

Discussion of Two Divergent Approaches to Building Technology Based Economic Development Through Increased Academic Research & Development

Purpose

This paper serves to examine two divergent approaches for investing Virginia's scarce resources to increase academic R&D activity – and with it technology based economic development – in the state. The first is to focus investment primarily in the very top research universities with the idea that these institutions have the greatest chance to compete on a national level for R&D dollars. The second is to focus investment on Virginia's major metropolitan areas with the idea that these areas have the greatest chance of converting additional R&D into meaningful economic development.

Does Virginia need two top 40-research universities?

Since having two top 40-research universities by 2010 was one of the goals articulated by Governor Warner during the campaign, it is probably a good place to begin the analysis. The only two Virginia institutions with a reasonable shot at reaching this goal are Virginia Tech and the University of Virginia. The most common approach to ranking research institutions is to use the NSF report of Total Academic R&D Expenditures. By this measure, Virginia Tech ranks 51 at \$192,672,000 (2000) and the University of Virginia ranks 58 at \$174,522,000. Virginia Tech has hovered at the 50-ish level for a few years now and given its recent growth rates is likely to have again cracked the top 50 when the 2001 figures come out around January 2003.

In comparison, the 40th place University of Alabama at Birmingham had 2000 expenditures of \$ 233,461,000. For Virginia Tech (51) to reach this goal, it would have to consistently grow faster than Alabama and the universities ranked number 41 through, probably, 55 for the next 10 years to make up what is now a \$40,789,000, or 21% expenditure gap. UVA (58) has an even greater challenge to make up what is currently a \$58,939,000 or 34% gap. To put these numbers in perspective, the combined \$99,728,000 increase needed is greater than the entire research budgets of Hampton Roads' research universities (\$94,387,000). The following passage illustrates the difficulty in reaching this goal ¹.

Research universities live in a highly competitive marketplace, and none of those in the top categories is likely to cease improving. This means that to get relatively better, a university must match and then exceed the growth of its competitors.

Although universities improve and decline in performance relative to each other, the patterns of change are much different in the top group than in the groups nearer the bottom of the table. In terms of federal research, for example, over a ten-year period, universities in the top groups change position infrequently. Members of these groups may move up or down by

¹ Lombardi, et. al., The Top American Research Universities, TheCenter at the University of Florida. July 2000.

one position at most. In the bottom groups, however, universities change position by much larger margins.

This pattern reflects the increasingly greater intensity of the competition towards the top.

Another way to measure the “top” research institutions is to use a combination of quantitative and qualitative factors. In its annual survey, “*The Top American Research Universities*²” The University of Florida ranks the University of Virginia within the top 40 of all research institutions. The ranking uses a methodology that includes research expenditures, private (financial) support, faculty quality, advanced training output (doctorates & post doctorates) and undergraduate quality. The Florida report is generally well regarded and has more rigor than some more common rankings like those found in *U.S. News & World Report*. Florida ranks universities by each category (above) using published data and then groups universities based on the number of categories in which they received a top ranking. Using this approach, there is no “top” university but cohorts of essentially equal universities that received the same scores. The Florida report ranks the University of Virginia in the top 26-32 research universities nationally, ahead of some 8 other universities with higher R&D expenditures. In comparison, Virginia Tech is listed in the top 64-73 research universities.

As seen above, the University of Virginia is far enough out of the top 40 in R&D expenditures that it will not crack this level without a significant effort over an extended period of time, most probably beyond the Governor’s self imposed 2010 time frame. It is, however, in the top 40 in terms of quality. This situation poses an interesting disconnect. Why is UVA, with its long history, excellent academic reputation (deserved), medical school, engineering school, business school, and significant endowment assets not already in the top 40, *or even the top 50*, with respect to research expenditures? My guess is that there is some other reason than financial need that explains why UVA does not have greater research expenditures. Perhaps it is because UVA doesn’t need to be a “top 40 R&D expender” to be considered a “top research institution.” Regardless, before a significant additional commitment of financial resources is made to attempt to bring UVA to the top 40 research spenders, the state should find out why it is not already there.

Using either methodology, if Virginia wants to be able to say it has a top 50-research university it can – with some comfort – say that it does. Looking only at quality, it can even say it has one top 40 institution. The more important question though is for what purpose do we want two top 40-research institutions? If the purpose is to have two elite research institutions, so that we may say we’re “competitive” with the best, the concept of allocating scarce resources to UVA and Tech so that those institutions can reach even higher levels may have merit.

² <http://thecenter.ufl.edu/research2001.html>

However, if the ultimate goal of R&D investment is economic development, such an investment will probably fall short of what is anticipated – and needed – to spur the Commonwealth to higher growth.

While it is generally accepted that world-class research institutions are necessary for technology based economic development, alone they are insufficient to create a technology region or state. To cite a brief example, Cornell University (15 overall or ~ 31 if the New York City based medical school is excluded) and the University of Iowa (38) are both top 40 research spenders – but neither the Finger Lakes region of New York nor the State of Iowa is generally considered a hot bed of technology industry. An argument can be made that this is due, in large part, to the fact that neither university is in a major metropolitan area with the requisite critical mass of industry and support firms necessary to efficiently translate such research flow into significant economic development. The remainder of this brief attempts to show why a strategy of allocating resources to universities in Virginia’s major metropolitan centers is probably a better approach to technology based economic development than further concentration at the top schools.

Place Matters

There is significant empirical and intuitive merit to the idea that “place, ” or more precisely “proximity,” is an important determinant of the economic impact of university R&D. Work by CHI Research, Inc.³ indicates that industry patents within a state are two to three times as likely to cite research papers coming from within the state than one would expect based on the state-by-state distribution of all papers cited in patents.

“One of the major arguments for the support of research institutions at the state or regional level is that this support contributes to technological growth within the state or region. Our findings show, unequivocally, that this is actually the case.” (CHI Research, 1998)

“Importantly, these citations bear out a strong pattern of industry preference for local scientific research. The patent citations show that companies in physical proximity to research universities use the latter’s research. In the process, they develop specialized linkages that foster the R&D commercialization process leading to competitive economic results.”

- Francis Narin, Ph.D., President, CHI Research, Forum Proceedings -- June 1998, Massachusetts Technology Collaborative

Research done at universities in major metropolitan areas has been shown to have a substantial impact on the local and regional economy. Moreover, for the same reasons that venture capitalists exhibit a preference for investing in

³ CHI Research, Inc. Haddon Heights, NJ 08035

companies close by, firms commercializing technology tend not to stray too far away from home to find innovative ideas.

Although university patents form a small percentage of national patenting, universities have come to dominate patenting in some of the most economically vibrant large cities... The increasing referencing from patents to scientific papers has also made visible the importance of universities and other public sector research institutions in local innovation... Innovators are said to favor locally produced knowledge because technological knowledge is complex and often tacit, requiring personal contact to transfer.

At first glance, scientific research results would seem comparatively easy to get - by attending conferences, reading journal articles or searching the Internet. Distance between the user of the research and the scientist's laboratory would seem to be no handicap; with cheap database searching and travel, one would expect it to be just as easy to find research across the world as across town. If a company is advancing leading-edge technology, and building on recent research, it should be able to use science from anywhere. So in the circumstances seemingly most inhospitable to finding the localization that results from complex knowledge being exchanged and developed through personal relationships, we find evidence that technological development has strong links to local scientific research.⁴

If proximity is important in realizing the benefits of research, the next question is "How far away is too far?" To my knowledge Chi has not examined research use as a strict function of distance from the originating institution. For the most part, their analyses have used data aggregated at the state level only. However, others have shown that the relationship strengthens with closer proximity to the research institution – even within a state. Examining R&D spillovers among firms, Federal Reserve economist Michael J. Orlando found just such a correlation.

"Geographically near R&D", defined as that conducted within a specified radius of each firm, is varied in the analysis from 25 to 800 miles. The preliminary analysis supports the conventional wisdom that distance attenuates spillovers. Spillovers are most significant among firms within a 50-mile radius of one another and this effect is attenuated with increasing distance.⁵"

The purpose of this discussion is to suggest that a strategy of further concentrating R&D assets in Virginia's two top research institutions, both located

⁴ The changing composition of innovative activity in the U.S. - a portrait based on patent analysis. Hicks, Breitzman, Olivastro & Hamilton. CHI Research, Inc.

⁵ On The Importance of Geographic and Technological Proximity for R&D Spillovers: An Empirical Investigation., Michael J. Orlando, July 2000., Research Division., Federal Reserve Bank Of Kansas City

outside the State's major metropolitan areas, will probably not have a significant, positive impact on the economy in Northern Virginia, Richmond or Hampton Roads -- which together represent 67% of the state's population. This concern is echoed in the call from Northern Virginia leaders for increasing R&D at George Mason University – not UVA or Tech. In November 2000 the Northern Virginia Roundtable, Fairfax Chamber of Commerce and Northern Virginia Technology Council came together to create a joint task force dedicated to *“driving George Mason to greatness.”* The document forming the task force states the reason for focusing on GMU quite succinctly, *“If we in Northern Virginia want a great economy, a great university is essential.”*

People Matter – The Advantage of R&D in Metropolitan Areas.

There is evidence that universities located in metropolitan areas have a larger impact on overall employment and income levels than rural universities. In a recent report, researchers from Cleveland State University found *“positive economic spin-offs from academic research in science and technology fields are enhanced if the research institution is located in a metropolitan area.”*⁶ The researchers found that if two regions, one metropolitan the other not, have universities of equal perceived quality, the metropolitan area will have a 5-year employment growth rate nearly 3.2 percentage points higher than the non-metro area. There is also a slightly larger increase in per capita incomes.

The researchers found that rural areas with quality PhD programs in these fields are better off than areas without quality programs but that there is a relationship between size of the area and economic benefits. *“In other words, metropolitan areas are more efficient in converting knowledge into employment growth.”* While the Cleveland State report is keen to point out that metropolitan population size alone does not determine excellence, it does appear to be a factor. Likewise, there appears to be a link between larger metropolitan areas and universities with large R&D expenditures. Of the top 40 research universities as measured by total R&D Expenditures (2000), the median metropolitan population is 1.35 million, or slightly less than Hampton Roads (see accompanying table). Moreover, 36 are in metropolitan regions with populations greater than 152,680 (Virginia Tech) and 35 are in regions larger than 159,576 (University of Virginia).

Such a conclusion also makes sense intuitively. For a variety of reasons, metropolitan areas tend to be the growth engines of a state's economy (i.e., Northern Virginia in the 1990s).

“As the focal points of economic activity, cities and counties within metropolitan areas are essential to the nation's economic development. The geographic concentration of business and people in metro areas

⁶ The Impact of the Reputation of Bio-life Science and Engineering Doctoral Programs on Regional Economic Development. Edward W. (Ned) Hill, Iryana Lendel and Larry Ledebur. Levin College of Urban Affairs, Cleveland State University 2002

creates unique economic conditions that generate new industries, speed the diffusion of knowledge, spur technological innovation, and increase productivity. Metro areas have larger markets for goods and services, more specialized labor pools, and more extensive and sophisticated transportation and telecommunications networks than non-metro areas. These competitive advantages make metro areas the engines of U.S. economic growth and global competitiveness. Today (1999), metro areas (which represent 80% of the population) generate more than 80% of the nation's employment (84%), income (85%), and production of goods and services (85%) and are the gateway for 83% of U.S. merchandise exports.⁷

Conclusion

As seen above, reaching the “top anything” in Academic R&D is a moving target. And the closer one gets to the top, the more competitive (read slow, difficult and expensive) such movement gets. Furthermore, economic spillovers from such research tend to increase with closer proximity to the research institution and metropolitan areas are in a better position to efficiently utilize the products of academic research such as skilled labor, technology diffusion and new products and processes that directly affect, or create, local establishments⁸. Together, these observations suggest the following:

1. The state's two largest research institutions are important but given their location in more rural areas of the state are not likely to be sufficient to meet the Commonwealth's technology based economic development needs. In an era of increasingly limited financial resources, a policy of building two top 40-research institutions will largely bypass Virginia's major metropolitan regions.
2. Efforts in building academic R&D capacity should not overlook Virginia's metropolitan areas (and their universities) as these will be the engines for future economic growth. To be successful in achieving technology based economic development through increased academic R&D, the Commonwealth should set, and provide funding to meet, ambitious yet achievable goals to increase the research competitiveness of all Virginia research institutions with a particular emphasis on those in major metropolitan areas.

⁷ U.S. Metro Economies: U.S. Metro Economies: The Engines of America's Growth 1999 Gross Metropolitan Product (GMP) for the Nation's 319 Metropolitan Areas. Standard and Poor's DRI division of the McGraw-Hill Companies. May, 2000. Prepared for the United States Conference of Mayors and the National Association of Counties

⁸ The Impact of the Reputation of Bio-life Science and Engineering Doctoral Programs on Regional Economic Development. Edward W. (Ned) Hill, Iryana Lendel and Larry Ledebur. Levin College of Urban Affairs, Cleveland State University

Top 40 Research Universities (2000 Expenditures) and Metropolitan Populations

	University	2000 Total Research Expenditures (\$ Thousands)	2000 Population	Tech/UVA Peer Institution?
1	Johns Hopkins University	901,156	2,552,994	
2	University of Wisconsin-Madison	554,361	426,526	VA, VT
3	University of Michigan, All Campuses	551,556	578,736	VA, VT
4	University of California-Los Angeles	530,826	9,519,338	
5	University of Washington - Seattle	529,342	2,414,616	
6	University of California-San Diego	518,559	2,813,833	
7	University of California-Berkeley	518,514	1,731,183	VA, VT
8	Stanford University	454,780	1,682,585	
9	University of California-San Francisco	443,013	1,731,183	
10	University of Pennsylvania	430,389	5,100,931	VA
11	Pennsylvania State U, All Campuses	427,575	135,758	VT
12	Massachusetts Institute of Technology	426,299	3,406,829	
13	Texas A&M University, All Campuses	423,004	152,415	VT
14	University of Minnesota, All Campuses	411,380	2,968,806	
15	Cornell University, All Campuses	410,393	96,501	VT
16	University of Illinois at Urbana-Champaign	373,024	179,669	VA, VT
17	University of California-Davis	364,789	168,660	
18	Washington University	362,216	2,603,607	VA
19	Ohio State University, All Campuses	361,399	1,540,157	VA, VT
20	Duke University	356,625	1,187,941	VA
21	University of Colorado, All Campuses	353,528	291,228	VA, VT
22	University of Arizona	345,090	843,746	VA, VT
23	Harvard University	341,810	3,406,829	
24	Baylor College of Medicine	334,175	4,177,646	
25	Columbia University in the City of New York	319,693	9,314,235	
26	University of Florida	313,692	217,955	
27	Georgia Institute of Technology, All Campuses	304,511	4,112,198	
28	University of Southern California	300,445	9,519,338	VA, VT
29	Yale University	296,706	542,149	
30	University of Pittsburgh, All Campuses	294,809	2,358,695	VA, VT
31	North Carolina State University at Raleigh	277,946	1,187,941	VT
32	University of Texas at Austin	272,811	1,249,763	VA, VT
33	University of North Carolina at Chapel Hill	269,072	1,187,941	
34	University of Georgia	258,476	153,444	
35	University of Maryland at College Park	252,429	2,065,242	VA, VT
36	Louisiana State University, All Campuses	251,233	602,894	
37	Northwestern University	245,774	8,272,768	VA
38	University of Iowa	236,944	111,006	VA, VT
39	Purdue University, All Campuses	234,536	182,821	VT
40	University of Alabama at Birmingham	233,461	921,106	
	Median for the Top 40	\$355,077	1,394,960	

Top 40 Research Universities (2000 Expenditures) and Metropolitan Populations

	University	2000 Total Research Expenditures (\$ Thousands)	2000 Population	Tech/UVA Peer Institution?
51	Virginia Polytechnic Institute and State University	192,672	152,680	
58	University of Virginia, All Campuses	174,522	159,576	
101	Hampton Roads	94,387	1,569,757	
106	Virginia Commonwealth University	88,220	996,512	
173	George Mason University	26,793	2,167,757	

Source: R&D Expenditures, NSF Academic R&D (2000); Population figures, Census Bureau; and Peer institution data, SCHEV website

Table Notes:

Cornell University is not in an MSA so population figures reflect Tompkins County, NY only.

UC Davis figures reflect Yolo County population only, however, Sacramento is within 20 miles and the Sacramento-Yolo CMSA has a population of 1,796,857.

University of Colorado at Boulder figures include only the Boulder MSA, however, Denver is only 30 miles away and the Denver-Boulder-Longmont CMSA has a population of 2,581,506.

University of MD-College Park includes only the MD portion of the Washington DC Metro area population of 4,923,153.

George Mason is placed in the VA portion of the DC Metro area of 4,923,153.

Virginia Tech is not in a metropolitan area so figures for the New River Planning District were used. If only Montgomery County is used, the population drops to 73,913.