M), the NPV generated by the project without considering NPV of UConn's share of patent revenues ($823 M) and UConn's share of patent revenues net of administration ($246M) and mark-ups on medical trials ($218M).

Notes: 1. NPV stands for Net Present Value.

This comparison looks only at the differential impacts of PA10-104 activities and Bioscience Connecticut at the UCHC campus. PA10-104 also adjusts for the expansion of the medical school enrolment by only 5 students a year for four years, as the original modeling done for PA10-104 assumed enrolment growth of 20 per year. Bioscience Connecticut's shift in emphasis at the UCHC campus to focus on commercially successful R&D offers significantly more benefits to Connecticut at all levels – citizens' health, job creation, innovation prospects, biomedical opportunities, and fiscal soundness—compared with those offered by PA10-104. The itemization below lays out the strategic differences and impacts between Bioscience Connecticut and PA10-104. (Appendix A lists the assumptions on which CCEA developed the analysis):

1. Net of operating support investment, excluded from PA10-104, total Investment in Bioscience Connecticut is $864M, covering construction of new facilities, inclusive of a hospital tower and ambulatory center and the original PA10-104 remodeling of older research facilities, plus implementation of the UConn Health Initiative; [4] this contrasts to $365M in the PA10-104 Investment;
2. Bioscience Connecticut accelerates, launches, and completes important structural elements of the project to stimulate construction employment in that struggling sector and expands medical

[4] The UConn health initiative includes provisions for increasing collaborative ties with other hospitals within the state inclusive of enhanced communications systems facilitating trials.

and dental enrolments sooner, with the major hospital tower and renovated research facilities completed by 2015, in contrast to the PA10-104 investment, which ramps up more slowly;

3. Bioscience Connecticut anticipates completing major new construction by 2015 and renovations included in PA10-104 investments by 2017 or 2018;
4. Adding 50 medical-surgical beds to the JDH essentially parallels those proposed in the remodeled economic assessment of the PA10-104 investment;
5. Incremental direct employment meets the normal staffing requirements for the expanded number of beds in the hospital tower (350) and the Ambulatory Care Center (233), the expanded medical and dental schools, and of Biosciences Connecticut (100 faculty);
6. The slightly higher costs of staffing in a teaching hospital are taken into account with a wage and salary supplement rather than doubling the staff per bed is as was done in the PA10-104 Investment ;[5]
7. The expanded enrollment of students entering medicine annually rises by 12 in 2014 and 25 in each year thereafter for four years with ongoing total enrolment of 100 above present levels rather than 5 annually for four years in 2017 onward under the PA10-104 investment; this expansion is important in meeting the need for doctors in Connecticut;[6]
8. Dental student enrolments follow the same pattern of initial enrolment but with 6 enrollments in 2014 and 12 thereafter for four years for an ongoing total enrolment of 48 above current levels;
9. This analysis of the benefits from implementing Bioscience Connecticut focuses primarily on the expansion at the UCHC campus, together with the benefits of partnering and collaboration, which are constrained to only those spin-offs and expansions based on Biosciences Connecticut's incremental IP. Minor additional investments in communications systems are included as part of undertaking clinical trials;

Bioscience Connecticut emphasizes the centrality of expanding biomedical research capabilities with recruitment of ten eminent researchers and forty clinician-scientists with primary responsibility for R&D, along with fifty patient-care and educational clinicians. The additional staffing will facilitate expansion of clinical trials. A strong future enhancement will be the concomitant ability of UCHC to graduate excellent students and simultaneously to create incentives for those graduates to remain in the state. Overall this new staffing lays the basis for generating significant new intellectual property, whose earnings will assist UCHC in becoming financially self-sufficient. This analysis adjusts estimates of residents and staff additions proportionately for the proposed renovation of JDH and the expanded medical and dental enrolments relative to present levels.

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[5] Medical research points to a relationship between ICU volume and quality of care for mechanically ventilated patients. After adjustment for severity of illness, demographic variables, and characteristics of the ICUs (including staffing by internists), higher ICU volume was significantly associated with lower ICU and hospital mortality rates. Typically, patient to nurse ratio is what determines the care. A ratio of 2 patients to 1 nurse is recommended for a medical ICU. This is unlike the ratio of 4:1 or 5:1 ratio in conventional contexts. See: floors.http://en.wikipedia.org/wiki/Intensive_care_unit#cite_note-4 (Feb 28, 2010)

[6] The share of the graduating class remaining in Connecticut has been rising over time and currently is in excess of 50%. Several factors have been working toward this dynamic including more recruiting of students from within the state, subsidies for those who remain to practice here. In addition, the improved Medical School is expected to enhance life-long learning of those who remain. These three factors are consistent with Dean Laurencin views and justify using the 60% retention rate assumed in this study.

Direct Benefits to the Economy

Investments Compared between Bioscience Connecticut and PA10-104

Bioscience Connecticut involves an investment of $864M to construct both a new hospital tower and an ambulatory care center, as well as to renovate the JDH and existing research space. Parallel with this expansion a new parking garage will also be constructed. There will be $521M in new construction and $318M in renovations, in addition to $25M for the UConn Health initiative. PA10-104 provided for just renovation of JDH and the UConn Health Initiative.

Financing includes $338M of previously authorized 21st UConn 2000 bonds, $254M of additional state bonding; $39M of Health Center capital funds, $30M in philanthropy and $203M through private investment. This investment is larger than that $365M envisioned under PA10-104, of which $265M was to come from state borrowing. Further, with Bioscience Connecticut, the analysis allocates construction and related activities, including design and machinery and equipment purchases, to 2011-2015, with only renovations running out to 2018; PA10-104 projected a slower pace of investment, with completion of new building waiting until 2017.

Operating Phase

The operating phase is designed to improve treatment of more patients, to educate more doctors and dentists, and to fulfill expectations that UCHC will generate revenues from IP and expanded research, as well as from trials, teaching, and training. Larger enrolments require additional teaching and research staff; increased scale creates an environment for more synergy within and externally to UCHC and generates new opportunities for students to work in research assistantships.

Even without recognizing any of the direct, indirect and induced employment from the use of IP by recipient firms, Bioscience Connecticut generates employment impacts double those of the PA10-104 investment, starting in 2011 and rising to 5,200 twenty years after start-up. Inclusion of the job impacts from the transfer of IP to start-ups and in growing existing firms adds a further 1,700 high-paying direct jobs in 2037[7] and an additional 9,500 indirect and induced inclusive of the expanded non-residential construction by firms whose expansions result for the use IP from the Biosciences Connecticut.

In addition, with the increased number of graduates in medicine and dentistry being recruited from within the state, subsidies for graduates to remain in the state, and increased opportunities for life-long learning at the expanded medical school, Connecticut retention rates among graduates should increase. These factors justify increasing current retention rates from just over 50% to the 60% assumed for this study. The study assumed that 50% of medical graduated go on to post-doctoral studies as do 25% of

[7] Currently incubator firms based on UCHC patents have created 5.5 jobs annually. The assumption used in this analysis is that start-ups employ 5 persons initially and on average double every four years as do extant Connecticut-based firms utilizing UCHC Biosciences IP for new product lines. Clearly, each firm or product line will not grow at that pace. Some will fall short while others may expand far more quickly.

dental graduates. With 50% of those graduates immediately going into practice, setting up offices in Connecticut within five years of graduation and 40% of specialists also setting up practices after a delay of another four years, and with each office having a staff of four to five, these incremental practices add at least 1,259 to Connecticut payrolls by 2037.[8]

Growth drivers are very different in PA10-104 and Biosciences Connecticut. Bioscience Connecticut features developing IP and the resulting revenues accruing to professional services, UCHC, and the state treasury, both through tax revenues and from offsets to what would otherwise be reliance on the state for on-going funding of the UCHC. It adds $142M to the state's revenue stream during construction and expansion of faculty and another $823M[9] in Net Present Value (NPV) from 2018 to 2037, during the bonding period, in contrast with the PA10-104 investment that generated $194M. Combined, the NPV of state incremental revenues from Biosciences Connecticut exceed the bonding being sought by $373M.

Other income from intellectual property is also expected to be reinvested. The analysis assumes that one patent is generated per million dollars in R&D and that only 1 out of 10 patents become commercially successful, with successful patents starting with annual royalty revenues of $250,000, and then doubling every four years[10] over 20 years[11] under current patent rules.

Currently IP revenues are divided, with one third accruing to the inventor and two-thirds to the University, of which half accrues to the intellectual property office and the other half to the University to support expansion of its research capacity. Should some or all of these latter third of IP revenues be used to offset revenues that would otherwise have come from the state over the period 2018-2037, it would add up to $278M (NPV) of net revenue benefit flowing to the state.

In addition, mark-ups from clinical trials are expect to add a fiscal contribution of $218M to total NPV of future benefits for just this segment of Bioscience Connecticut. This brings total net revenue to the state to $581M, nearly equal the entire cost of bonding. This implies a rate of return of close to 100%— a generous margin for this strategic investment.

UCHC's track record for creating spin-offs has doubled in each of the last three decades from 2 in the 1980s to 8 in the first decade of the 21st century. In line with such growth rates and with the Biosciences Connecticut initiative under the IP assumptions above, 15 Connecticut-based spin-offs will emerge between now and 2037. The report further assumes that operating firms either currently located in Connecticut or attracted to it utilize IP from biosciences to expand in the state at the rate of 16 expansions per 100 commercially successful patents. This leads to 31 instances where the IP is used by existing Connecticut firms for expansion. Companies utilizing IP from biosciences laboratories generate high-quality, well-paying jobs. Based on past performance, Table 3 indicates the percentage of IP expected to flow to specific industries and the average earnings per employee in 2010 as a percentage of national average wages.

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[8] Similar assumptions were also made for dentists albeit their average office employment is 4.5.

[9] NPV is discounted at 5% to 2017.

[10] Based on Dean Laurencin's professional judgment and UCHC's experience with its current R&D conversion to IP. The University of Connecticut's intellectual property office reported to the university board that 1.4% of its patents were being deployed, above the one in 100 assumed.

[11] **^** 35 U.S.C. § 154(a)(2)

Table 3: Likely Distribution of IP Awards among Connecticut Industries

Industry	Likely Share of IP Awards[1]	Average Weekly Earnings All Employees[2]	Average Weekly Earnings All Employees as % of National Average[2]
Medical Equipment and Supplies	67%	1,011.82	131.28
Pharmaceuticals	17%	1,210.80	157.10
Software	16%	1,779.23	230.85

Source: (1) UConn Intellectual Property Office and (2) data base at http://data.bls.gov/

Employment growth associated with each of these adoptions of IP begins modestly at five employees and on average grows 18% annually. The REMI model was then used to delineate the impact of those expansions on Connecticut, inclusive of the stimulated investments as well as indirect and induced impacts.

Aside from the spin-offs and other users of IP, the fifty medical-surgical beds require a staff complement of 350 in addition to those on faculty. From 2019-2022, in Bioscience Connecticut, there is continued growth of about 57 employees per year as more graduates remain in Connecticut, establish practices, and hire staff. After 2022, the number rises to 95 annually with post-doctoral graduates also beginning to establish practices.[12]

Economic Impacts

The Connecticut Center for Economic Analysis (CCEA) at the University of Connecticut developed this analysis of the economic benefits that would flow from the implementation of Bioscience Connecticut, including construction and subsequence operations of the healthcare and research activities described above. This results of this analysis, based on the dynamic REMI model of the Connecticut economy, flow from the initial investment of $864M, in contrast to the PA10-104 investment of $365M. Bioscience Connecticut successfully leverages the state's contribution with its focus on expanding enrolments in medicine and dentistry, construction of the new hospital tower and new research facilities, the addition of ten eminent researchers and forty clinician-scientists, and the transfer of IP to Connecticut spin-offs and operational firms. Bioscience Connecticut thus builds on the components of, PA10-104, which provided for 50 additional faculty and clinicians, renovation of JDH, and expanded clinical trials.

The payoffs from Bioscience Connecticut to Connecticut's citizens in terms of jobs and income and to state government in terms of new tax revenue are impressive:

HEALTH: Connecticut, with its population aged sixty-five and older at 506,000 in 2010, currently projected to grow to 647,000 in 2020 and then to 818,000 in 2030, will require additional medical services. Increased annual enrolment of medical students under Bioscience Connecticut is five times that in the PA10-104 investment. Supplemented by twelve additional dentists

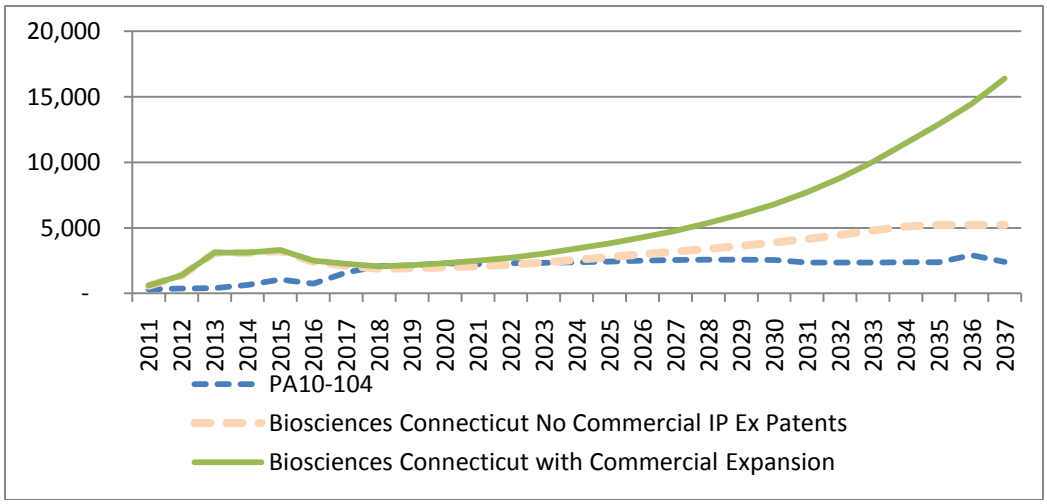
[12] In all cases these expansion were ramped-up over five years in order to reflect the times needed to finance and launch private practices.

annually over current enrolment levels and by increased shares of candidates staying in Connecticut, this expansion will largely meet these demands.

JOBS: Bioscience Connecticut generates in excess of a 2,100 jobs above the base case for each year during the start-up of operations and grows to 16,400 jobs by 2037. This number of jobs is well ahead of the creation of jobs of less than 3,000 under PA10-104. This projection includes estimates of the jobs that the new research productivity and resulting IP would generate through spin-offs, expansion of existing firms, and attraction of new firms.

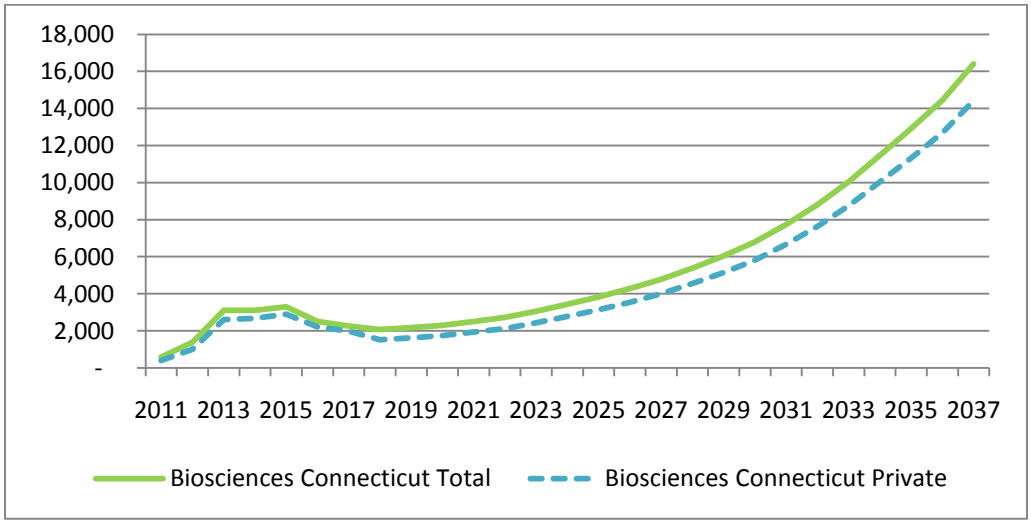
The following chart illustrates comparative growth in jobs resulting from PA10-104, Biosciences Connecticut without consideration of the impact of IP, and the projected total impact.

Chart 1: Job Growth Impact (Number of Jobs)



A relatively small share of this employment growth is in the public sector, as the spread between the two lines in Chart 2 below reveals:

Chart 2: Public Sector Job Growth Impact from Biosciences Connecticut (# of Jobs)



INCOME:

By 2037, Bioscience Connecticut increases nominal personal income $4.6 billion, more than five-times that of the PA10-104 investment, which delivers only $0.9 billion. Combined with employment data, these results demonstrate that Bioscience Connecticut generates good quality, well-paying jobs relative to the PA10-104 reliance on expanded clinical services. Chart 3 shows these differences in millions of dollars.

Chart 3: Personal Income Impact (Millions of Current $)

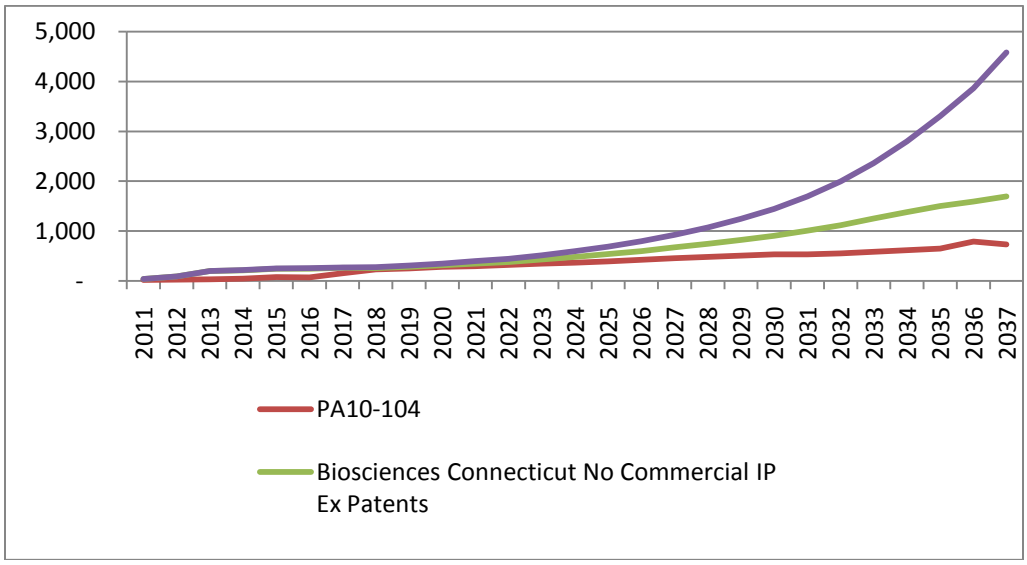
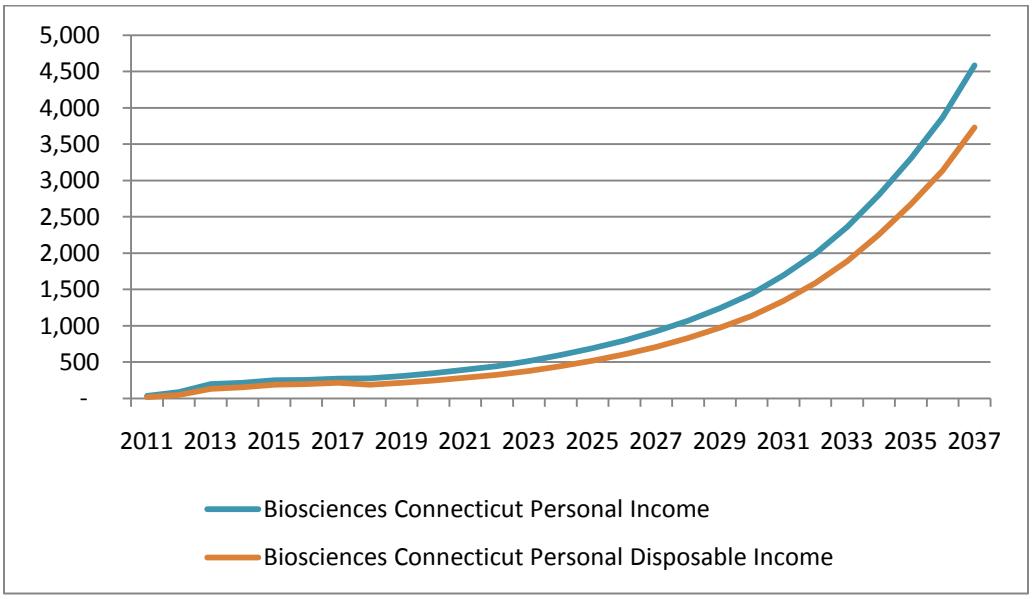


Chart 4 below shows the growth in personal income, personal income taxes—the spread between the lines—and personal disposable income, in millions of current dollars inclusive of commercialization of IP.

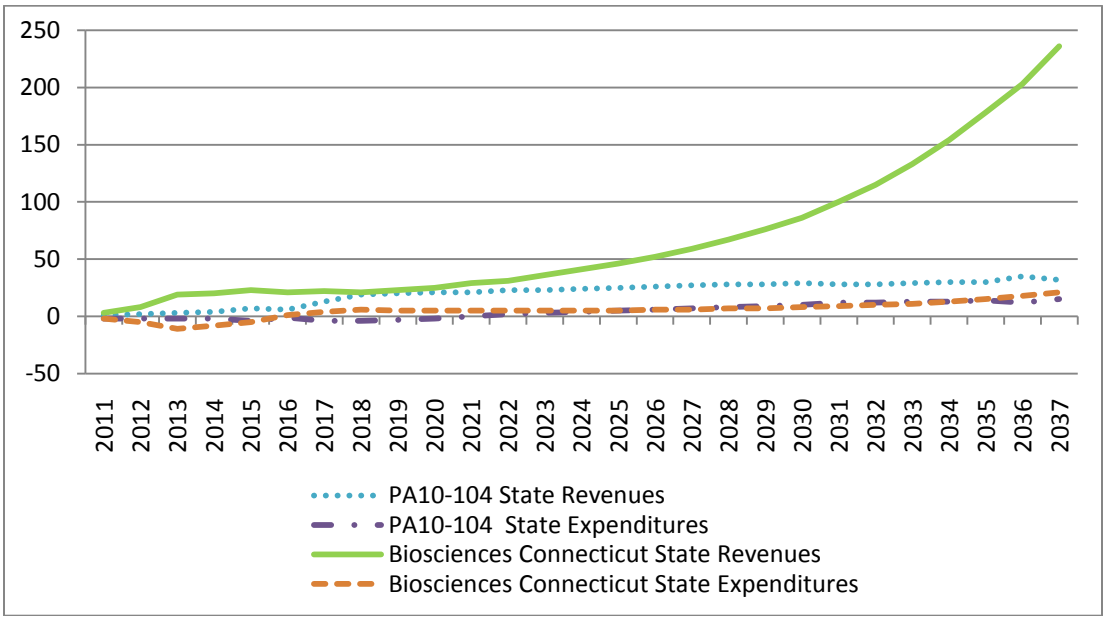
Chart 4: Personal Income and Personal Disposable Income Impact (Millions of Current $)



FISCAL BENEFITS:

The analysis projects fiscal benefits—new tax revenue—based on the REMI model and then adds benefits to the state as UCHC becomes more financially independent, based on the flow of revenue from patents. Bioscience Connecticut delivers $142M in new tax revenues during construction and initial staffing in the period through to and including 2017. Discounted at 5% annually over the first 20 years of full operations, the incremental changes net of expenditures under Bioscience Connecticut contribute another $823M to the state's tax revenues. Tax revenues generated more than cover Bioscience Connecticut $823M bonding. Any surpluses can be used to build further capacity while accelerating financial self-sufficiency. The following chart, in millions of 2008 dollars, demonstrates that the state would be positioned either to start paying off some of the financing early or to accumulate revenue not used to cover interest charges in a separate capital fund that could earn income from 2023 onward, thereby reducing net interest on the proposed bonding and further enhancing the state's fiscal position.

Chart 5: State Revenue and Expenditure Impact, Bioscience Connecticut Compared with PA10204 (Millions Fixed 2008$)



Conclusion:

Bioscience Connecticut delivers proportionately far more to Connecticut in terms of job creation, increased personal income, and tax revenues than PA10-104. It does so because of its focus on expanding enrolments and building a powerful research basis, resulting in generation of IP on which Connecticut industry grows; this dynamic dramatically improves projected outcomes. Equally important, Bioscience Connecticut creates significant potential for sustained future growth, growth that is simply absent from Pa10-104, which would plateau after full implementation.

Appendix A: Key Assumptions

Introduction

This discussion of assumptions clarifies the concepts underlying the assessment of the economic impacts. Because REMI is dynamic and because project construction and operations occur through time, the REMI-based analysis is the one of the few approaches available that projects impacts through time on Connecticut's economy. This discussion begins with the construction phase and then moves to staffing of all activities, operations, and expectations for patents, in particular their revenue generating capabilities. In addition, growth in medical and dental school enrolment will allow Connecticut to redress the problem of retirement of many physicians and surgeons that reflect baby boom demographics, with bulging demands for replacements. The main text has already addressed both outcomes and their related issues.

Construction

The main construction assumptions in terms of expenditures and timing appear in Table A1. The initial date is set at the design stage. The completion date is the expected time of occupancy.

Table A1: Bioscience Connecticut Construction Expenditures and Timing

Building	Value (Millions 2011 dollars)	Initial	Completion
New Hospital Tower	318	2011	2015
Renovation of the John Dempsey Hospital	163	2011	2018
New Ambulatory Care Center	203	2011	2014
Renovations Alterations to Research Space	155	2011	2016
Sub-Total	**839**	2011	2017
UConn Health Initiative	**25**	2011	2017
Total	**864**		

Funding

Bioscience Connecticut involves an investment of $864M, including $338M of previously authorized 21st UConn 2000 bonds, $254M of additional state bonding; $39M of Health Center capital funds, $30M in philanthropy and $203M through private investment. This investment is larger than the $365 envisioned under PA10-104; of this, $265M was to come from state borrowing. Further, with Bioscience Connecticut, the analysis allocates construction and related activities, including design and machinery and equipment purchases, to 2011-2015[13], with only renovations running out to 2018; PA10-104 projected a slower pace of investment, with completion of new building waiting until 2017.

[13] This analysis was based on the earlier shares of construction and equipment from earlier estimates of the New Tower compressed to meet the accelerated construction.

Operations

Commensurate with the transfer of beds to the Children's Hospital and the expansion of beds in the state, JDH staff is expected to grow by 78 per year from 2012 to 2015[14] and to top out at 350 when fully operative. The addition of these 50 revenue-generating medical-surgical beds is critical to the future sustainability of JDH. The Ambulatory Care Center was also staffed to the same level per bed, topping out at 233 jobs annually when fully operational.

The addition of ten full professor- researchers and forty clinician-scientists, with research, clinical and teaching responsibilities based on an average 30/60/10 time split, will strengthen and expand the research base at UCHC. These individuals will be recruited over three years and will generate significant external research funding. Conservatively, eminent scientists will generate $740,000 annually in public sector research grants from outside the state as well as additional funds from private sector sources. The base $740,000 is equivalent to having two NIH grants and some additional income from other funding sources. Funds accrue to the state economy in the form of remuneration and through diverse R&D supply chains, commensurate with the range of R&D projects focused on advanced instruments, software, and pharmaceuticals.

Expectations for the fifty new clinical recruits are more modest at $350,000 in external R&D funding within four years of their appointments. These individuals are expected to work with an average of three- research assistants or post-doctoral students. Additional support for technicians and other support staff has also been specified within the model resulting from the Incremental R&D funds classified in "Professional and Technical Services." New recruits are expected to ramp-up their dependence on external grants by a quarter of that amount annually until they achieve their targets.

No account is taken of the stimulus and synergy that these new recruits are expected to have on current faculty. In that respect, the assumptions are modest. Stipends for new eminent researchers is $300,000 annually; new clinician-scientists $200,000; researchers $100,000; research assistants $37,000. In the initial three years of each hire, these research funds are paid from funds contained in the proposal but on a decreasing annual basis as new external funding replaces these funds. As noted in the discussion above, the NIH is one source, but various foundations focused on specific diseases also support medical biomedical research, as does the corporate sector.

Increased operating costs of the new tower are modeled as a 50 bed expansion, using detailed operating input used in earlier previous CCEA study.[15]

Enrolment and Graduation

Enrolment of students entering medicine rises annually by twelve in 2014 and twenty-five in each year thereafter for four years, rather than 5 new entrants annually for four years in 2017 onward under PA10-104; this expansion is important in meeting the need for doctors in Connecticut. Dental student enrolments follow the same pattern of initial enrolment but with 6 enrollments in 2014 and 12 thereafter for four years. Fully operative, total incremental enrolment in medicine will be 100 and in dentistry 48. This contrasts with 20 medical students under PA10-104.

[14] This level of incremental employment is expected because there are 6.7 hospital employees on average per bed in Connecticut hospitals, BLS data on Connecticut hospital employees divided by the number of active beds, without having the security concerns that there are at the JDH due to its special role in caring for wards of the state. The 350 expansion is then commensurate with the 50 additional clinical beds and security. Given that JDH is also a teaching hospital the number is conservative.

[15] Stan McMillen and Philip Shaw, "The FY 2006 Economic Impact of Continuing Operations of the University of Connecticut Health Center (Fourth Report)."

In addition, with the increased number of graduates in medicine and dentistry being recruited from within the state, subsidies to remain in the state upon graduation, and increased opportunities for life-long learning at the expanded medical school, Connecticut retention rates rise among all graduates. These factors justify increasing current retention rates from just over 50% currently to the 60% assumed in this study. The study assumed that 50% of medical graduated go on to post doctoral studies as do 25% of dental graduates. It also assumes that 50% of those graduates immediately go into practice setting up offices in Connecticut within five years of graduation with 40% of specialists also setting up practices after a delay of another four years. In consultation with the Deans of Medicine and Dentistry, doctors' staffs were set modestly at four and dental staffs at five. This approach results in at least an addition of 1,259 direct jobs to Connecticut payrolls by 2037.[16] For both professions, office capitalization was $300,000, renewable for doctors every 10 years and for dentists every five years.

Enhanced Research Productivity

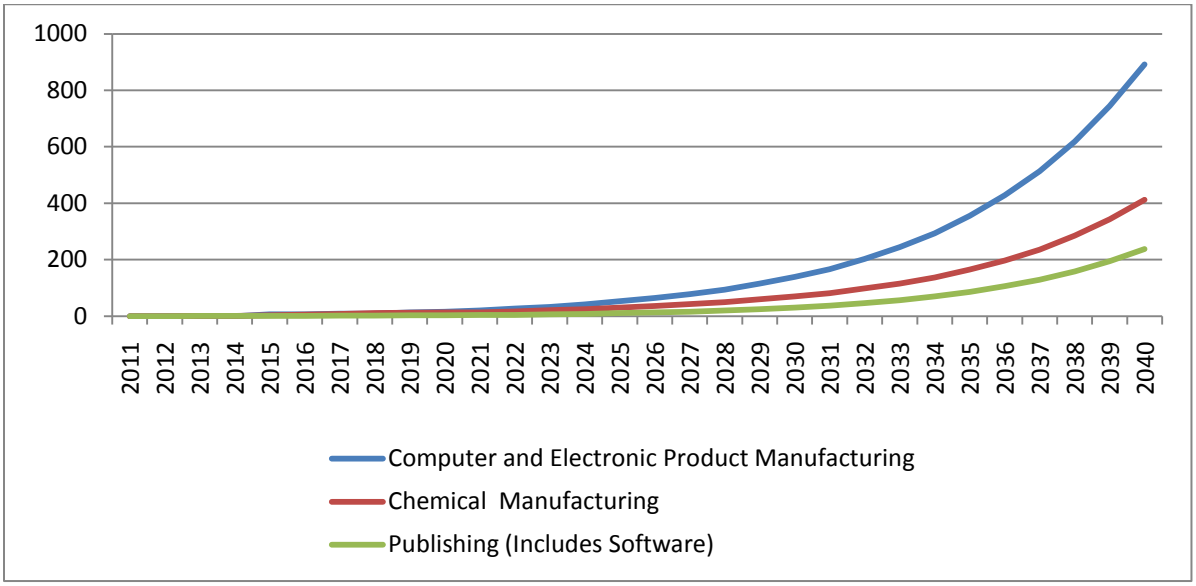
The expansion accommodates additional researchers and clinician-scientists; they are expected to produce commercial patents which, in turn, will generate revenues. While there can be wide variations among such results, there are also economies of scale in innovation generation that the assembled critical mass should facilitate. Our assumptions about the generation of patents are that on average one patent will be produced per $1,000,000 of R&D, and that one in ten of these will be commercially successful. The analysis projects commercially successful patents earning $250,000 in the first year after patent filing and doubling every four years thereafter, before falling to zero at the end of each patent's effective life of 20 years.[17] Revenues are unlikely to drop quite that quickly where brand loyalty can be generated. While these revenues for patents only begin modestly, they rise to $105M by 2035. This assumption is modestly bullish as it assumes work to utilize the IP will commence upon patent filing. Doing so reflects the view that even filing is a double edged a sword because it makes public what theretofore was private. To capitalize on minimum knowledge among competitors, many companies continue to build on their IP both prior to and immediately after patent filings, so no hiatus is taken into account here. A more conservative approach would be to wait for patent approval, but that strategy carries its own risks of being beaten to market and foreshortening the period of effective protection.

UCHC's track record for creating spin-offs has doubled in each of the last three decades, from 2 in the 1980s to 8 in the first decade of the 21st century.[18] In line with such growth rates and the establishment of Biosciences Connecticut under the IP assumptions above, the study assumes 15 Connecticut-based spin-offs emerge between now and 2037. The study further assumes that operating firms either currently located in Connecticut or attracted to it utilize IP from biosciences to expand in the state at the rate of 16 expansions per 100 commercially successful patents. This leads to 31 instances where the IP is used by existing Connecticut firms for expansion. Companies utilizing IP from biosciences laboratories generate high-quality well-paying jobs. Table 3 (page 9 above) lays out the percentage of IP expected to flow to specific industries and the average earnings per employee in 2010 as a percentage of national average wages.

Combined by 2037, these three industries commercializing the IP account for 41.5% of the real fixed GDP (2000$) expansion from the stimulus. As Chart A1 illustrates, these innovators expand over time. Although not shown, their sector share of CTGDP growth expands over time.

[16] Similar assumptions were also made for dentists albeit their average office employment is 4.5.
[17] ^ 35 U.S.C. § 154(a)(2)
[18] UConn Office of Intellectual Property, Board Presentation.

Chart A1: Impact on Key Innovators



The REMI analysis does not take account for associated businesses that are likely to locate in Connecticut—whether as spinoffs, retention of firms currently here, or locate here—to make use of the patents or take advantage of access to the researchers. To the extent such relocations result from Biosciences Connecticut R&D, the impacts could be considerably larger than shown. Both UCHC and the CCEA also expect the additional research staff to have synergistic impacts on the current staff so that the research output is expected to be larger than modeled. In recognition of the use of UCHC property, at least two mills of every dollar of patent income will be allocated to offset what would otherwise have been state subsidies to JDH.

The new stage 1 and stage 2 trials require the types of medical expertise that UCHC is recruiting. In keeping with current plans, these early-stage trials have been modeled modestly as generating revenues of $700,000 in 2011 by staff already recruited based on the expected expansion, rising to $5.3M by 2016 and then remaining at that level. The assumptions of the higher level trials lying behind PA10-104 remain in place for the clinical educators. There is clearly room for more growth. The dollar values attributed to early stage trials however pales beside those expected from later stage trials, with possible partnerships with other Connecticut hospitals. The analysis of PA10-104 already demonstrated possible benefits from ramping-up higher stage trails; that remains a possibility subject to further negotiations with those partners.

The UConn Health Initiative is modeled as an educational initiative at $25M commencing in 2011 and continuing into 2018 in equally distributed shares annually.