ECONOMIC IMPACTS OF THE UNIVERSITY OF VIRGINIA CANCER CENTER AND EXPANDED STATE SUPPORT

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EXECUTIVE SUMMARY

This study examines the economic impact of the University of Virginia Cancer Center and of a proposed state funding increase of $5 million each year. These funds would be used for expanding clinical trials, improving translational research, and augmenting outreach activities, particularly in the Southwest region of Virginia. In addition to improving citizen health and technology transfer, the funds will move the Center towards National Cancer Institute (NCI) Comprehensive Cancer Center status. This designation would bring additional funding from the NCI and other public and private sources.

This study examines the economic impact of the Center using REMI PI+, a respected, peer-reviewed regional model. Only the most easily quantified aspects of Cancer Center operations such as payroll and procurement and startup activity are used in the model. Since the Center also affects the economy by improving citizen health and productivity, encouraging technological progress, stimulating agglomeration economies, and increasing amenities, the economic impacts are conservative estimates.

Results indicate that the Center currently generates at least 1,535 jobs in the Virginia economy. $127.4 million in total industrial output, $77.8 million in gross domestic product, and $8.6 million in state tax revenue. Proposed state funding increases would stimulate additional external research funding and startup activity. Based on extrapolations of national NCI Comprehensive Center funding patterns, it is projected that increased state funding would create between 500 and 1,300 jobs, $42.4 and $107.7 million in output, $26.5 and $67.6 million in gross domestic product, and $3.6 million and $9.4 million in tax revenues by 2020.

INTRODUCTION

The University of Virginia Cancer Center is a leading national and global cancer research center. It is also a valuable state health care resource and economic engine. This study examines the economic impact of the Cancer Center and of proposed increases in state funding that would be targeted toward expanding the Center's clinical trials programs, improving the ability of the Center to translate basic research discoveries into commercial results, and augmenting state outreach and prevention activities, particularly in the medically underserved region of Southwest Virginia. In addition to improving the health of Virginia residents and Cancer Center technology transfer capabilities, the funds would help to build the capacity needed to move the Center towards National Cancer Institute (NCI) Comprehensive Cancer Center status. Being designated a Comprehensive Center would bring additional funding assistance from the NCI and more importantly could have a potentially profound effect on the ability of the center to leverage additional financial support from federal, business and non-profit/philanthropic sources.

This study examines the economic impact of the Cancer Center using a model, REMI PI+ (Regional Economic Models, Inc. Policy Insight Plus), calibrated for Virginia. REMI PI+ is a respected, peer-reviewed model that has been used by federal, state, and local government agencies and private consultants to study and quantify the economic impacts of colleges and universities, health care, and state budgetary issues. Indeed, the Weldon Cooper Center has recently used the exact same model to examine the economic impacts of Virginia public higher education (Rephann, Knapp, and Shobe 2009), federal health care reforms (Rephann 2010), and state budget cuts (Rephann 2010).

It was not possible to adequately measure every Cancer Center activity that results in economic impact. Therefore, the study focuses on the most readily quantifiable aspects of Cancer Center operations such as payroll and procurement expenditures and the activity of university startups related to Cancer Center sponsored research. Some of this information is drawn from the University of Virginia Cancer Center, University of Virginia Financial Reports, and the University of Virginia Patent Foundation. In addition, extrapolations for modeling purposes are made based on national NCI center funding patterns and information collected on University of Virginia startups by the Weldon Cooper Center. Yet, the Cancer Center will affect the economy in myriad other ways such as improving the health, longevity, and productivity of Virginia residents, encouraging technological progress, stimulating regional agglomeration economies, and augmenting the state's stock of consumer amenities. Therefore, the economic impact results presented here should be viewed as conservative estimates.

The study is divided into several sections. The first section provides a brief overview of the National Cancer Institute program and the University of Virginia Cancer Center, including its history, geographical context, research strengths, and improvement plans. The second section describes mechanisms by which the Cancer Center affects state economic activity. The third section presents important features of the REMI PI+ model and the methodology for obtaining statewide economic impacts. The fourth outlines data assembly for the model and mapping of University of Virginia Cancer Center expenditure and university startup activity onto REMI PI+ policy variables for economic impact and forecasting purposes. The fifth section presents the results.

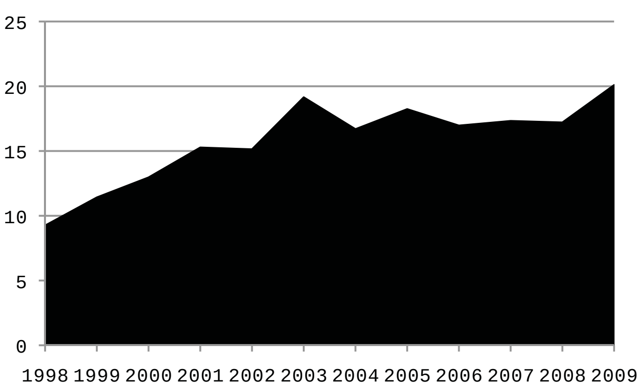
SECTION 1
UNIVERSITY OF VIRGINIA CANCER CENTER OVERVIEW

The National Cancer Institutes (NCI) cancer centers program was created in 1971 by the National Cancer Act to establish regional centers of excellence in cancer research, training, prevention, and treatment. There are currently sixty-six such centers around the United States, with higher concentrations in Southern California, the Northeast, and the Midwest (Birkmeyer et al. 2004). The NCI recognizes two types of centers: generic cancer centers (26 in total) and comprehensive cancer centers (40 in total). Cancer Centers conduct basic research, clinical research, and/or population science research and foster cross-disciplinary collaboration.[1] Comprehensive Cancer Centers must show expertise in all three areas. In addition, they must conduct clinical trials, provide outreach and education activities, and help educate the public and healthcare professionals.

By the mid 1980s, the University of Virginia School of Medicine had built significant strength in basic research. Faculty researchers had made internationally recognized contributions in basic research in the areas of molecular and cell biology. In addition, significant clinical work was occurring in the areas of endocrinology and infectious diseases. However, the university's rural location made it difficult to conduct large clinical trials and population-based studies. In 1987, UVA applied for NCI designation as a "Basic Science Center" and was awarded funding based on its strengths in laboratory research. The NCI has served as a significant source of financial support for the center, both in terms of NCI Cancer Center core funding and in terms of other competitive grant funding. Total NCI funding grew from $9.2 million in 1998 to $20.1 million in 2009 (see **Figure 1**).

The University of Virginia Cancer Center has made considerable strides in developing capacity in all three NCI areas required for Comprehensive Center designation. The university continues to expand its strengths in basic sciences and is recognized as one of the top programs in the world. It is ranked number 5 in the area of epigentics by ScienceWatch, a division of Thomson Reuters. Bibliometric indices based on the Web of Science database rank the Cancer Center fifth in phosphorylation, 11th in membrane protein structure, 13th in cancer cell migration, 14th in cancer immunotherapy, and 18th in cancer cell signaling.[2] Moreover, U.S. News and World Report ranks the University of Virginia Medical Center as the 32nd best hospital for cancer in the country.[3]

Figure 1. University of Virginia Cancer Center NCI Funding, 1998-2009



Source: National Cancer Institute

The Center has also made progress in clinical trials and population research. For example, the Center formed a Clinical Trials Office and Protocol Review and Monitoring System in the mid 1990s and recently purchased a clinical trials management software system. The Center has increased its outreach activities in medically underserved areas. For example, with the assistance of tobacco settlement funds, the Center has begun a program called "Healthy Appalachia Works" that provides training, screening, prevention, and telemedicine specialty care.

The Cancer Center also is among the university's most prodigious generators of intellectual property, business spinoffs, and licensure revenues. For example, two hundred and twenty five patents were issued to Cancer Center members over just the five-year period 2006-2010. Since 1991, twenty-one startups have resulted based on university-licensed technologies developed by Cancer Center members. Eleven of these firms currently operate in Virginia and employ at least 117 workers. One university startup named Upstate Biotechnology/Argonex was sold for $200 million, with 25 percent of the profit going to the University of Virginia.

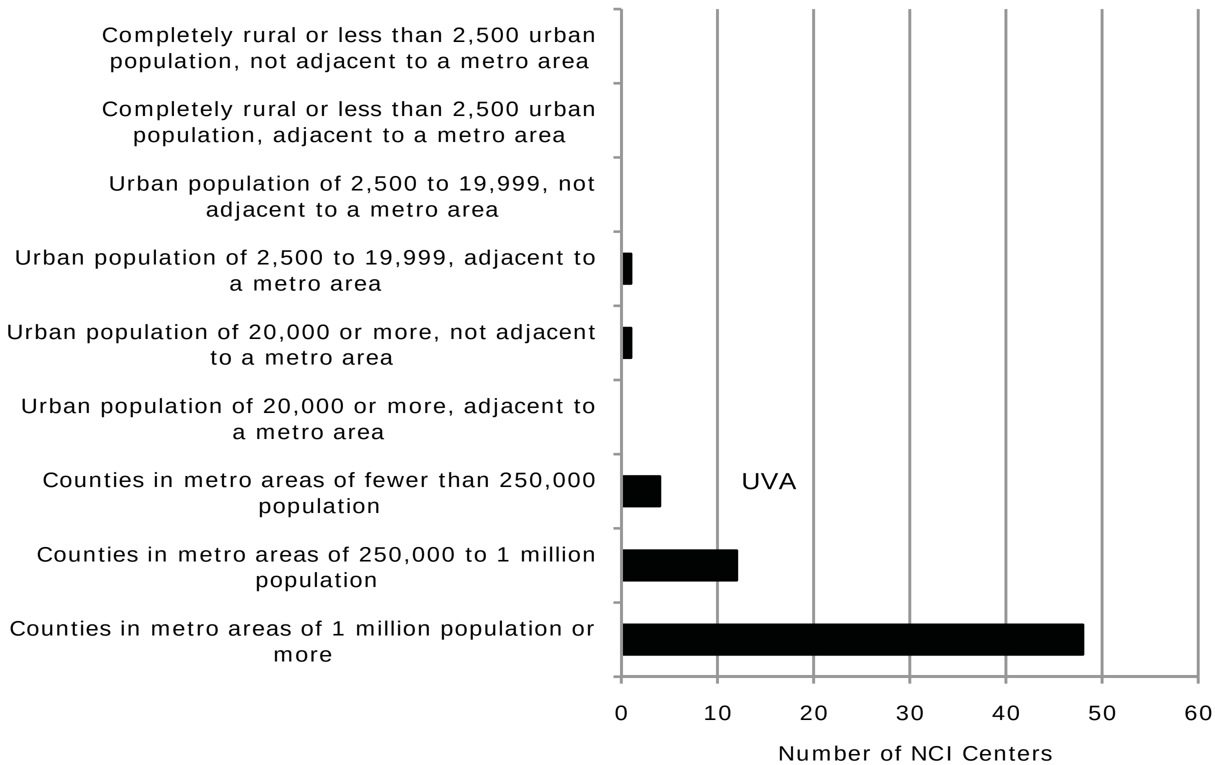
Yet, the Center still faces significant challenges. The infrastructure for conducting extensive clinical trials is incomplete. Only 5-10 percent of University of Virginia patients are on clinical trials compared to a 10-20 percent level expected of Comprehensive Cancer Centers. The University needs to increase the number of researchers, physicians, nurses, and other staff to adequately support a clinical trials network. Moreover, the University's rural service area serves as a significant barrier. The University of Virginia Cancer Center is among the most rural of all the NCI cancer centers. It is one of only six cancer centers located outside of a metropolitan area with at least 250,000 residents (see **Figure 2**) and much of its service area encompasses rural western and southwestern Virginia where patients often drive from two to six hours to reach UVA. This distance makes it difficult for them to participate in clinical trials, which often require repeat visits for tests and checkups. Lastly,

1 Cancer Center Support Grants (CCSGs) for NCI-designated Cancer Centers (P30) http://grants.nih.gov/grants/guide/pa-files/PAR-11-005.html

2 University of Virginia Cancer Center Cancer Center Support Grant Application, January 24, 2011.

3 http://health.usnews.com/best-hospitals/rankings/cancer

Figure 2. Number of NCI Centers by Urban Rural Continuum Category



Source: National Cancer Institute based on USDA Urban Rural Continuum

trials are costly and often not covered by medical insurance. The University estimates that it loses approximately $5,000 for every patient on a non-commercial therapeutic trial.[4]

The University also recognizes the need to improve translational research. The university has missed opportunities to convert laboratory research discoveries into new ways to diagnose and treat cancer. In many instances, UVA discoveries have been further developed for commercial application by biotechnology or pharmaceutical companies in other states. New faculty recruitments in areas like medicinal chemistry and pharmacology and building additional capacity in areas such as drug screening and pre-clinical trials would help the Cancer Center move to the next level.[5]

The University of Virginia Cancer Center currently receives $1 million in annual support from the state (Chesser 2010). In addition, a grant of Tobacco indemnification funds of approximately $1 million supports Healthy Appalachia. Although significant, these allotments are still substantially below levels found at cancer centers outside Virginia, which average $12.8 million (Chesser 2010). In order to make additional progress, the UVA Cancer Center is requesting additional state support of approximately $5 million per year that will enable it to build the capacity to become competitive for Comprehensive Cancer Center designation. This funding would also help the state move forward on cancer treatment goals and objectives outlined in *The Virginia Cancer Plan, 2008-2012*. Funding would be dedicated to the following improvements: (1) enhancing clinical trials capability ($2 million per year), (2) building a Virginia Cancer Network ($1.5 million per year), and (3) increasing capacity for translating and commercializing discoveries ($1.5 million per year).

4 University of Virginia Cancer Center Cancer Center Support Grant Application, January 24, 2011.
5 University of Virginia Cancer Center Cancer Center Support Grant Application, January 24, 2011.

SECTION 2
ECONOMIC IMPACT MECHANISMS

The University of Virginia Cancer Center enhances the economy in a variety of different ways. These contributions can be gauged using alternative economic metrics, including (a) economic impact, (b) fiscal impact, and (c) social cost-benefit. Economic impact analysis measures the effect that a project has on the economy of an area in terms of employment, output, or income. Fiscal impact analysis measures the public service costs and revenues associated with a project. Social cost-benefit provides the widest measure of economic valuation. In addition to quantifying the value of market goods and services that result from a project, it imputes the values of non-market goods and services.

This study focuses primarily on economic impacts. Given this emphasis, the Cancer Center can affect state economic activity through any the following channels:

- ***Research expenditures***. The vast majority of research funding for the University of Virginia Cancer Center is derived from out-of-state sources. This external funding represents an injection of new expenditure into the state economy that stimulates additional spending due to the purchases of state product and labor inputs and subsequent rounds of spending induced by the in-state purchases of input providing firms and households.

- ***Patient expenditures on cancer care***. The University of Virginia Cancer Center provides clinical patient care to thousands of patients. If clinical care were not available, many patients would need to travel elsewhere, including out of state to receive this type of care. Therefore, the existence of the Cancer Center results in the attraction and retention of patient revenues and supports spending in the Virginia economy.

- ***Commercialization of discoveries***. Technologies discovered in university labs are commercialized and result in new Virginia startup firms that employ Virginia residents. In addition, the university and faculty/staff earn licensure and royalty income from firms that is re-spent on productive investments and consumer goods. Lastly, Virginia firms that purchase university technologies may grow as a result.

- ***Labor supply and labor productivity***. Improvements in cancer detection, prevention practices, and treatment can be expected to improve the health status of labor force participants, which in turn increases labor productivity. Productivity improvements may result from decreased absenteeism and presenteeism (lower productivity on the job due to health). Related business costs (e.g., short-term disability, workers' compensation, costs of overtime for replacement employees, and costs associated with employee turnover) may decrease. Cancer care improvements may also increase the labor supply by reducing mortality rates (Birkmeyer et al. 2004) of the working age population or by improving labor force participation rates as a result of improved health.

- ***Technological change***. Cancer-related basic research and development yield broad technological advances that can be applied in a variety of fields, including biotechnology, chemistry, materials sciences, etc., to improve industrial processes, products, and services. These investments may improve national and state total factor productivity. A portion of the productivity improvement may be localized because of the importance of face-to-face contact in transmitting tacit or unpublished knowledge generated by university researchers (Audretsch and Stephan 1996).

- ***Firm clustering***. The University of Virginia Cancer Center has resulted in approximately a dozen medical device, pharmaceutical, and biotechnology startups that have chosen to remain in the Charlottesville region. In addition, the region has attracted other firms from these industries. Economic research suggests regional agglomeration economies result from the geographical clustering of similar firms in part because of the potential for sharing knowledge and the availability of a wider pool of highly skilled workers and other specialized inputs (Porter 2000).

- ***Amenities***. The Cancer Center results in expanded and improved health services for the commonwealth and shorter travel times for care. Building health care quality can increase the well-being of residents by improving regional amenities (Bartik and Erickcek 2007), including the amenity value of increased life expectancy (Carstensen and Gunther 2009). Migrants choose places to live based on amenity values and expected wage levels and are, therefore, more likely to choose Virginia as a place of residence.

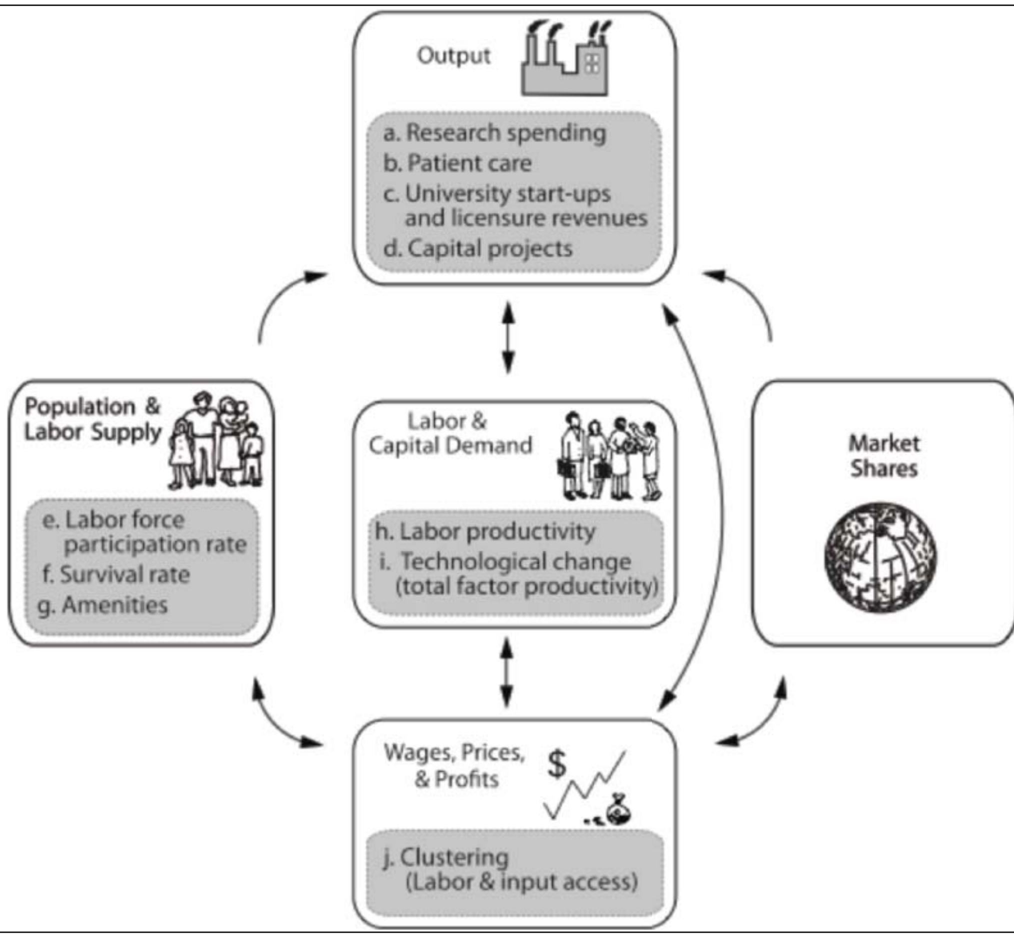
SECTION 3
METHODOLOGY

The Regional Economic Models, Inc. Policy Insight Plus (REMI PI+) model is a dynamic, multi-sector regional economic simulation model used for economic forecasting and measuring the impact of public policy changes on economic activity, area demographics, and government fiscal conditions. REMI PI+ is a conjoined model that utilizes different economic modeling approaches, including input-output analysis, econometric forecasting, and computable general equilibrium (Treyz, Rickman, and Shao 1991). The model used in this analysis includes 70 industry sectors and was customized for the state of Virginia. REMI PI+ and earlier versions of the software have been used in thousands of national and regional economic studies, including studies of university research centers and at least two studies of NCI Cancer Centers (Washington Economics Group, Inc. 2009; Deitrick and Briem 2007).

The REMI model contains five major modules or blocks (see Figure 3), which interact simultaneously. The Output Block determines expenditures for final demand, including consumption, investment, government and imports as well as demand for intermediate inputs. Final demand responds to changes in other model blocks. This module contains a key engine in the model, an input-output model based on the Bureau of Economic Analysis (BEA) benchmark transactions table that measures flows of goods and services among industries. The Labor and Capital Demand Block determines employment, capital and fuel demand as well as labor productivity. The Population and Labor Force Block models the population characteristics of the region, including age, race and sex composition. Labor force participation adjusts in response to changes in wages and employment opportunities. A key driver of population changes is migration, which is influenced by relative wage levels as well as amenities. The Wage, Price and Costs Block determines factor and product price. The Market Shares Block helps to measure exports from and imports to the region. Changes in market share are driven by production costs, demand characteristics, distance to markets and output.

Figure 3 shows how the mechanisms of economic impact described in the previous section relate to the modules in the

Figure 3. Modular Structure of the REMI PI+ Model with Cancer Center Economic Impact Mechanisms



REMI model. This study will consider only those selected linkages that affect the Output block and, in some instance, only selected expenditures within those linkages. These items are more readily quantifiable than many of the others and include expenditures resulting from the (a) attraction of research funds, (b) outpatient clinical patient care, and the (c) employment of Virginia workers by university startups. Because of the absence of many economic stimuli, the economic impact estimates provided in this study should be regarded as quite conservative. For example, outpatient clinical care reflects the kinds of care that will be provided in the new Emily Couric Clinical Cancer Center. It does not capture expenditures associated with cancer surgery, in-patient care, pharmacy, diagnostic labs, etc. The analysis does not measure the economic effects of startup equity and licensing revenues that accrue to the university and faculty researchers. It does not examine economic benefits or impacts of improved patient health and longevity or productivity increases attributable to technological breakthroughs. It does not measure the economic impacts of large capital projects (e.g., Emily Couric Clincal Cancer Center).

SECTION 4
DATA AND IMPLEMENTATION

Economic impacts are evaluated in two phases. First, an economic impact analysis is performed for the University of Virginia Cancer Center under current conditions. Second, economic impact forecasts are developed based on an alternative research spending projections. Economic impacts will result from core state funding increases of $5 million per annum, which leverages additional NCI funding, foundation/philanthropic funding, pharmaceutical company funding, and other funding. In addition, the attraction of additional research funding will result in more university startups.

Economic Impact of Current Operations

Table 1 shows some of the key assumptions used in the empirical analysis. The Cancer Center economic impact is estimated based on research funds, clinical patient care expenditures, and Cancer Center related university startup activity. **Table A**. in the appendix maps cancer center employment and spending items onto REMI PI+model block and policy variables.

Table 1. Input Data for Examining Economic Impact of Cancer Center

Area	Employment	Expenditures
Research	500	$55.5 million (70% compensation and 30% procurement)
Institutional Support	234	$21.7 million (88% compensation and 12% procurement)
Patient Care	83	$11.7 million (59% compensation and 41% procurement)
University Startups	117	REMI data for miscellaneous manufacturing, chemical manufacturing, and professional and technical services

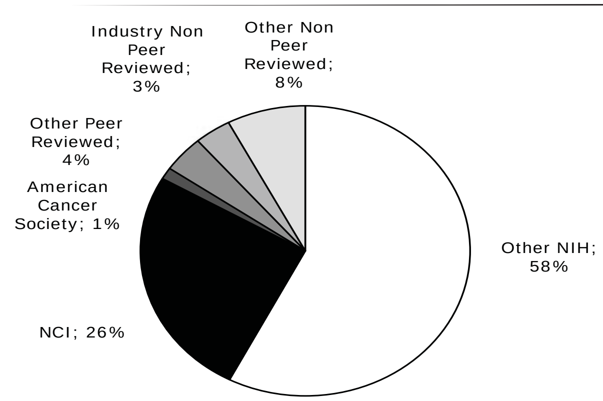
The Cancer Center was a conduit for 325 grants and contracts during FY11 that totaled $77.2 million. The vast majority of this funding comes from out-of-state sponsors, with the National Institute of Health providing 58 percent of the support and National Cancer Institute 26 percent (see **Figure 4**). $55.5 million of this amount directly supports cancer research and results in the employment of approximately 500 people at the University. An estimated 70 percent of the research expenditures were made on compensation with the remainder on procurement.

$21.7 million or 28 percent of the total Cancer Center research funds support university overhead such as facilities, university administrative activities, institutional support services (e.g., library, information technology), departmental administrative expenses and state government administrative expenses. According to the University *FY2009-2010 Indirect Cost Reports*, approximately 29 percent goes to state government.[1] Technically this share is returned to the state but effectively the sum is returned to the University as part of its state appropriation. 17 percent is returned to the individual department. Because these funds may have helped support Cancer Center members and in order to avoid the possibility of double counting, departmental funds were excluded in computing the economic impact of indirect costs. Since the exact disbursement of the remaining funds and effect on university employment were not available, they were extrapolated based on operating expense information from the *2009-10 President's Report* and institutional employment information.[2]

The Cancer Center also generates additional revenue for clinical trial outpatient care. These revenues were $11.7 million in FY 2011 and resulted in the employment of 83 full-time equivalent employees. These personnel include positions such as nurses and social workers involved in the delivery of patient care. Fifty-nine percent was for compensation. The remainder was allocated to procurement expenditure categories.

Table 2 shows a list of Cancer Center related university startups over the period 1991-2010. An estimated 11 startups since 1991 are currently operating in Virginia and have created an estimated 117 jobs by 2010. These jobs were assigned to three REMI industries: miscellaneous manufacturing (which includes medical devices), chemical manufacturing (which includes pharmaceuticals), and professional and technical services (which includes scientific research and development). Information on sales and expenses were not available. Therefore, default sector REMI PI+ values for compensation and expenditure patterns were used. It seems likely that these values substantially underestimate actual values. For instance, Burns (2009) estimates the average biopharmaceutical wage in Virginia at $88,330 in 2006 but the

Figure 4. University of Virginia Cancer Center Research Funding Sources Distribution, FY 2011



1 Source: *Indirect Cost Reports, FY2009-2010*. http://www.virginia.edu/finance/finanalysis/overhead.html

2 It was assumed that operating expenses for institutional support and operation of plant were reflective of F&A spending patterns (Note 9: Expense Classification Matrix), University of Virginia President's Report 2009-10.

Table 2. List of UVA Cancer Center Related University Startups Located in Virginia, 1991-2010

Firm	Year	Product
Humagen Fertility Diagnostics	1991	Diagnostic Kit
Argonex	1997	Pharmaceuticals
Discovery Therapeutics (now Aderis Pharmaceuticals)	1997	Pharmaceuticals
Adenosine Therapeutics, LLC (Purchased by Clinical Data Inc.)	1999	Pharmaceuticals
AdvaGen (formerly DirectGene)	1999	Pharmaceuticals
Pinnacle Pharmaceuticals, Inc.	2000	Pharmaceuticals
Diffusion Pharmaceuticals	2001	Pharmaceuticals
TAU Therapeutics, LLC	2005	Pharmaceuticals
BioMotion Analytics	2006	Medical Diagnostics
Alexander BioDiscoveries	2010	Biological Products
Ultra Genome	2010	Medical Diagnostics

Source: University of Virginia Patent Foundation and University of Virginia Cancer Center

REMI 70 sector model equivalent is the chemical manufacturing sector which has an average wage of $61,768 for the same year. Therefore, the economic impact of startups reported here likely understates the true economic impact.

Economic Impact of Improved State Funding

The University of Virginia Cancer Center will utilize proposed state funding in the amount of $5 million each year to improve its clinical trials capacity, expand its state cancer network, and increase translational research. These enhancements will enable the center to work toward achieving NCI Comprehensive Cancer Center status. Such a designation would open the door to additional NCI financial support that is available only to such centers. In addition, it would allow the Cancer Center to leverage this funding to obtain additional NIH funding, foundation/philanthropic funding, pharmaceutical company funding, and other funding. New research funding and improved commercialization infrastructure would also improve the Cancer Center's ability to generate business startups and secure additional licensure and royalty revenue for the university and the research community.

Table 3. National Cancer Institute FY2009 Funding ($ Millions)

Percentile/Mean	Amount
University of Virginia Cancer Center	$20.1
NCI Basic Cancer Centersw	N=26
25th percentile	$14.0
50th percentile (median)	$16.0
75th percentile	$21.1
100th percentile (maximum)	$54.9
Mean	$19.2
NCI Comprehensive Cancer Centers	N=40
25th percentile	$27.4
50th percentile (median)	$40.3
75th percentile	$65.3
100th percentile (maximum)	$139.2
Mean	$51.9

Source: National Cancer Institute

The state funding could also have an effect on patient care revenues. An estimated 1,500 Virginia residents currently travel outside of the state to receive clinical cancer care treatment. This number represents a conservative estimate based on surveys of four cancer treatment facilities in adjoining states (i.e., Georgetown University, Johns Hopkins University, Duke University, Wake Forest University). The actual number is likely much higher. The availability of more clinical trials at sites in Virginia would result in many more of these patients seeking treatment locally. Instead of Virginia residents in effect importing health services, the spending would be retained in the Virginia economy. The average cost associated with the initial phase of cancer patient care is approximately $40,000 in 2010 dollars.[3] Therefore, if expanded University of Virginia Cancer Center clinical trials resulted in a recapture rate of 20%, it would produce a state economic stimulus of about $12 million.

The analysis described here estimates the economic impact of the $5 million in additional state funding each year. It also examines two categories of additional economic stimulus: new research funding that results from state-funded capacity improvements and new business startups resulting from expanded research funding.

For the purposes of estimating the effect of state funding on overall research expenditures, two leveraging factors were utilized based on NCI awards to NCI Comprehensive Centers in FY09. **Table 3** shows that the University of Virginia Cancer secured $20.1 million in NCI funding that year. This amount was slightly higher than the $19.2 mean funding for generic NCI Cancer Centers for the year. In contrast, NCI Comprehensive Cancer Centers averaged $51.9 million in mean NCI funding. It is difficult, however, to disentangle the effect of NCI designation from other factors such as institution and center size, regular

3 National Cancer Institute, Cancer Prevalence and Cost of Care Projections http://costprojections.cancer.gov/

Table 4. Scenario Assumptions

Assumption	Baseline	#1 (Low)	#2 (High)
Baseline Research Funding Multiplier	1	1.36	2.00
Total Research Funding	$77.2 million	$105.2 by 10th year	$154.8 million by 10th year
State Clinical, Network, and Commercialization Funding	0	$5 million per year	$5 million per year
University Startups	1 job per $9.8 million research expenditure	1 job per $9.8 million research expenditure	1 job per $9.8 million research expenditure

state funding support, and other factors that might affect an institution's ability to secure NCI funds. Therefore, two scenarios were constructed (see **Table 4**). The first scenario assumed that the University of Virginia Cancer Center would be able to obtain funding equal to the 25th percentile of NCI Comprehensive Cancer Centers (which results in an increase in research funds of 36%). The second scenario assumed that the university would achieve the median funding level of comprehensive centers in ten years (which results in a 100% increase over the baseline FY 2011 level). The build-out period to achieve this added research activity is assumed to be 10 years at a constant (linear) rate of increase. Finally, the NCI funding multiplier is applied to non-NCI baseline research funds as well.

It should be noted that these assumptions are more modest than made in other studies that projected the effects of NCI Cancer Center designation (see Perryman Group 2006 for an analysis of the University of Kansas Medical Center and Center for Governmental Studies 2005 for a study of the University of Rochester Medical Center). These studies projected existing funding multipliers ranging from 1.7 to 2.4 (University of Rochester) to 3.7 (University of Kansas) and much shorter build-out periods of 5 years. Moreover, the University of Virginia Cancer Center has exhibited very high rates of leverage for some categories of support. For instance, CCSG Pilot Project Funds and Developmental Funds were able to obtain matching ratios ranging from 8:1 to 14:1 over the past grant funding cycle.[4]

Estimates for the number of startups stimulated are based on average university startup employment per dollar of university research revenue. An analysis of AUTM data over the period 1997-2007 shows that the average university generates one startup per $99.2 million in research expenditure.[5] At the University of Virginia, it is much better -- $53.2 million per startup—which possibly reflects the impact of the University's intellectual eminence and commercialization policies (Gregorio and Shane 2003). The average University of Virginia startups over that period had generated an estimated 5.4 Virginia jobs. Extrapolating over this pattern means that each $9.8 million in research expenditure creates one Virginia job. This figure is likely to be somewhat conservative for two reasons. First, the Cancer Center appears to have a higher ratio of startup activity and employment per research dollar than the University at large if current research funding is representative of recent history. Second, state funding targeted to translational and commercialization initiatives should boost the business startup rate above current levels.

4 University of Virginia Cancer Center Cancer Center Support Grant Application, January 24, 2011.

5 Association of University Technology Managers, Statistics Access for Tech Transfer (STATT)

SECTION 5
RESULTS

Table 5 reports the results of REMI economic impact analysis for the University of Virginia Cancer Center's current (FY 2011) operations divided into the impact categories of research, patient care and university startups.[1] Results are reported in terms of (1) employment, (2) total output, and (3) gross domestic product (GDP). Employment includes full-time and part-time workers and the self-employed and is measured by place-of-work rather than place-of-residence. Output reflects the total value of industry production during a period, including the value of intermediate input purchases. GDP is a common measure of economic activity that reflects the value of goods and services produced in the economy for final demand. All values are expressed in terms of 2005 dollars.

Table 5. Economic Impacts of University of Virginia Cancer Center (Dollar Denominated Values Expressed in 2005 Dollars)

Economic Variable	Research	Patient Care	Startups	Total
Employment	1,159	167	209	1,535
Total output	77,453,613	18,127,441	31,799,316	127,380,371
Gross domestic product	48,339,843	10,955,810	18,524,170	77,819,824
Disposable Personal income	48,553,467	6,683,350	7,965,088	63,201,904

Source: Center for Economic and Policy Studies based on data from the University of Virginia Cancer Center and Virginia REMI PI+ Model.

Results indicate that the Cancer Center creates 1,535 jobs in the Virginia economy. Of these, 934 are directly the result of the Cancer Center while another 601 are generated indirectly as a result of the purchases of the input providers. The vast majority of the jobs (1,159) are connected to Cancer Center research funds that are derived primarily from out-of-state sources. Current operations also account for $127.4 million in total industrial output, and $77.8 million in gross domestic product.

Table 6 shows the impact of the Cancer Center on state tax revenues. State revenues are calculated at state average rates using REMI PI+ and include revenue sources such as sales taxes, license taxes, individual and corporate income taxes, liquor store revenue and intergovernmental revenue. The Cancer Center generates over $8.6 million in state revenues. It is important to note that this revenue impact does not include university licensure revenues and the revenue impacts of the Cancer Center's research indirect cost contribution to state and university F&A.

Table 6. Tax Revenue Impact of UVA Cancer Center (Dollar Denominated Values Expressed in 2010 Dollars)

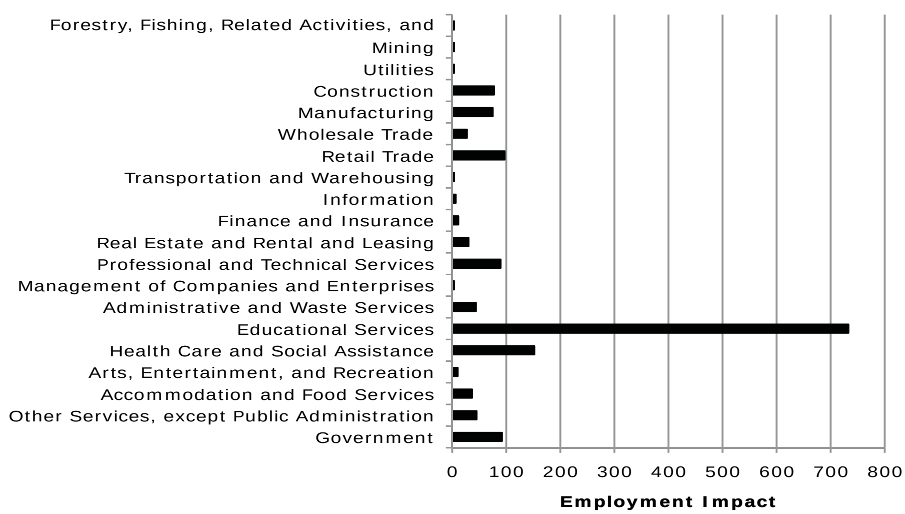
Category	Tax Revenue
Research	6,561,279
Patient Care	907,898
Startups	1,163,483
Total	8,632,660

Source: Center for Economic and Policy Studies based on data from the University of Virginia Cancer Center and REMI PI+ Model.

1 The REMI model operates on the basis of calendar years. To simplify the analysis, fiscal year numbers were assumed to align with calendar years.

Figure 5 shows the distribution of employment impacts among different sectors of the economy. The largest impact occurs in the educational services industry, which includes university direct employment. The health care and social assistance sector reflects largely the direct employment related to clinical patient care services. A significant portion of the professional and technical services impact is related to the direct employment of university startups in scientific research and development. Other impacts are generally attributable to procurement purchases and household spending. Industries receiving sizeable employment impacts include retail trade (97), government (90), and construction (77).

Figure 5. Employment Impacts by Industry, 2010



Source: Center for Economic and Policy Studies based on data from the University of Virginia Cancer Center and REMI PI+ Model.

Table 7 on page 19 provides the economic impacts for the two alternative funding scenarios resulting from increased state funding support for the Cancer Center. The first scenario shows a gain nearly 500 annual jobs by 2020, $42.4 million in total output, and $26.5 million in GDP. The second, more favorable funding scenario simulation creates an impact of 1,300 jobs by 2020, $107.7 million in output, and $67.6 in gross domestic product.

Table 7. Annual Economic Impacts of State Funding Increase, Scenarios 1 and 2 (Dollar Denominated Values Expressed in 2005 Dollars), 2011-2020

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Employment										
Scenario 1	121	159	200	239	280	320	365	411	453	497
Scenario 2	206	327	449	575	700	819	941	1,061	1,181	1,300
Output										
Scenario 1	10,803,223	12,695,313	15,136,719	17,761,230	20,507,813	23,498,535	27,343,750	31,127,930	34,790,039	42,419,434
Scenario 2	17,150,879	25,390,625	33,813,477	43,151,855	52,856,445	62,316,895	72,692,871	83,251,953	93,444,824	107,666,016
Gross Domestic Product										
Scenario 1	6,652,832	7,873,535	9,246,826	11,016,846	12,847,900	14,556,885	17,059,326	19,500,732	21,911,621	26,489,258
Scenario 2	10,620,117	15,838,623	20,996,094	26,855,469	33,111,572	38,848,877	45,501,709	52,276,611	59,082,031	67,565,918

Source: Center for Economic and Policy Studies based on funding assumptions, data from the University of Virginia Cancer Center and Virginia REMI PI+ Model.

These economic impacts generate substantial tax revenues (see **Table 8**). The first scenario generates an additional $3.6 million by 2020 while the second results in $9.4 million. Therefore, increased funding would create the economic conditions for recouping anywhere from 72 percent to over 188 percent of the added annual state outlays by 2020.

Table 8. Annual Tax Revenue Impacts of State Funding Increase for UVA Cancer Center (Dollar Denominated Values Expressed in 2010 Dollars), 2011-2020

Year	Scenario 1	Scenario 2
2011	701,904	1,182,556
2012	808,716	1,796,722
2013	896,454	2,578,735
2014	1,350,403	3,437,042
2015	1,693,726	4,394,531
2016	1,998,901	5,279,541
2017	2,380,371	6,301,880
2018	2,796,173	7,347,107
2019	3,185,272	8,354,187
2020	3,643,036	9,410,858

Source: Center for Economic and Policy Studies based on funding assumptions, data from the University of Virginia Cancer Center and Virginia REMI PI+ Model.

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APPENDIX

Table A. Mapping of University of Virginia Cancer Center Related Expenditures and Employment onto REMI PI+ Policy Variables

Area	Action	Model Block→Category→Detail→Change
Research	Payroll	Output and Demand→Industry Employment→Educational Services→Increase
		Output and Demand→Industry Employment→Compensation (Amount)→Educational Services→Increase
	Procurement	Output and Demand→Exogenous Final Demand→All Sectors→Increase
Patient Care	Payroll	Output and Demand→Industry Employment→Hospitals →Increase
		Output and Demand→Industry Employment→Compensation (Amount)→Hospitals→ Increase
	Procurement	Output and Demand→Firm Sales→Hospitals→Increase
		Output and Demand→Exogenous Final Demand→Miscellaneous Manufacturing, Chemical manufacturing, Professional and technical services→Increase
Startups	Operations	Output and Demand→Industry Employment→Miscelllaneous manufacturing, professional and technical services, Chemical manufacturing→Increase