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VIRGINIA BUSINESS CLIMATE RANKINGS

Assessing ranking variables dealing with the economic growth, innovation, higher education, and infrastructure policy

VIRGINIA TECH™ | Pamplin College of Business

EXECUTIVE SUMMARY

Since the end of the recession, Virginia has found itself in the unusual position of lagging behind much of the nation in terms of economic and business growth. As a state that was ranked number one in several business rankings prior to and during the recession, the Commonwealth has fallen in the rankings since then. Recently, the Virginia Chamber Foundation and the Virginia Economic Development Partnership (VEDP) have both investigated the many variables contributing to Virginia's declining rankings. The Virginia Chamber analysis revealed that Virginia's opportunities for growth may be hindered by longstanding challenges such as the cost of doing business in the state, inefficiencies in the state incentive programs, deficiencies in transportation infrastructure, and limitations to broadband infrastructure. Based on a variables matrix developed by VEDP, Virginia Tech reviewed 16 variables that had policy implications for economic growth, infrastructure, higher education, and innovation.

Infrastructure

Infrastructure is inextricably linked to economic prosperity. Transportation infrastructure, for instance, enables the efficient movement of goods and services across communities, links supply chains, connects workers to their jobs, and more. As such, it has a significant impact on business productivity, gross domestic product (GDP), employment, personal income, and international competitiveness. The variables reviewed for this area largely revolved around the costs and time it takes to commute to work, state spending on roads, quality of roads, and costs of poor quality roads ($ and fatalities). Compared to other states, Virginia spends less per road mile, has narrower and poorer quality roads, and significant congestion in its urban areas. Some options Virginia might consider are:

1) Continue to make quality and capacity improvements to major urban highway networks.
2) Consider ways of building on Virginia's P3 strengths to leverage public investment in multi-modal forms of transportation
3) Incentivize local and regional investment in key transportation corridors important to economic development using Smart Scale funding variables.
4) Consider the benefits and downsides of transferring and incentivizing the transfer of secondary roads control to the regional level.
5) Effectively promote infrastructure improvements to business and media entities.

Higher Education

Higher education benefits individuals, who earn more, more capable of moving up the socioeconomic ladder, and have healthier lifestyles with lower healthcare costs in their lifetime. Compared to the high school graduate counterparts, those with bachelor's degrees or above rely less on public assistance and contribute more to taxes. Many also argue that the higher education institution leads to greater economic growth through its research and human capital development; hence, its place in many business climate rankings. The variables reviewed in this area dealt with higher education funding in Virginia. While many of Virginia's peer states have increased their funding since 2000, Virginia funding of higher education has declined by 17%. Moreover, the state ranks 41st in state and local funding per full-time college student, with $5,139 per full-time student. We recommend increasing funding while tying

these funds to an outcomes-based funding model in order to improve variables in other human capital and workforce subindexes of other rankings groups. Specifically:

1) Dedicate more state funding to supporting higher education funding, particularly funding to economically disadvantage families.
2) Increased funding should also be accompanied by targeted policy that incentivizes partnerships with industry and provides experiential learning opportunities to prepare students better for the workforce.
3) Support outcomes-based incentives for higher education funding, including programs like VA's Fast Forward grant and programs that support attraction and retention of underrepresented populations in post-secondary programs.
4) Outcomes-based funding should align with VA's emerging and driver industries.

Innovation

Technological change in the 21st century is the result of the inventors, entrepreneurs, and innovators who take risks and leverage new ideas, products, and processes. Where these "pioneers" choose to do this work can have immense implications for localities (Henderson and Weiler, 2009). The state can do much to send the signal and develop the reputation that Virginia is inherently supportive of entrepreneurs and has policies to support innovative practices. Recommendation include:

1) Increase incentives and funding for R&D and commercialization.
2) Improve upon the existing IEMS system.
3) Expand and promote a high-tech workforce pipeline that leverages Virginia's industrial strengths.
4) Continue to cultivate and expand university-driven economic development and leverage their relationships with Federal anchors.

Economic Growth

Consumer spending and health of the residential real estate market are highly related to the success of growing businesses that employ higher than median wage workers. As such, Virginia must attract and grow innovative businesses. Relative to higher-ranking states, Virginia is less aggressive in its support for venture capital investment in the state, whether in encouraging venture capitalists to come to Virginia or in encouraging venture capital investment in Virginia's Businesses. In addition, Virginia is less aggressive in direct support for research and development efforts and technology commercialization. Both of these areas create an environment that is attractive to new technology development and entrepreneurial business growth. To ultimately encourage consumer spending and a healthier residential market, we recommend supporting business growth by increasing funding for R&D and commercialization as well as by increasing and revising tax incentives for venture capital investment. These changes should align with regional target industries that provide higher than median regional wages, perhaps aligning with recently establish GO Virginia target industries. These recommendations tie in heavily to the variables and goals for the innovation section.

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INTRODUCTION

Since the end of the recession, Virginia has found itself in the unusual position of lagging behind much of the nation economically. Job creation and wage growth in Virginia are slow, while peer states appear to be seeing gains. Virginia has dropped from being the #1 state in the U.S. for business in 2011 to a ranking of #13 for 2016.[1] This drop can be attributed to the state's decline in indicator rankings such as economic climate, infrastructure quality, technology use, business friendliness, tax policy and incentives, labor supply and education, as well as innovation.[2] The state's longstanding dependence on federal spending presents a structural challenge, as highlighted in the Virginia Chamber's Blueprint process, the GO Virginia program, and the Governor's New Virginia Economy initiative.

Recently, the Virginia Chamber Foundation and the Virginia Economic Development Partnership (VEDP) have investigated the variables (or measures) contributing to Virginia's declining rankings. The Virginia Chamber analysis revealed that Virginia's opportunities for growth may be hindered by longstanding challenges such as the cost of doing business, inefficiencies in state incentive programs, deficiencies in transportation infrastructure, and limitations to broadband infrastructure. VEDP has since developed a matrix of variables from nine different rankings groups[3] to assess policy areas where Virginia could meaningfully impact its business climate and overall rankings.

Aligning with the Virginia Chamber study, Virginia Tech's Pamplin College of Business and the Virginia Tech Office of Economic Development examined variables related to economic growth, infrastructure, higher education, and innovation. The table below lists the four ranking areas and variables that Virginia Tech examined as well as VEDP's initial assessment of whether addressing each variable through policy changes may have a meaningful impact on business climate rankings.

Table 1. Reviewed Business Climate Variables

Ranking Area	Variable	Meaningful Impact?
Economic Growth	Consumer spending	Maybe
	Health of residential real estate market	Maybe
Infrastructure	Commute time/Avg. travel time to work	Yes
	Transportation infrastructure (air, highway, rail)	Yes
	Perception of broadband leaders	Maybe
	Perception of infrastructure upgrade leaders	Maybe
	Quality of roads and bridges	Maybe
Higher Education	Long-term funding trends for higher education	Maybe
	State and local funding per full-time college student	Maybe
Innovation	Federal health, science and agricultural research grants	Yes
	Number of patents issued to residents	Yes
	Record of high-tech business formation	Yes
	Employment in high-tech industry as % of total employment	Yes
	Individuals in science and engineering occupations as % of the labor force	Yes
	Perception of STEM job leaders	Yes
	Support for innovation	Yes

[1] CNBC America's Top States for Businesses, Changes in Virginia's Rankings in CNBC Survey 2011-2016
[2] CNBC America's Top States for Business, 2011; Forbes Best States for Business, 2013; Tax Foundation State Business Tax Climate Index
[3] These rankings systems were from Beacon Hill Institute, Business Facilities, CNBC, Forbes, and Pollina

In the following, Virginia Tech reviews four policy areas with their respective variables: economic growth, infrastructure, higher education, and innovation. We identify specific policy recommendations to improve Virginia's future position based on the aforementioned variable rankings. To do this, we examined how the business climate rankings groups measured the listed variables above. This analysis helped Virginia Tech assess how policy might effectively influence these variables and thus impact Virginia's standing in future rankings. Note that these variables often contribute to subindex rankings (e.g. innovation, infrastructure, education, and economic growth). The subindexes then combine to form the larger business climate ranking. Thus analyzing these variables and how Virginia ranked with respect to these variables, their ensuing subindexes, and finally the business climate rankings overall, was sometimes analogous to thinking about the relationship between Russian nesting dolls. For example, we analyzed how Virginia's low ranking in the state high education spending variable affected its rank in the education and human capital subindexes of different rankings groups, and then how those subindexes contribute to the larger rankings.

In Phase 2, we identified comparable states based on state rankings and other factors specific to each policy area. For instance, for infrastructure, we identified highly ranked states with comparable topographies and transportation infrastructure. Reviewing policy trends within these states, we identified possible steps that Virginia could or should not take that would potentially impact one or more variables.

In Phase 3 of this research, Virginia Tech conduct some stakeholder outreach during which we gauges the feasibility of these policies for the Commonwealth of Virginia. This document includes a brief description of variables and their place in business rankings, an analysis of these variables, a short description of possible policies from other best practice states, and a list of vetted policy recommendations for Virginia.

A REVIEW OF BUSINESS RANKINGS AND EXAMINED VARIABLES

A wide variety of business rankings exist in the Unites States and internationally. Following VEDP's lead, Virginia Tech focused on five different rankings groups: *Beacon Hill Institute*, *Business Facilities*, *CNBC*, *Forbes*, and *Pollina*. Each of these groups based their state rankings on a compilation of subject matter subindexed (such as the four policy areas explored in this report) and a number or variables comprising these subindexes. We define variables as quantitative and sometimes qualitative measures that help to measure the success of a state in a certain area such as quality of roads or consumer spending growth. These rankings groups pull variable data from other rankings—e.g. Area Development, Chief Executive, Development Counsellors International, Site Selection, and the Reason Foundation—as well as other organizations and sources such as the U.S. Census, Bureau of Economic Analysis, American Society of Civil Engineers, State Higher Education Officers Association, National Science Foundation, and others.

Although this report bases much of its analysis and recommendation on these rankings variables, it is important to note the failings in relying too much on rankings when considering policy. Rankings data is largely based on secondary data as well as, in some cases, perception. In the case of secondary data, the variables are only as good as the data collection and reporting to data analysis groups (such as those listed above). Not all states collect and report data in the same way or have comparable accessibility to

data; thus, the data reported by these difference organizations may not always be as comparable as it seems. Moreover, data and policy tend to lag behind current circumstances. Some rankings groups must pull variable data from two years ago simply because that is the only data available. Meanwhile, current data has actually shown significant improvement due to policy and actions by state and local governments. Perceptions of what and how well a state is doing may also play a role in the rankings no matter how scientific the methodologies of rankings groups. Thus, in some case, policy may play less of a role in influencing business rankings as cohesive marketing and communication of state business activities and incentives.

Finally, many of the variables included in these business rankings are not necessarily reflections of good business activity, but are inputs that are assumed to result in good business activity. For example, these rankings groups make the assumption that large amounts of spending on infrastructure, education, and other activities result in good business outcomes for the state, which is not always the case. Indeed, in the transportation section of this report, it is evident that while Virginia may not spend as much dollars per mile of road and has a larger proportion of narrower roads compared to other states (both measures are input variables), the Commonwealth has a lower fatality rate than many states (an outcome variable). As such, this report does attempt to account for not just the influence policy has on each of the variables examined, but also on the overall business outcomes for Virginia.

INFRASTRUCTURE-RELATED VARIABLES

While infrastructure can include water and sewer, telecommunication networks, public transit, ports and waterways, and airports, this report section focuses mostly on transportation infrastructure, specifically the state of roadways in Virginia. Of the infrastructure variables Virginia Tech explored, most of the data used to measure these variables had larger policy implications for state-owned road networks than for other infrastructure in the state; however, we do reference broadband, rail, airport, bridge and intermodal infrastructure to some extent.

In recent years, the state of our nation's infrastructure has become a growing concern, as evidenced during the 2016 presidential election when both main party candidates highlighted improving U.S. infrastructure as a key policy point. This concern stems not only from threats to health and safety of our population but also from unease with our nation's economic growth. Infrastructure is inextricably linked to economic prosperity. Indeed, one definition for infrastructure is, "the basic physical and organizational structures needed for the operation of society or enterprise or the services and facilities necessary for an economy to function."[4] Transportation infrastructure, for instance, enables the efficient movement of goods and services across communities, links supply chains, connects workers to their jobs, and more. As such, it has a significant impact on business productivity, gross domestic product (GDP), employment, personal income, and international competitiveness.[5]

[4] Wagner, L. (2012). "Infrastructure Lessons for Economic Growth and Business Success." AreaDevelopment. Retrieved from: http://www.areadevelopment.com/logisticsInfrastructure/Summer2012/infrastructure-effects-economic-development-success-27628151.shtml.

[5] American Society of Civil Engineers (2017). Infrastructure Report Card: Economic Impact. Retrieved from: https://www.infrastructurereportcard.org/the-impact/economic-impact/; Puentes, R. (2015). "Why Infrastructure Matters: Rotten Roads, Bum Economy". Brookings Institute Op-Ed. Retrieved from: https://www.brookings.edu/opinions/why-infrastructure-matters-rotten-roads-bum-economy/

Spending on infrastructure has declined in the past several decades despite its significance to the nation's economy and evidence of aging and excessive use. A 2016 American Society of Civil Engineers (ASCE) economic study predicted that if federal and state governments fail to close a $206 billion annual investment gap, failing infrastructure will cost $3.9 trillion in losses to the U.S. GDP, $7 trillion in lost business sales, and 2.5 million lost American jobs by 2025.[6] Meanwhile, Congress passed Moving Ahead for Progress in the 21st Century (MAP-21) in 2012 and the Fixing America's Surface Transportation (FAST) Act in 2015. These laws call for contributing more funds to improving infrastructure while mandating that state Departments of Transportation (DOTs) and Metropolitan Planning Organizations (MPOs) develop performance measures to receive federal funding for the multimodal transportation system in their state or region. Their performance measures (safety, infrastructure condition, congestion reduction, system reliability, freight movement, and economic vitality) are variables important to business climate rankings.

State strategic plans for transportation tend to reflect this federal mandate as well as explore issues of road quality, funding, and institutional collaboration. Virginia's legislature and Department of Transportation (VDOT) have been particularly proactive in recent years in response to federal legislation and growing demand from citizens and industry. In 2013, the state house passed HB2313, which significantly increased funding to Virginia's transportation system, diversified the state's transportation revenue, and subsequently initiated the Smart Scale system, which helps to strategically prioritize infrastructure projects. Many of the measures the Smart Scale uses directly align with variables used in business climate rankings. Some of the projects initiated through HB2313 focus on transportation corridors with high congestion and poor road quality, which would affect many of the variables we describe below. These projects include:

- **I-95 HOT Lanes** – The billion-dollar project has improved congestion, mobility and connectivity on the busiest road in Northern Virginia.
    - *Status – Complete*
- **Route 29 Solutions** – The Charlottesville-area project will widen Route 29, one of the area's most traveled routes, to six lanes and improve upon existing traffic signals.
    - *Status – Under Construction, Estimated Completion: October 2017*
- **I-64 Capacity Improvements** – Multiple widening projects are taking place in the Hampton Roads area to alleviate major congestion issues.
    - *Status – Under Construction, Estimated Completion: 2021*
- **Transform 66** – Multiple improvement projects are in the works to transform Northern Virginia's Interstate 66, both inside and outside the beltway.
    - *Status – Qualification Proposals Submitted, Estimated Completion (Outside the Beltway): 2021*.[7]

Many of these larger capital projects have been facilitated through private-public partnerships. Indeed, Virginia is recognized as a national leader in transportation infrastructure private-public partnerships according to Secretary Aubrey Layne during a May 2017 state Senate Environment and Public Works Subcommittee hearing on transportation and infrastructure.

[6] American Society of Civil Engineers (2017).
[7] Virginians for Better Transportation (2017). HB2313 Overview. Retrieved from: http://vbtva.com/hb2313.aspx.

> *Since 2007, we have closed 5 public-private partnership deals that transfer design, construction, finance, operations and maintenance responsibilities to the private sector. Collectively these deals are worth more than $9 billion, with more than $2.5 billion coming from private equity, less than $1 billion in public funds, and the remaining from privately backed debt. In addition, we are currently negotiating contracts for an additional $1 billion in public-private partnership improvements along the I-95/I-395 corridor.* [8]

These projects leverage public dollars to improve not only roads infrastructure, but other transportation infrastructure as well, resulting in improved road quality and capacity for improved industry attraction and development.

Virginia Tech researchers explored the following variables that key organizations (e.g. *CNBC*, *Business Facilities*, *Pollina*, and Beacon Hill) incorporate into their business climate rankings:

Average commute times. Average commute times and congestion data are variables used by *Beacon Hill Institute*, *CNBC*, *Forbes* and others. While this variable can be influenced by the quality of public transit, over 86% of Virginian residents drive to work. Even 67% of residents in Alexandria and 59% in Arlington, where public transit is more prevalent, drive cars.[9] The average commute time in Virginia is 28.5 minutes, which is a longer average commute time than 43 other states in the U.S.[10] The Washington DC metropolitan area, in particular, is ranked first in the nation for yearly delay, excess fuel, and congestion costs per auto commuter. Congestion cost per commuter is $1,834 annually in the DC metro area.[11] The American Society of Civil Engineers gives Virginia roads a D grade, stating, "a lack of capacity results in traffic congestion and gridlock, especially in Washington DC-VA-MD and Hampton Roads regions that negatively impact commuters, industry, and the economy."[12]

Transportation infrastructure (*Pollina*). *Pollina*'s transportation infrastructure variable is often inclusive of other infrastructure variables highlighted in business climate rankings; for instance, dollars spent on state-owned roads, quality of road infrastructure, and road fatality rates.[13] *Pollina* uses these indicators in its infrastructure subindex, ranking Virginia 25th in the nation. The Commonwealth struggles in this subindex primarily because of its high percentage of state-owned roads compared to most states in the U.S. Similar states that report large percentages of state-controlled roads also tend to rank poorly in *Pollina*'s infrastructure subindex. According to the Federal Highway Administration, states control 20% of roadways on average. The remainder are owned and overseen by metropolitan areas, counties and townships. Virginia controls 78% of state roadways, including highways, secondary and artillery

[8] Commonwealth of Virginia (May 2017). Testimony of the Honorable Aubrey Layne Secretary of Transportation for the Commonwealth of Virginia. Senate Environment and Public Work's Subcommittee on Transportation and Infrastructure. Retrieved from: https://www.epw.senate.gov/public/_cache/files/d/c/dcaf3f1d-323e-4408-83f6-bf0cf71440d1/B5A0BAB8E95A5332CFDFF85DD4DDEE5E.layne-testimony-05.16.17.pdf.

[9] American Community Survey 2016 One-Year Estimates.

[10] Ibid.

[11] Texas A&M Transportation Institute (2014). Congestion Levels and Trends. Retrieved from: https://mobility.tamu.edu/ums/national-congestion-tables/.

[12] American Society of Civil Engineers (2017).

[13] Although transportation infrastructure can include air, rail, and roads, we highlight road indicators for several reasons. First, business rankings tend to use separate variables for air transportation, including air passengers per capita and availability of air travel. VEDP already highlighted those variables as "no action proposed at this time", possibly because air transit in Virginia is already well-regarded. Second, state policy may not be able to influence rail infrastructure, as it is mostly privately owned.

roads.[14] As such, when rankings groups like *Pollina* wish to incorporate dollars spent per road mile as a variable in their sub-index, states like Virginia will have fall at the bottom of the list unless they spend significantly more money than other states. Thus, despite the fact Virginia is in the top ten for 2015 road spending at $4.2 billion, spending per road mile places Virginia at 43 out of 50 states.[15] Meanwhile, *Forbes* ranks transportation infrastructure using Moody's bond rating, or the credit quality of state bonds issued for transportation infrastructure construction. Virginia Transportation bonds are rated Aa1—the second highest investment grade one can receive—which contributes to Virginia's 3rd place in *Forbes*' Regulatory Environment subgroup.[16]

Quality of roads and bridges (*Pollina* and *CNBC*). *Pollina* and *CNBC* both use this variable in their rankings. Quality of roads and bridges can be a factor of rural and urban interstate pavement conditions, number of deficient bridges, narrow rural lanes, and fatality rates. As *CNBC* uses the American Society of Civil Engineers as one of its sources, commute and congestion are also linked to road quality. Virginia's low percentage of excellent roads, its higher portions of narrow rural roads and its congestion may hamper the state in these rankings. A Virginia motorist pays $556 annually due to roads in need of repair, compared to the national average, $533.[17]

- *Pavement Conditions:* Of Virginia's over 75 thousand miles of public road, 23% are in poor condition according to the International Roughness Index. Commonwealth rural and urban roads are ranked 12th and 21st respectively for roads qualifying as poor. However, Virginia also has lower percentages of roads qualifying as excellent compared to other states. For excellent roads, rural and urban roads are ranked 43rd (34.3%) and 41st (23.8%) respectively.[18] The Virginia Department of Transportation (VDOT), however, notes that when rural roads are repaved and treated, the roughness of those roads can actually go up, which raises the question of the validity of this measure.
- *Deficient Bridges:* 6.7% of Virginia bridges are structurally deficient, which is better than the national average, 9.1%.[19] Moreover, VDOT explains that the measure has actually improved since the National Bridge Inventory was last updated in 2016. The percent of deficient bridges in the Commonwealth is now a little over 5%.
- *Narrow Rural Lanes:* Virginia ranked 49 out of 50 states for percent of "narrow" rural roads, or those that are less than 12 feet wide. Of Virginia's almost 1,300 miles sampled, 33.5% were classified as narrow. The next state ranked just above Virginia was Arkansas, which had 24.6% narrow roads.[20] VDOT notes that this measure is so high because Virginia includes subdivisions, which average about 9 feet.
- *Fatality Rates:* This is another measure incorporated in *CNBC* and *Pollina* subindex rankings. Virginia had a lower fatality rate than 39 states in 2015, with 9.1 deaths per billion vehicle

[14] Department of Transportation (2015). Retrieved from: https://www.fhwa.dot.gov/policyinformation/statistics/2015/
[15] Ibid.
[16] Moody's (2017). Virginia Credit Ratings. Retrieved from: https://www.moodys.com/credit-ratings/Virginia-Commonwealth-of-credit-rating-600026613
[17] American Community Survey 2016 One-Year Estimates; Federal Highway Administration (2017); American Society of Civil Engineers (2017). Infrastructure Report Card. Retrieved from: https://www.infrastructurereportcard.org
[18] Federal Highway Administration (FHWA; 2017). Highway Statistics 2015. Retrieved from: https://www.fhwa.dot.gov/policyinformation/statistics.cfm
[19] FHWA (2017). National Bridge Inventory Database. Retrieved from: https://www.fhwa.dot.gov/bridge/nbi.cfm
[20] FHWA (2017). Highway Statistics 2015. Retrieved from: https://www.fhwa.dot.gov/policyinformation/statistics.cfm

manuals annually.[21] Road fatalities are particularly low in Northern Virginia and the Hampton Roads, but are high in the Southside region.[22] Unlike the measures described above, fatality rate is more of an outcome measure of road quality. Thus, although Virginia roads tend to be narrower and designated "poorer" than other states on average, other state policies such as law enforcement, motor vehicle inspections, school driver training and awareness, and health campaigns (e.g. alcohol use) have resulted in this road safety outcome measure. To learn more about Virginia's proactive and performance-based road safety policies, see its 2017 Highway Safety Plan: https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/va_fy17hsp.pdf.

Perceptions of infrastructure (*Business Facilities*). *Business Facilities* uses three infrastructure variables that are heavily influenced by perceptions: best infrastructure, perceptions of broadband leaders and perceptions of infrastructure upgrade leaders. Based on exchanges with *Business Facilities* rankings authors, these rankings seem highly dependent on state marketing and outreach to business leaders. For example, the publicity Virginia Beach received for infrastructure upgrades to its port system, which allows for larger cargo ships coming through the Panama Canal, may have improved Virginia's port infrastructure reputation among business leaders. In this case, Virginia ranks well. *Business Facilities* ranks Virginia tenth in the nation for best infrastructure and seventh for broadband leaders. Promoting new infrastructure initiatives, such as expanding broadband in the state, may increase these rankings in the future.

Policy Examples from Other States

Virginia Tech reviewed five states with somewhat comparable road miles and topography to Virginia, which would influence transportation infrastructure policy, particularly spending and quality of the infrastructure. Georgia, Kentucky, Ohio and Tennessee are well-ranked in general, but they are also in the top ten of several infrastructure rankings. Additionally, we reviewed transportation infrastructure policy of the lower ranked Pennsylvania, which is one of a handful of states that are similar to Virginia in that the state controls the majority of the road network.

Table 2: Key Business Climate Infrastructure Metrics of Virginia and Peer States[23]

	VA	GA	KY	OH	PA	TN
2016 Avg Commute Time (minutes)	**28.5**	28.5	23.3	23.4	26.9	25.1
2016 Annual Delay per Auto Commuter (hours)	**60.65**	45.83	37.50	35.12	38.45	38.88
2015 Total Road Miles	**75,061**	128,134	79,857	122,926	120,091	95,637
% 2015 State-controlled Roads	**78%**	14%	35%	17%	34%	15%
2015 Annual Spending ($ Billions)	**$4.21**	$2.65	$2.61	$4.34	$8.04	$1.82
2015 Annual spending per state-controlled mile	**$71,829**	$146,909	$92,681	$213,040	$281,943	$108,828
2015 % roads in poor condition	**23%**	4%	8%	17%	32%	8%
2015 % narrow roads (<12ft)	**33.5%**	5.8%	9.6%	8.3%	24.2%	16.0%
2015 Cost per motorist for poor roads	**$556**	$196	$331	$475	$606	$271
2015 % Deficient bridges	**6.7%**	4.7%	8.1%	6.9%	19.8%	5.0%
Fatalities/100 Million Vehicle Miles	**0.91**	1.21	1.56	0.98	1.19	1.25

[21] Ibid.
[22] Virginia Performs (2015). Retrieved from: http://vaperforms.virginia.gov/indicators/publicSafety/trafficFatalities.php.
[23] American Community Survey 2016 One-Year Estimates; Federal Highway Administration (2017); American Society of Civil Engineers (2017). Infrastructure Report Card. Retrieved from: https://www.infrastructurereportcard.org.

Georgia

Georgia ranks highly in the infrastructure subindex of two of the business climate rankings (*CNBC*: #4; Business Facility: #6) and outside of the top ten in the *Forbes* and Beacon Hill infrastructure rankings. Georgia has four distinguishing factors that may increase its ranking scores compared to Virginia. First, GDOT manages a relatively small share of the road system (15%) compared to Virginia.[24] Most GDOT roads are highways, which typically are maintained at higher levels than secondary roads. The majority of secondary roads are managed by county and local government, which is sometimes supported by GDOT via improvement grants, housing data, and a certification process for localities to administer federally funded projects.[25] The result of this difference in ownership is disbursements towards reconstruction and improvements in Georgia ($64,648 per state controlled lane-mile) are about twice that of Virginia ($31,242 per lane-mile); a similar difference is apparent in total disbursements per lane mile (GA: $146,909; VA: $71,829).[26]

Second, Georgia's has added 4,700 lane miles of roadway since 2006, adding to its overall capacity and reducing congestion. Congestion in Atlanta went from costing a commuter $1,865 in 2005 to costing them $1,120 in 2011, a difference of $745 in annual savings. Annual delay per auto commuter is moderately lower in Georgia (45 hours) as compared to Virginia (60 hours). Third, Georgia's road infrastructure is of high quality. A relatively high number of roads are classified as excellent in Georgia (50%) as compared to Virginia (24%), and only 4% are considered in poor quality compared to Virginia's 23%. As such, annual costs to motorists from driving on roads in need of repair are only $196 per motorist (compared to Virginia's $556). Fourth, because of its high profile investments and efforts to improve its infrastructure, Georgia may rank more highly for organizations like *Business Facilities*.

Georgia has undertaken multiple initiatives to address projected funding gaps to maintain transportation systems. For example, the Transportation Investment Act of 2010 (TIA) created 12 regional special districts and allowed citizens in each district to vote on a 10 year, one percent regional transportation sales tax, to fund a list of transportation projects selected by their local elected officials. Three districts have since approved this tax. Additionally, Georgia recently passed the Transportation Funding Act of 2015 which included additional revenue sources for transportation projects including: increasing the state motor fuel excise tax rates (from 7.5 cents to 26 cents per gallon); hotel/motel nightly fee ($5 per night), heavy vehicle annual impact fee, fee for alternative fuel vehicles, removal of rebates for zero emission vehicles. Furthermore, the SSTP illustrates a variety of different funding scenarios for each state transportation system; then frames performance measures for each scenario and implications for economic growth.

Kentucky

Kentucky is ranked in the top half (*CNBC* #6, Beacon Hill #6, and *Pollina* #14) in a majority of the infrastructure subindexes (ranks #35 for *Forbes* and outside the top 10 for Business Facility). Each ranking where Kentucky has performed well highlighted the strengths in the state's infrastructure, which include the state's large waterway improvement project (*CNBC*), low average time of travel for commuters (*CNBC* and Beacon Hill), cheap electricity prices (Beacon Hill), and quality of pavement

[24] Federal Highway Administration (2017).
[25] Ibid.
[26] Federal Highway Administration (2017).

(*Pollina*). Kentucky performs better than Virginia on annual delay per auto commuter (37.5 hours), percent of narrow rural roads (17.25%), and quality of roads. Of Kentucky's 79,857 lane miles, only 8% are in poor condition. The state also has a high percentage of excellent roads: urban interstate (71%), rural interstate (52%) and rural other principal arterial (43%). Kentucky's spending on construction and improvement is almost double Virginia's, but spending on maintenance is slightly lower. Total spending in Kentucky is more than $20K per mile more than in Virginia.

Kentucky Transportation Cabinet (KYTC) is in charge of the management and planning of the state's 28,197 road miles (35.6% of state-controlled roads). KYTC works closely with MPOs to coordinate planning, along with actively engaging 15 Area Development Districts and 12 Highway Districts outside of metropolitan areas. In 2004, Kentucky began the process of formalizing the transfer of jurisdictional power from local to state controlled roads to reduce the burden on localities. The state will accept roads from localities in exchange for localities taking one-mile of road from the state system. Local roads transferred to the state must meet certain standards; for example, they must be classified as arterial or connectors, have a width equal to or greater than 10 feet, and be paved and meet the current Division of Maintenance standards. Kentucky's process of establishing guidelines and a framework to transfer jurisdictional control could be a model used by Virginia in dealing with that state's highway system.

Kentucky's success in infrastructure rankings may be due to the relative size of the budget, distribution of funding, and the state's commitment to maintaining connectivity of a largely rural population. Kentucky has a floating gas tax that is tied to the wholesale tax rate, and has a floor of $.20 per gallon, which is higher than Virginia's current tax rate. Notably unlike Virginia, a majority of funds are distributed to road construction and improvement (76%) compared to maintenance in the 2015 fiscal year. As for long-term planning Kentucky's top priority is providing safe roads, however improvement project goals emphasize Kentucky's commitment to "Improving local, regional, and global connectivity and access" and "dependable access to markets, jobs and resources." Going forward Kentucky is adopting performance measures in line with MAP-21, which include measures on safety, pavement condition, freight performance, system performance, congestion mitigation and air quality.

Ohio

Ohio is well-ranked for its infrastructure due to its lower average commute time, high spending on roads per mile, and strong intermodal network *CNBC* ranks Ohio's infrastructure 5th and *Beacon Hill Institute* ranks it 3rd in the nation. For Beacon Hill, Ohio seems to have a competitive advantage in mobile phones per 1000 people, average rent of two bedroom apartments, and average travel time to work. Its average commute times and low annual delays are among the best of the peer states viewed here, despite the state's three large and one medium-sized metropolitan regions across the state. One reason for this better commute time may be its greater number of lanes along both urban and rural roads. Ohio has a higher ratio of lane miles to road miles (2.57:1) than Virginia (2.17:1). Particularly in more urban areas, where congestion is greatest, Ohio has 3.35 lanes miles per mile of road compared to Virginia's 2.45 lane miles to mile of road. Similarly, about 8.3% of rural Ohio roads are considered narrow compared to Virginia's 33.5% of narrow roads.

Ohio Department of Transportation (ODOT) spends about $100 million more annually than Virginia on its roads infrastructure. However, much of its spending passes directly to local governments to support their roads infrastructure. Approximately 19.4% or $366 million in Federal funding is passed on to local programs, including Metropolitan Planning Organizations, city and county pavements and bridges, and

various enhancement projects. This allocation of federal funds to local government is three times the amount required by the federal government. Despite this high rate of spending, the quality of Ohio's roads is still not what it should be. Ohio's percentage of poor roads (17%) is only 6% less than Virginia (23%) but better than the national average (20%). Its urban and rural roads considered in excellent condition are about 15% greater than in Virginia. As a result, the average Ohio motorist pays $475 annually for poor quality roads.

To make ODOT's spending more effective on improving Ohio's road quality and overall economic development, Ohio has created the Strategic Transportation System (STS) initiative and developed a TRAC system for vetting infrastructure projects. According to *CNBC*, the state moves "massive quantities of goods every day" using its intermodal network of inland ports (the Ohio River and Lake Erie), railways, and highways. Ohio is ranked 4th nationally for the miles of freight railroad and 9th nationally for the tons of cargo shipped through its ports. To build on this economic strength, the STS initiative identifies key transportation corridors necessary to economic growth. ODOT explains, "In the coming years, the STS will become a tool that state, regional, and local transportation agencies use to prioritize and coordinate additional discretionary transportation investments. ODOT will use the STS to help target investments and strategies to the transportation facilities most critical to Ohio's success." The TRAC system incentivizes projects that decrease road congestion and crashes, that target the transportation corridors identified as necessary for economic growth, that are projected to increase regions' GDP and employment, and that show evidence of private-public local investment.

Pennsylvania

Pennsylvania performs poorly across the infrastructure subindex of all the business rankings (#25 Beacon Hill, #38 *CNBC*, #41 *Pollina*, #39 *Forbes*, and outside the top 10 for *Business Facilities*). This is partly due to quality issues across the system, including poor quality roads, relatively a high fatality rate, and comparably narrow roads to Virginia. These poor quality indicators come even as the state has substantially larger disbursements in both construction ($124,509 per state controlled mile) and maintenance ($51,190 per state controlled mile) compared to Virginia. These higher spending trends came into effect in 2013, when the state legislature passed a steep funding increase for transportation, which can partly account for the discrepancies in spending versus road indicator performance. Impact on road quality may not have gone into effect and/or shown up in the variables contributing to infrastructure rankings.

Pennsylvania's ACT-89 added an additional $2.3 billion in funding to the state's transportation infrastructure over a five year period (2013 - 2018). Part of the funds come from the restructuring of the state's retail gas tax to a wholesale gas tax, which increased by 87% from $.312 to $.582 per gallon. Under ACT-89, localities would receive the same proportion of state funding; however, the state provided additional funds for low-traffic-volume rural roads, increased incentives for municipalities seeking to consolidate with other regional partners, and created a multimodal investment grant fund.

To improve its infrastructure, Pennsylvania is also incentivizing localities to take control of public roads. Similar to Virginia, Pennsylvania took control of many local and rural roads during the early 20th century in an effort to improve economic development. Currently Pennsylvania Department of Transportation (PennDOT) maintains and manages about 56,415 road miles (35%). Starting in 1981, however, the state started to incentivize localities to take control of public roads within their jurisdiction. The program is now called the Highway Transfer "Turnback" Program and provides $4,000 in funding for every mile of

road a locality adopts into their system. Roads that have gone under improvement and are considered 'functionally-local state-owned' are eligible for the program. Roads are given back to localities based on a cooperative and voluntary basis.

Economic development is highlighted in the ACT-89 legislation, the state's long-term planning, and several other transportation activities. Part of the performance objectives in ACT-89 are to increase access to jobs and increase personal and freight mobility. In the future, Pennsylvania plans to incorporate system performance measures including number of fatalities and serious injuries, annual hours of truck/auto delays (cost of delays), and annual savings through PennDOT modernization.

Tennessee

Tennessee is ranked second in the nation by *CNBC* and *Business Facilities* for transportation infrastructure. One reason may be its well-publicized IMPROVE Act from this past year. *CNBC* describes the Tennessee Valley Authority as a model for public works management, stating, "the state's IMPROVE Act relies on gasoline taxes and user fees to fund nearly a thousand highway projects, while ultimately cutting state and local taxes by $500 million a year."[27] While cutting taxes in several other areas to allow for a $500 million tax cut annually in the coming years, the new IMPROVE Act increases gas taxes and fees to fund 962 needed road and bridge projects across 95 counties in Tennessee. These increased funding mechanisms include:

- Increased vehicle registration (+$5 for passenger motor vehicles, +$10 for commercial motor vehicles transporting passengers, and +$20 for commercial and freight motor vehicles.
- Electric Vehicle Registration Fee (+$100 in addition to standard fee)
- Gas Tax (From $0.20 to $0.26 by 2019)
- Diesel Tax (From $0.17 to $0.27 by 2019)
- Compressed Natural Gas and Liquified Gas (increase by $0.08 each)

These revenue increases are particularly important for Tennessee, which was more dependent on federal highway funds than the national average (26%) with 42% of all receipts coming from federal highway funds.

Another reason Tennessee may be well-known for its public works is its collaboration among state, regional and local governments to strategically prioritize infrastructure construction and maintenance. In 2013, TDOT established the Office of Community Transportation (OCT) to support coordination between TDOT, public transportation organizations, private non-profit transportation providers, and public agencies by: 1) Partnering with local agencies to coordinate appropriate land use and infrastructure; 2) Strengthening local partner collaboration on transportation decisions; and 3) Improving communication between TDOT and local partners through planning efforts.

BHI ranks and *Pollina* rank Tennessee 17th in infrastructure (not just transportation infrastructure). The states low annual spending and as few as 8% of roads in poor condition may have contributed somewhat to the state being in the upper half of state infrastructure rankings. However, Tennessee still has higher fatality rates.

[27] CNBC (2016). The 10 states with the best infrastructure in America. Retrieved from: https://www.cnbc.com/2017/07/11/10-us-states-with-best-infrastructure-cnbc-top-states-for-business.html

Possible Implications for Virginia

Continue to make quality and capacity improvements to major urban highway networks and public transit systems to improve commuter time and congestion costs. Similar to what Georgia did since 2006, Virginia has already made capacity improvements to some of its most congested roads including I-95, I-495, and several other roads in Northern Virginia and Hampton Roads. **In time, these current improvements may be reflected in probably the most influential variable we reviewed: average commuter time.** Continuing these capacity building projects can be beneficial to overall rankings. However, other policy factors may also contribute such as improving other modes of transportation such as freight and passenger rail and public transit (bus and commuter rail). Already, Amtrak lines connecting Roanoke, VA to Northern Virginia may result in less traffic and increased capacity on I-81. The continued extension of the DC metro out to Northern Virginia suburbs may also help with congestion challenges. As done in Ohio, Virginia may identify key transportation corridors necessary for economic growth, incentivizing their development through its Smart Scale system. While this effort will require resources, it is also the most likely chance of pushing the transportation infrastructure rankings needle over the long-term. Federal grants such as Fastlane grants, which provide funding to nationally significant freight and highway projects, the Transportation Investment Generating Economic Recovery (TIGER) grant program, and continued/expanded private-public partnerships may be options for alleviate some of the financial burden.

Consider transferring more control of roads to townships, counties and regional entities. Any organization that uses Reason Foundation statistics (like *Pollina*) inadvertently favors states who control fewer road miles. Drawing from Federal Highway Administration (FHA) data, the Reason Foundation measures state spending by dollars per state-controlled miles. Only a small handful of states control as many miles of road as Virginia. Examples include Alaska, Delaware, North Carolina and West Virginia. None of these states have highly ranked transportation infrastructure, leaving them and the Commonwealth at a disadvantage in this ranking system. In the short-term, the state might devise a means of accounting for this difference in its reporting to the Department of Transportation FHA.

In the long-term, more local control with state support may not only improve certain rankings, but it could also help to improve overall infrastructure revenues. A Brookings op-ed noted that:

> Metropolitan transportation initiatives are popular among voters. According to the Center for Transportation Excellence, 71 percent of measures were passed in 2014 as were 73 percent in 2013. While state level ballot measures on infrastructure spending are far less common, in 2013, eight states voted to raise taxes for such projects. This includes both conservative strongholds such as Wyoming and Democrat-controlled legislatures in states such as Maryland.[28]

As such, exploring methods of transferring control to more arterial and secondary roads to the regional level *may* encourage voters to more willingly support increased transportation funding, thus improving overall road quality. A 1998 report also identified VDOT control over secondary road maintenance and construction as a possible future hindrance to the state, particularly as urban areas grow. The report identified failures to communication between these rapidly growing localities and VDOT offices in planning construction projects that have implications for transportation infrastructure, resulting in

[28] Puentes, R. (2015). "Why Infrastructure Matters: Rotten Roads, Bum Economy". Brookings Institute Op-Ed. Retrieved from: https://www.brookings.edu/opinions/why-infrastructure-matters-rotten-roads-bum-economy/

inefficiencies and dollars lost. Because planning responsibilities are spread between the locality and state, neither are always aware of the others requirements. Seen in a different light, however, greater control of roads at the state level can be economically beneficial to the state. Economies of scales can make state-control of roads more financially efficient and may allow for quality consistency across the Commonwealth. One stakeholder who reviewed this report noted that the consistency of Virginia's road quality is being recognized by those in the autonomous road industry who are look at Virginia as a location prospect.

If such a step were deemed useful, Virginia may use the Kentucky and Pennsylvania models to develop a means of transferring control, as they have seemed more effective that the current Virginia policy. To incentivize localities or regions to take control of roads, however, the state must take several measures to make such an initiative palatable to local and regional entities. Cost is the primary constraint for county and regional takeover of secondary road responsibilities. Localities would need significant financial support from the state through both regular budgeting and specific project construction. See Ohio, Pennsylvania and Georgia as possible examples.

Table 3: Summary Recommendations and Variable Impacts

Recommendation	Affected Variables	Degree of Impact
Continue to make quality and capacity improvements to major urban highway networks	Quality of Transportation Infrastructure; Average Commute Time	Immediate impact on perceptions and average commute time rankings depending on the road. This could impact rankings of several business climate groups.
Consider ways of building on Virginia's private-public partnership strengths to leverage public investment in multi-modal forms of transportation	Quality of Transportation Infrastructure; Average Commute Time	Immediate impact on perceptions and average commute time rankings. This could impact rankings of several business climate groups.
Incentivize local and regional investment in key transportation corridors important to economic development using Smart Scale funding variables	Quality of Transportation Infrastructure; Average Commute Time	Probably long-term impact on quality infrastructure and commute time variables, significantly affecting larger infrastructure subindex ranking.
Consider the benefits and downsides of transferring and incentivizing the transfer of secondary roads control to the regional level	Transportation Infrastructure: Dollars spent on state-owned roads	Long-term policy change that would affect *Pollina* rankings immediately, but may also increase roads quality and local funding in the long-term
Effectively promote infrastructure improvements to business and media entities	Perceptions rankings	Immediate effect on perceptions rankings

HIGHER EDUCATION VARIABLES

According to the College Board's 2016 higher education report, those with post-secondary education are more likely to, "earn more, pay more taxes, and are more likely than others to be employed".[29] Average median earnings for individuals with bachelor's degrees are 67% higher than median earnings of high school graduates. They will also pay $6,900 more in taxes annually. Those who enrolled in a bachelor's degree program at 18 and graduated are expected "to earn enough relative to the median high school graduate by age 34 to compensate for being out of the labor force for four years and for paying the full tuition and fees and books and supplies without any grant aid." Finally, higher education increases the chance that individuals move up the socioeconomic ladder, rely less on public assistance, and have healthier lifestyles with lower healthcare costs in their lifetime.[30]

Historically, higher education has also been one of the driving forces for innovation within industry through its research and workforce training, which is why higher education variables appear in many business climate rankings. According to the Milken Institute:

> *Human capital is the most important intangible asset of a regional or state economy… It is essential for states and any regional economy to invest in human capital so they can gain sustainable competitive advantages in today's globally interconnected economy. Consequently, universities, community colleges, and accredited technical and vocational training facilities are key to regional economic growth and prosperity*.[31]

Yet, the Great Recession led to state budget cuts and a nationwide decline in state support for higher education. All but five states have not returned to their peak higher education funding rates of 2008.[32] Meanwhile, rising tuition costs have resulted in tuition comprising about 47.8% of total higher education revenue in the U.S.[33] Many higher education institutions have frozen, rolled back or at least slowed increases to student tuition in the past year or so, recognizing the affordability and accessibility problems of post-secondary education that accompany rising tuition costs. For this reason, states have also shown a steady increase in support for student financial aid, about a 2% annual increase.[34]

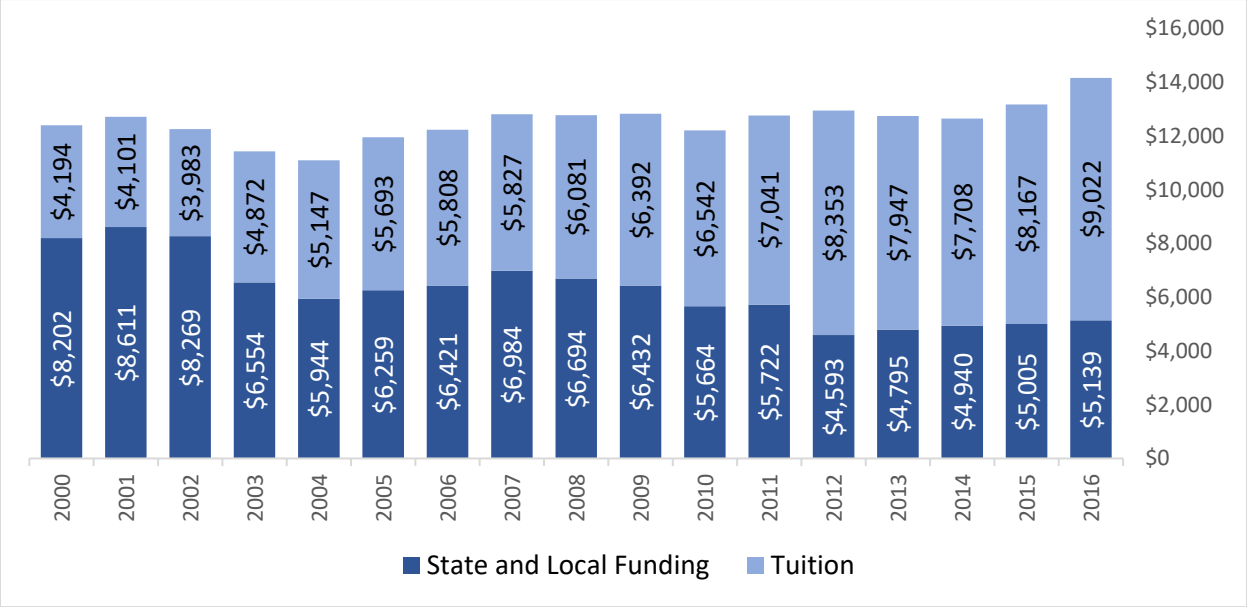
Virginia schools are even more dependent on tuition revenue, with 63.7% of their funding coming from tuition dollars. According to State Council for Higher Education in Virginia (SCHEV), in 2017, tuition and other fees accounted for 53% of the cost of higher education for families. In 2004, the state set a 33% target for these costs. The state's share of higher education costs has fallen to 47% in 2017, compared to its 67% target[35]. The state has recognized the need to increase its share of the higher education costs

[29] Ma, J. et al (2016). Education Pays 2016: The Benefits of Higher Education for Individuals and Society. College Board. Retrieved from: https://trends.collegeboard.org/education-pays.
[30] Ibid.
[31] DeVol, R. et al (2016). State Technology and Science Index: Sustaining America's Innovation Economy. Milken Institute. Retrieved from: http://www.milkeninstitute.org/publications/view/827
[32] Seltzer, R. (2017). "Illinois and Everyone Else." Inside Higher Ed. Retrieved from: https://www.insidehighered.com/news/2017/04/20/state-support-higher-education-increased-2016-not-counting-illinois.
[33] Ibid.
[34] Seltzer, R. (2017).
[35] Martz, M. (2017, August 2). "Virginia is $660 million short on higher education funding, SCHEV says." Richmond-Times Dispatch. Retrieved from http://www.roanoke.com/news/virginia/virginia-is-million-short-on-higher-education-funding-schev-says/article_c57165c5-85dc-5736-adf0-5f596acbff39.html

borne by families. SCHEV's report states this challenge in stark terms: "If the next 10 years are similar to the last 10 years for Virginia public higher education, our system is indeed in peril and all options to improve its future should be considered," SCHEV said in its annual report on tuition and fees.[36] According to the SCHEV report, in-state undergraduate tuition and fees at Virginia public institutions in 2017-2018 are estimated to rank ninth-highest in the nation for the doctoral/research category. For comprehensive institutions, tuition and fees are expected to be the 4th highest in the nation. Even tuition and fees at Virginia's two-year colleges have steadily increased since 2000 and are estimated to be the seventh-highest in the United States in 2018[37].

Figure 1 shows the decline in state higher education spending in blue and the increase in tuition revenue in green. Full-time enrollment numbers have also increased over the long-term but have declined since 2012, as illustrated in the red trend line below.[38]

Figure 1. Virginia Higher Education Costs per Full-Time Student (FTE)[38]



This decline in state higher education spending contrasts with the increase in economic activity generated by higher education in Virginia. In 2007 dollars, the economic activity generated by Virginia public higher education expenditures and improvements totaled $23.976 billion, nearly 2 percent of the state's gross domestic product[39]. The report from the Weldon Cooper Center for Public Service found that Virginia's public higher education entities accounted for 144,500 total jobs in 2007. The report highlighted a range of public higher education impacts to the Commonwealth including the various

[36] Ibid.
[37] State Council for Higher Education in Virginia. 2017-2018 Tuition and Fees Report. Retrieved from http://www.schev.edu/index/reports/schev-reports/2017-18-tuition-and-fees-report
[38] State Higher Education Executive Officers (2016). State Wave Charts (1991-2016). Retrieved from: https://public.tableau.com/profile/sheeo#!/vizhome/SHEF2016InteractiveStateData/About
[39] Rephann, T. et al (2009, October). Study of the Economic Impact of Virginia Public Higher Education. Weldon Cooper Center for Public Service,

social benefits of higher education: community productivity, higher community educational attainment, better community health, lower crime, and greater social engagement. Since the time of that report, Virginia public universities have continued to grow in terms of enrollment, employment, facilities, and reach as their broader economic benefits have become even more apparent.

To keep up with growing demand for workers with higher education degrees and rising tuition costs, increased state spending on higher education is necessary for the overall future of higher education and for increasing Virginia's standing in variables measuring state support. However, many have begun to question the underlying premise that more financial support for higher education will equate to a better business climate and economic growth. State-formula funding for post-secondary education institutions has not traditionally been results-oriented. Colleges around the nation typically have received state funding based on full-time equivalent student enrollment numbers at the beginning of a semester. This method incentives institutions to maximize enrollments and, secondarily, to enhance efforts to improve access to postsecondary education.

This funding method, however, has often been disconnected from successful degree completion. Virginia is at the forefront of a small group of states exploring more intentional outcomes-based models. The Higher Education Advisory Committee in Virginia has discussed a proposed formula to address this challenge and move in the direction of outcomes-based incentives. The formula would assign points based on the number of degrees awarded each year as well as certain other factors such as degree types (STEM-H professions).

When viewing business climate rankings relevant to higher education, state funding is often a top input variable. Two spending variables are of particular interest to business climate rankings groups: long-term funding for higher education and state/local funding per full-time college student (FTE). These variables tend to contribute to a composite index of higher education and human capital development. Thus, they are accompanied by more outcome measures such as the number of degrees (particularly STEM degrees) and percentages of workforce with higher education degrees, science and technology-related degrees, etc. Below are descriptions of the two variables Virginia Tech explored.

Long-term funding for higher education (*CNBC*)

In the *CNBC* Education Subrankings, Virginia is ranked 13th. *CNBC* Education rankings, "consider the number of higher-education institutions in each state, as well as long-term funding trends for higher education. We look at several measures of K–12 education, including test scores, class size and spending, and we look at technology infrastructure in the schools. We also look at lifelong learning opportunities in each state."[40] Of these variables, VEDP has marked long-term funding for higher education as the only potential variable on which to take immediate action. Other variables, such as K-12, already show relative good rankings above the national average. Indeed, increasing long-term funding will not only affect *CNBC* rankings, but other business climate rankings as well (e.g. *Pollina*).

[40] CNBC (2016). America's Top States for Business 2017: Methodology and sources. Retrieved from: https://www.cnbc.com/2017/06/12/heres-how-your-state-can-become-a-cnbc-top-state-for-business.html

Milken Institute also incorporates long-term funding for higher education into its Human Capital Investment rankings. In 2016, Milken ranked Virginia 7th in the country.[41]

Although Virginia is the 12th highest ranked state in terms of total dollar spending on higher education, education appropriations have decreased 17% since 2000. When regulating for Cost of Living, Enrollment Mix, and Inflation across different states, we find that Virginia spent $1.7 billion in 2000, $1.68 billion in 2008, and $1.4 billion in 2016. Meanwhile, 20 other states increased their funding in higher education since 2000 including California (16%), Texas (38%), New York (34%), North Carolina (19%), and Georgia (9%). All of these states spend at least double the amount of money on higher education as Virginia.[42]

State and local funding per full-time college student (*Pollina*)

State and local funding per full-time college student is one of nineteen variables in *Pollina*'s Stage I evaluation of states, which is comprised of several labor, tax and infrastructure variables. Since 2009, Virginia has been in the top ten states for this stage, to some extent because the Commonwealth was less affected economically by the Great Recession and because of its favorable tax structure for businesses. In 2011, Virginia ranked 1st in *Pollina*'s first state evaluation. It fell to ninth place by 2015. Despite this favorable ranking, the state and local funding per full-time college student variable **did not** contribute to these high rankings. In *Pollina*'s scorecard, Virginia ranked 40th and received an F for this variable.[43] According to *Pollina*, increasing this variable is one of the most likely variables (one of three) to improve Virginia's current business climate ranking (4th).

Data from the State Higher Education Executive Office ranked Virginia 41st in 2016, with $5,139 per full-time student. Top ranked states for this variable include Wyoming ($17,157), Alaska ($16,692), Hawaii ($13,243), Connecticut ($11,095), and New York ($10,130). Other comparable states include California (6th; $9,360), North Carolina (9th; $8,686), and Maryland (12th; $8,291).[44]

Policy Examples from Other States

Virginia Tech chose three states with decidedly different approaches to higher education spending policy: New York, Minnesotta, and Colorado.. However, the three states are also ranked well in different education and human capital rankings thanks to their education outcomes. In addition to *CNBC* and *Pollina*, we also looked at rankings from U.S. News and Milken Institute. Using U.S. News rankings and National Center for Education Statistics, we attempted to control for K-12 outcomes such as test scores and college readiness.[45]

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[41] DeVol, R. et al (2016). State Technology and Science Index: Sustaining America's Innovation Economy. Milken Institute. Retrieved from: http://www.milkeninstitute.org/publications/view/827

[42] 2016 SHEF Report, State Higher Education Executive Officers. Retrieved from: http://sheeo.org/shef2016

[43] Pollina, B. (2015). Pollina Corporate Top 10 Pro-Business States for 2015. Retrieved from: http://www.pollina.com/top10probusiness.html

[44] 2016 SHEF Report, State Higher Education Executive Officers. Retrieved from: http://sheeo.org/shef2016

[45] U.S. News (2016). Pre-K – 12 Rankings. Retrieved from: https://www.usnews.com/news/best-states/rankings/education/prek-12; National Center for Education Statistics (2015). National Report Card. Retrieved from: https://www.nationsreportcard.gov/profiles/stateprofile?chort=1&sub=RED&sj=&sfj=NP&st=MN&year=2015R3.

Table 4: Relevant Higher Education Spending Variables Contributing to Business Climate Rankings

	VA	NY	MN	CO
2016 State Spending ($Billions)	$1.42	$3.95	$1.21	$0.68
% Spending Change (2000-2016)	-17%	34%	-23%	-12%
Funding per FTE	$5,135	$10,130	$6,605	$4,412
Tuition Contribution to HEI $ (%)	64.1%	37.3%	53.5%	68.8%

New York

New York has a different higher education funding structure than Virginia. State and location appropriations for higher education in NY were $3.9 billion 2016, that is 2.8 times more than appropriations for Virginia. New York has seen a 34% increase in state funding since 2000, compared to Virginia's 17% decline. Tuition only contributes to 37.3% of total higher education revenue in New York, which is 26.8 percentage points lower than Virginia's tuition contribution. Moreover, compared to Virginia, localities contribute significantly more to higher education. Local support was about 29% of total higher education revenue for 2-year institutions and 6% for 4-year institutions (including tuition). In Virginia, local support was about 2% and 5% for 2-year and 4-year institutions respectively.

As a result of this spending difference, *Pollina* gives New York an A grade for state and local funding per full-time student and grades New York fairly well in other variables including college completion (ranked 9th) and average annual teacher salary (ranked 1st; public and secondary schools).. Nevertheless, New York falls in the middle of *Pollina*'s ranking due to other factors outside of education. *CNBC* ranks New York fifth in its education subindex thanks to the state's strong support for public education even though the state fairs poorly in *CNBC*'s education other outcome variables (high school test scores and elementary school math and reading scores).

A large portion of New York's expenditure in funding is allocated to the state's extensive programming to increase the accessibility and affordability of higher education. These targeted programs provide financial assistance to New York residents that are unable to pay for tuition and the population most vulnerable to tuition increases. Historically, the New York State Tuition Assistance Program (TAP) has provided financial assistance to eligible residents. Recently in 2017, New York passed the Excelsior Scholarship, which provided tuition-free college (2- or 4-year colleges) for individuals in families earning less than $125,000 a year once the program is fully implemented.[46] Both programs described above are added to other financial assistance grants, including Pell grants, but New York provides help in applying to both state and federal grant programs. These programs are touted as successes, not due to the expansion of funding, but due to the support efforts to ensure students that receive assistance are prepared for college and to leave college, 'career-ready.' Funding is coupled with several other intermediate programs that are targeted to economically disadvantage and disabled students. For instance, the Higher Education Opportunity Program, provides students mentoring, pre-freshmen courses to prepare students with the expectation of college courses, remedial coursework, and financial

[46] Higher Education Service Corporation (HESC; 2017). Excelsior Scholarship Program. Retrieved from: https://www.hesc.ny.gov/pay-for-college/financial-aid/types-of-financial-aid/nys-grants-scholarships-awards/the-excelsior-scholarship.html

assistance.[47] Additionally, the New York State Early College High School (ECHS) Programs, provide supports to "students who are traditionally underrepresented in postsecondary education," including academic support from both the high school and college partner. The objective of the program is to bring the student to grade level and therefore, capable of completing advance high school and collegiate courses.[48]

In addition to high state spending for higher education, New York has several programs to better align workforce development, higher education outcomes, and private industry labor demands. Part of this alignment has included the Next Generation NY Job linkage program, which is an incentive funding programing for the state's community colleges based on performance metrics. Included in the performance metrics are number of students employed in the second quarter following graduation, timely completion of degrees, number of students who engage in career and employment opportunities, and student wage gains that outpace inflation.[49] The Pathways in Technology Early College High School (P-TECH) program allows high school students to earn an associate degree careers in technology, manufacturing, healthcare, and finance. P-TECH is a public-private partnership, and matches private industry with specific community colleges and degree programs.[50] The states SUNY (4 year colleges) and CUNY 2020 (2 year colleges) programs award colleges that leverage private sector resources and developed academic programs that provide jobs to graduates and support local economic growth.[51] The 2020 grants are competitively awarded based on the implementation plan submitted by each college.

Minnesota

Minnesota has similar higher education spending trends to Virginia with a significant spending decline since 2000 and a growing reliance on tuition dollars. Compared to Virginia, however, Minnesota spends $1,000 more per student. Moreover, Minnesota tends to come out better in the overall rankings dealing with education and human capital. *CNBC* ranks Minnesota 2nd in its education subindex. All human resource factors for Minnesota in the *Pollina* rankings are given an A or B except higher education spending. These include high school graduation rates, college completions, and teacher compensation. Virginia is given a C or below on all of these except college completion (A).[52] Minnesota is also ranked fifth in Milken Institute's Human Capital index.

Similar to the DC and Northern Virginia region, Minnesota is among the top places for post-secondary degree jobs (among the top five in the nation), which highlights its need for better higher education

[47] New York State Assembly (2015). "2015-16 Budget Provides Funding for Vital Academic Programs to Put Students on the Higher Education Road to Success". Retrieved from: http://nyassembly.gov/Press/20150401a/; The University of the State of New York (2013). The Statewide Plan for Higher Education. Retrieved from: http://www.regents.nysed.gov/common/regents/files/213hea1%5B1%5D.pdf.

[48] New York State Education Department (2017). Smart Scholars ECHS. Retrieved from: http://www.highered.nysed.gov/kiap/SmartScholarsEarlyCollegeHighSchool_000.htm

[49] Fashion Institute of Technology (FIT; 2015). Performance Improvement Plan; FIT. Retrieved from: https://www.suny.edu/media/suny/content-assets/documents/excels/SUNY-Excels-PIP-Narrative_Fashion-Institute_20151223.pdf. National Conference of State Legislatures (NCSL; 2015). Performance-Based Funding for Higher Education. Retrieved from: http://www.ncsl.org/research/education/performance-funding.aspx

[50] Office of Postsecondary Access, Support & Success (2017). NYS P-TECH Partner Information. Retrieved from: http://www.highered.nysed.gov/kiap/scholarships/documents/PartnershipsforCohortIIIIII.pdf

[51] SUNY (2015). NYSUNY 2020 Challenge Grants. Retrieved from: https://www.suny.edu/impact/business/nysuny-2020/. CUNY (2015). NY State 2020 Challenge Grant. Retrieved from: http://www2.cuny.edu/about/administration/offices/fpcm/2020challenge/.

[52] In truth, Minnesota struggles in the Pollina rankings due to its taxes, union status, and worker compensation policies.

outcomes to maintain its qualified workforce in the future.[53] In 2015, the state legislature set a postsecondary education attainment goal, stating "70% of Minnesota adults (age 25-44) will have attained a postsecondary certificate or degree by 2025 (Minn. Laws 2015 Chapter 69 Article 3 Sec. 6).[54]

Like Virginia, Minnesota is also experimenting with outcomes-based funding models. In 2015, Governor Dayton proposed and signed into law, The Equity in Attainment and Job Connection Grant Program, providing funding for proposals focused on improving postsecondary success and employment outcomes for students historically underrepresented in higher education.[55] Most of the recent grantees of this program address at least one of Minnesota's best practice strategies.

1. Social and Campus Integration: first-year seminars emphasizing group activities and building strong skillsets (e.g. critical thinking, writing, literacy, collaboration); service-learning programs to help students engage their communities and develop a sense of belonging; and summer bridge programs to ease the transition from high school and provide additional knowledge and support for the coming year.
2. Promoting Long-Term Academic Success: proactive advising and degree mapping where professional advisors regularly initiate contact with students to assist with decisions about their degree program, financial aid issues, and classroom-based issues.
3. Alternative Delivery Models for Developmental Education: Traditional development education can negatively affect students' confidence, increase the costs of higher education, and potentially prevent post-secondary completion. Possible alternative models include paired courses, mainstreaming with support, and co-curricular programming.
4. Emergency Assistance: Access to adequate housing, food, and transportation combined with the costs of education often prevent students from entering or finishing postsecondary programs. In addition, these students may be reluctant to disclose their situation. Some programs are developing alternative programming, which attempt to address these challenges.

Colorado

Although Colorado is 46th in state funding per student ($4412), it is still highly ranked in overall education and human capital subindexes that contribute to business climate rankings; for instance, *CNBC* (12th in education and 4th in workforce), U.S. News (8th in education), Milken Institute (1st in human capital). The state ranks well in Milken and other innovation and business rankings due to its large numbers of science and engineering graduates, high percentages of those with bachelor's degrees, and 31 4-year institutions that collaborate regularly with local businesses to train and attract an educated workforce.[56] Thus, while Colorado's funding is low, its overall education outcomes seem very high.

As stated before, state-formula funding has traditionally been on full time equivalent student enrollment numbers at the beginning of a semester. Virginia and another small group of states have

[53] Carnevale, A., N. Smith, and J. Strohl (2010). Help Wanted: Projections of Job and Higher Education Requirements through 2018. Georgetown University Center of Education and the Workforce. Retrieved from: https://cew.georgetown.edu/wp-content/uploads/2014/12/fullreport.pdf.
[54] Minnesota Office of Higher Education (2016). Educating for the Future Update and Policy Guide. Retrieved from: https://www.ohe.state.mn.us/pdf/EducatingForTheFuturePolicyGuide2017.pdf.
[55] Minnesota Office of Higher Education (2017). Education Attainment Goal 2025. Retrieved from: https://www.ohe.state.mn.us/mPg.cfm?pageID=2187.
[56] DeVol, R. et al (2016).

begun to explore more outcomes-based models of funding. Colorado is one of the fellow early-adopters. Colorado provides an early adopter model here. The model identifies a threshold state funding amount and identifies a percentage over that baseline that would be appropriated based on each institution's performance. The framework has four overall goals: increase attainment; improve student success; diversify enrollment and reduce attainment gaps among students from underserved communities; and promote financial stewardship. Institutions collaboratively select metrics that are common across all institutions and also identify institutional specific metrics to measure progress. It is too early to gauge results of Colorado's model, though a number of other states (in addition to Virginia) are considering steps in this direction.

Similar to Virginia, Colorado is still exploring new funding formulas to increase higher education funding while maintain this outcomes-oriented approach. Colorado experienced a 12% decrease in long-term higher education funding since 2000 and has begun to increase its overall contribution to higher education during the last ten years (7% increase).

Possible Implications for Virginia

Public higher education is a crucial economic cornerstone for the Commonwealth. Virginia has 15 four-year public institutions, 23 community colleges, and 1 junior college. In 2015-2016, the state's public institutions awarded nearly 15,000 certificates and over 71,000 degrees at all levels. This report section offers a number of considerations for Virginia in terms of building on this strong foundation:

The first, most central, and most readily apparent way to improve higher education variables related to business climate rankings concerns state funding. To increase these variables, **Virginia should dedicate more state funding to supporting higher education funding.** Currently, funding is significantly below peer and national averages. Relatedly, to increase accessibility for higher education, **Virginia could expand funding to students that are economically disadvantaged.** As described above, New York is one example of a state with a progressive financial aid policy. New York recently passed legislation to provide tuition-free college for all its residents. Moreover, New York's financial aid is supported by comprehensive programming to support students that received financial assistance.

Virginia could also continue to actively explore and champion outcomes-based higher education funding incentives. This type of approach would help the state identify metrics, gauge the performance of individual institutions, and incentivize results related to increasing attainment; improving student success; diversifying enrollment and reducing attainment gaps among students from underserved communities; and promoting improved financial stewardship. As examples, **Virginia should continue to pursue outcomes-based incentives for higher education funding such as the Fast Forward grant system that allows student to pay only one-third of tuition for community college programming that leads to in-demand middle-skill jobs. Virginia could also pursue programmatic outcome-based models to provide postsecondary education programs funding to address the needs of historically underrepresented populations (e.g. first-generation and minority students), as done in Minnesota.** Like Minnesota, minority and immigrant populations in Virginia are increasing. Ensuring they gain access to and succeed in higher education programs will help grow Virginia's qualified workforce in the future.

To improve overall outcomes in the business climate, increased funding should be accompanied by targeted policy that incentivizes partnerships with industry and provides experiential learning opportunities to prepare students better for the workforce. New York has several innovative programs and grants that could serve as a framework for Virginia to follow. In addition, policies, programs and outcomes-focused incentives could align more with Virginia's current and future talent needs in the state's critical industry sectors such as identified VEDP target sectors or GO Virginia target clusters. Virginia should consider more tightly linking funding to the extent to which higher education programs connect to the needs of Virginia business and identified industry sectors.

Table 5: Summary Recommendations and Variable Impacts

Recommendation	Affected Variables	Degree of Impact
Dedicate more state funding to supporting higher education funding, particularly funding to economically disadvantage families.	Funding variables for both *Pollina* and *CNBC*	This step would immediately impact both education sub-indexes as Virginia tends to do very well *except* for measures dealing with education funding.
Increased funding should also be accompanied by targeted policy that incentivizes partnerships with industry and provides experiential learning opportunities to prepare students better for the workforce.	These policy recommendations are based on reviews of current education policy and trends in the United States, including the case studies we reviewed. They are more reflective of how increased funding should be implemented to align better with other workforce and human capital outcome measures found within numerous business rankings. These policies would have long-term effects and would not necessary be reflected in business rankings for many years. The most immediate workforce and human capital outcome measures may be number of STEM graduates within the state.	
Support outcomes-based incentives for higher education funding, including programs like VA's Fast Forward grant and programs that support attraction and retention of underrepresented populations in post-secondary programs.		
Outcomes-based funding should align with VA's emerging and driver industries.		

INNOVATION VARIABLES

Technological change in the 21st century has been rapid and powerful. Such changes are the result of the inventors, entrepreneurs, and innovators who take risks and leverage new ideas, products, and processes. Where these "pioneers" choose to do this work can have immense implications for localities.[57] Entrepreneurs and innovators are able to do what they do because of state and local governments who can enable innovation by ensuring a climate that is open to such a change, supplying a workforce that can be deployed to hasten change, and providing other inputs required to make innovative products and processes take shape. Given the right environment, innovators can have

[57] Henderson, J., & Weiler, S. (2010). Entrepreneurs and job growth: Probing the boundaries of time and space. *Economic Development Quarterly*, *24*(1), 23-32.

positive effects on local taxes and quality of life, and can foster a virtuous cycle of continued innovation and investment.[58]

There is more we can do to send the signal and develop the reputation that Virginia is inherently supportive of entrepreneurs and has policies in place to support innovative policy and practices, both of which are essential to attracting innovative talent. When government leaders encourage new business models, welcome and adopt forward-looking technologies, and foster business-friendly fiscal policies, they create spaces where innovators and entrepreneurs will want to live, work, and play. Recognizing that success often begets further success, one can also expect that other entrepreneurs will be drawn to these perks and the promise that they will also have spaces and supports to innovate as well. Recent research supports the idea that highly entrepreneurial communities see an uptick in high-quality jobs and strong economic growth.[59]

Virginia has much to celebrate when it comes to innovation. The Commonwealth has earned a reputation as being a tech powerhouse, having a strong business climate, and offering an abundance of science and engineering employment opportunities. Despite these strengths, the Commonwealth fares poorly when it comes to tax friendliness (including unemployment insurance and individual income taxes, patents issued, and certain Federal health, science, and agricultural research grants. The Commonwealth also has a mixed track record when it comes to net formation of high-tech businesses, moving from 38th in 2012, to 1st in 2014, and 3rd in 2016. Peer states like Colorado, Washington, and North Carolina have been able to maintain their top 25 status in this category since the beginning of the Great Recession.

Success in the 21st century economy will require innovative practices. The *CNBC* rankings recognize support for innovation, patents issued to residents, and federal health, science, and agricultural research grants as good measures of innovation within states. In general, Virginia has maintained a Top 20 ranking for many of these measures. In naming Virginia a three-time Innovation Champion, the Innovation Scorecard highlights Virginia's comparatively light regulations, large tech workforce, and recent improvements in the speed of its average internet connection. Virginia is in good company, joining Colorado, Delaware, Maryland, Massachusetts, Michigan, New Hampshire, North Dakota, Utah, and Washington as 2017 Innovative Champions. Colorado, Maryland, New Hampshire, and Washington are new to the list in 2017, boasting strong tech workforces and a large number of STEM graduates.

Existing resources in the Commonwealth provide a strong platform for innovation-related development. In addition to its many federally-funded R&D facilities, the Commonwealth also enjoys a highly educated employment base of technology professionals (ranked 2nd in 2015 by *BHI*). Innovative research is already taking place at 11 Federally Funded R&D Centers and 23 FLC Laboratories such as the Homeland Security Institute, NASA Langley Research Center, and the Thomas Jefferson National Accelerator Facility. In 2015, Virginia-based federal agencies and laboratories received federal R&D investment of $7.4

[58] Goetz, S. J., & Rupasingha, A. (2014). The determinants of self-employment growth: Insights from county-level data, 2000-2009. *Economic Development Quarterly*, *28*(1), 42-60.

[59] Haltiwanger, J., Jarmin, R. S., & Miranda, J. (2013). Who creates jobs? Small versus large versus young. *Review of Economics and Statistics*, *95*(2), 347-361.

million.[60] Capitalizing on these existing strengths will be key to improving Virginia's standings in the innovation rankings. Indeed, mediocre results in the *CNBC* rankings (16th in 2017 for Technology & Innovation) and the *BHI* (17th in 2015 for Technology) suggest there is more than can be done to increase innovation within Virginia. Below we delve into five specific variables to shed light on things that are working and things that are not when it comes to innovation in Virginia.

Federal health, science and agriculture research grants

Virginia scores fairly well when it comes to awards from Federal health, science, and agricultural research grants, maintaining Top 20 status for USDA, NSF, and NIH grants in both the number of grants and total dollar value of these grants in 2015. In FY 2015, Virginia ranked third for total federal R&D funding through businesses, universities, federal labs, and all other institutions combined. Home to HHS's National Institutes of Health (NIH), Maryland was the top state recipient at $16.8 billion and received 48% of its funding from HHS. California ranked second with $15.3 billion, receiving 93% of its funding from DOD, DOE, HHS and NASA. Virginia (ranked 3rd) received the bulk of its federal R&D obligations from DOD (77% of $7.5 billion).[61] The steep drop off in total obligations between 2nd-ranked California and 3rd-ranked Virginia should be noted; Virginia received less than half of what California or Maryland did in 2015. When DOD funds are removed from the tally, Virginia's rankings for research grants drops dramatically (see Table 6 and 7 below). Though Virginia enjoys a top 20 ranking for total number of grants and total dollar amount of grants from NIH, NSF, and USDA, it does not reach the top 10 for any of those categories.

Table 6: Top Ranked States Receiving Research Grants (# Of Grants)[62]

	NIH grants	NSF grants	USDA grants	All grants
1	California (7720)	California (2,557)	California (122)	California (10,399)
2	Massachusetts (5029)	New York (1,529)	Texas (95)	New York (6,565)
3	New York (4953)	Massachusetts (1,285)	New York (83)	Massachusetts (6,358)
4	Pennsylvania (3464)	Texas (1,111)	North Carolina (74)	Pennsylvania (4,549)
5	Texas (2633)	Pennsylvania (1,033)	Minnesota (69)	Texas (3839)
6	Maryland (2358)	Illinois (848)	Michigan (68)	Maryland (2,955)
7	North Carolina (2221)	Michigan (680)	Montana (65)	North Carolina (2,933)
8	Illinois (1995)	North Carolina (638)	Alabama (64)	Illinois (2,892)
9	Ohio (1694)	Colorado (610)	Georgia (63)	Ohio (2,290)
10	Washington (1555)	Florida (587)	Florida (62)	Michigan (2,278)
	Virginia (20th - 816)	Virginia (12th – 553)	Virginia (15th – 53)	Virginia (18th – 1,422)

[60] Federal Laboratory Consortium for Technology Transfer (FLC) (2015).
State Profiles. Retrieved from:
https://www.federallabs.org/index.php?tray=topic_states&tid=1FLtop216&cid=1FL199&state=VA

[61] National Science Foundation, National Center for Science and Engineering Statistics, Survey of Federal Funds for Research and Development, FYs 2015–17.

[62] US Department of Health and Human Services (2016) NIH Research Portfolio Online Reporting Tool. Retrieved from https://www.report.nih.gov/award/index.cfm; National Science Foundation (2016). Award Summary: by State/Institution FY 2016. Retrieved
from https://dellweb.bfa.nsf.gov/awdlst2/default.asp; USDA (FY2016) National Institute of Food and Agriculture Recent Awards. Retrieved from
https://portal.nifa.usda.gov/lmd4/recent_awards?report_title=Recent%20Awards&from_site=NIFA&search_label=Awards%20Listing

Table 7: Top Ranked States Receiving Research Grants Dollars ($)[62]

	NIH grants	NSF grants	USDA grants	All grants
1	California ($3.7B)	California ($963M)	California ($65M)	California ($4.7B)
2	Massachusetts ($2.6B)	New York ($480M)	Texas ($62M)	Massachusetts ($3.0B)
3	New York ($2.2B)	Massachusetts ($449M)	N. Carolina ($60M)	New York ($2.7B)
4	Pennsylvania ($1.6B)	Texas ($344M)	New York ($57M)	Pennsylvania ($1.9B)
5	Maryland ($1.5B)	Maryland ($343M)	Michigan ($43M)	Maryland ($1.8B)
6	North Carolina ($1.2B)	Colorado ($320M)	Minnesota ($42M)	Texas ($1.5B)
7	Texas ($1.1B)	Illinois ($316M)	Georgia ($42M)	North Carolina ($1.4B)
8	Washington ($953M)	Pennsylvania ($275M)	Missouri ($41M)	Illinois ($1.2B)
9	Illinois ($818M)	Arizona ($256M)	Florida ($40M)	Washington ($1.1B)
10	Ohio ($734M)	Ohio ($239M)	Illinois ($40M)	Ohio ($1.0B)
	Virginia (20th - $349M)	Virginia (12th – $215M)	Virginia (18th $31M)	Virginia (19th – $596M)

Note that the top three states in awards for NIH and NSF grants are the same (NY, CA, and MA) but some different states can be found in the top three for USDA grants. This difference is likely due to the more rural and agrarian nature of Texas and North Carolina, who join California as top states for USDA awards. All three states also have strong state university networks with land grant missions. To improve Virginia's ranking for awards from Federal health, science, and agricultural research grants, incremental improvements may prove useful in moving the needle. Building upon the Commonwealth's successes in growing Virginia's share of NIH, NSF, and USDA grants should be a policy focus in coming years.

Number of patents issued to residents (*Beacon Hill Institute* and *CNBC*)

The U.S. Patent and Trademark Office provides data on the number of U.S. patent documents (i.e., utility patents, design patents, plant patents, reissue patents, defensive publications, and statutory invention registrations) granted since 1977, broken down by the state or country of origin. About 90% of all patent documents granted by USPTO are utility patent grants, also known as "patents for inventions." Yearly totals are provided for the most recent years.

Table 8: Top Ranked States According To Number Of Patents Issued (# of patents)

	2011	2012	2013	2014	2015
1	CA (30,749)	CA (34,660)	CA (39,139)	CA (43,679)	CA (43,609)
2	TX(8,044)	TX (8,930)	TX (9,821)	TX (10,692)	TX (10,561)
3	NY (7,842)	NY (8,557)	NY (9,363)	NY (9,770)	NY (9,391)
4	MA (5,526)	MA (6,119)	MA (6,767)	WA (7,148)	MA (7,234)
5	WA (5,264)	WA (5,985)	WA (6,569)	MA (7,079)	WA (7,038)
6	IL (4,594)	IL (5,078)	MI(5,640)	IL (5,924)	MI (6,184)
7	MI (4,397)	MI (4,997)	IL(5,357)	MI (5,822)	IL (5,026)
8	NJ (4,276)	NJ (4,656)	NJ(5,257)	NJ (5,508)	NJ (5,026)
9	MN (4,227)	FL (4,453)	MN (4,789)	MN (5,082)	FL (4,913)
10	OH (3,903)	MN (4,278)	FL (4,761)	FL (5,022)	MN (4,852)
	VA (20TH 1,744)	VA (21ST 1,817)	VA (21ST 2031)	VA (21st 2,184)	VA (21st 2,222)

Source: https://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_all.htm

Patent data can be helpful in understanding where innovation is taking place, but recent research reminds us that patents per capita reflects only one measure of direct forms of innovation and is therefore an incomplete measure of innovation.[63] Patent origin is determined by the residence of the first-named inventor, so the rankings denote the home state of the inventor and not the place of employment (an important distinction for states like Virginia that include large, multi-jurisdictional metropolitan areas). Much like the rankings for Federal grants discussed above, Virginia hovers around the Top 20 in most years for patents as well. Increasing patent levels, however, seems like something that can be more readily influenced. Research shows that patenting increases in places with higher median incomes and education levels, and in places where there are large corporate research and development centers.[64]

Given how difficult it is to change the aforementioned factors, it is unsurprising that there is very little noise in terms of the Top 10 states for patenting. With only one exception, the Top 10 states have remained unchanged since 2011. Among those, California far exceeds all other states in terms of the number of patents issued annually. Texas and New York follow closely in second and third place, respectively. The top three states are driven largely by the strengths of key innovative metropolitan areas. In 2016, San Jose, San Francisco, Austin, and San Diego were the top four in terms of patents per capita and the New York metro area was number 13. Low patenting rates by Virginia metropolitan areas certainly play a role in the broader Commonwealth's mediocre showing on this variable. To improve upon this showing, the Commonwealth should draw upon the existing expertise of its many prestigious universities. Consulting with Virginia Tech Intellectual Properties (VTIP), Inc., VCU's Innovation Gateway, and UVA's Licensing and Ventures Group to improve patent production would be a logical next step.

Record of high-tech business formation

As part of the Milken Institute's Technology Concentration and Dynamism Composite Index, Milken utilizes data from the U.S. Census Bureau to rank states based on their "Net Formation of High-Tech Establishments per 10,000 business establishments. According to Milken, "this indicator measures the number of high-tech establishment births minus the number of high-tech business establishment deaths during a one-year period. This figure is then divided by increments of 10,000 business establishments in each state. A business establishment is considered in this indicator only if it has an Employer Identification Number (EIN) issued by the U.S. Census Bureau. High-technology and total establishments' birth data is compiled by the U.S. Census Bureau under contract with Taratec Corporation." Based on this figure, Virginia ranked 38th in 2008, 1st in 2010, and 3rd in 2012. The turbulent rankings for Virginia and other states suggests a lot of noise in the data. Nevertheless, states like Colorado, Oregon, Texas, New York, Washington, Pennsylvania, and North Carolina have managed to stay in the top 25 since the beginning of the recession.

[63] Li, D., Azoulay, P., & Sampat, B. N. (2017). The applied value of public investments in biomedical research. *Science*, *356*(6333), 78-81.

[64] Rothwell, J., Lobo, J., Strumsky, D., & Muro, M. (2016). Patenting prosperity: invention and economic performance in the United States and its metropolitan areas. The Brookings Institution.

Virginia is already home to the **Center for Innovative Technology (CIT)**, which includes a research and development (R&D) service line that supports technology company formation and attraction in the Commonwealth. Leveraging CIT's existing assets like the Commonwealth Research Commercialization Fund (CRCF), the Commonwealth Research and Technology Strategic Roadmap, and the Innovation and Entrepreneurship Measurement System (IEMS) will be essential if the Commonwealth is to improve on its record of high-tech business formation.

Employment in high-tech industry as % of total employment (*Beacon Hill Institute*)

Virginia fares well when it comes to high-tech employment. In 2013, Virginia was ranked first in the *Beacon Hill Institute*'s subindex for employment in high-tech industry as percent of total employment. More recently, Virginia's ranking has been downgraded to 2nd place behind Massachusetts in both 2014 and 2015. The State Technology and Science Index (Milken) for 2016 ranks Virginia as 8th in terms of its Technology and Science Workforce Composite Index, denoting a drop from 5th place in 2015. When examining the components of the composite, Virginia ranks highly when it comes to employment intensity in Computer and Information Scientists (3), Computer Network Architects (1), Computer Network Support Specialists (3), Network and Computer Systems Administrators (1), Nuclear Engineers (1), Operations Research Analysts (2), Physicists (3), Software Developers - Systems Software (2). Virginia ranks in the bottom half in terms of intensity of employment in Agricultural and Food Science Technicians (35), Biological Scientists – Other (30), Chemical Technicians (28), Chemists (26), Industrial Engineers (42), and Zoologist and Wildlife Biologists (35). As the Milken report overview notes, "The commonwealth continues to have the highest concentration of workers in computer and mathematical occupations in the country, engaged in high-tech and research work at world-class companies and institutions in the northern Virginia technology corridor" (State Technology and Science Index 2016, 13).

Individuals in science and engineering occupations as % of the labor force (*Beacon Hill Institute*)

Much like the high-tech labor force rankings, Virginia ranks highly in terms of the percentage of the labor force that works in science and engineering occupations. The *BHI* rankings show Virginia as 1st from 2013 - 2015. Sources for their data were the National Science Foundation (SESTAT Database) and Bureau of Labor Statistics. Note that this ranking is based on 2013 data, just after the recession. BLS estimates suggest that 328,490 people or 9% of total employment in Virginia were in STEM occupations in 2014. Virginia ranked 5th in terms of its total employment in STEM occupations, just behind California (1), Texas (2), New York (3), and Florida (4). For the purposes of this ranking, the BLS defines STEM occupations as including computer and mathematical, architecture and engineering, and life and physical science occupations; managerial and postsecondary teaching occupations related to these functional areas; and sales occupations requiring scientific or technical knowledge at the postsecondary level.

Though Virginia presently enjoys a large science and engineering workforce, the Commonwealth has become a net exporter of college-educated adult workers in general. According to Virginia Performs 2015 data, there were 84,427 college-educated adult in-migrants compared to 86,810 out-migrants in Virginia. This is the second year of negative migration flow since 2012. A net migration rate of -1.1 per 1,000 residents ranks Virginia 24th among US states. Neighboring states varied from a low of -2.4 percent

in Maryland to highs of 6.3 percent in Tennessee and 11.4 percent in North Carolina.[65] Keeping close watch on these migration trends, especially in STEM fields, is essential to ensuring a robust STEM talent pipeline in Virginia.

Policy Examples from Other States

Massachusetts

Massachusetts consistently ranks in the top 5 for nearly all measures of innovation. A deliberate and structured approach to economic development has allowed innovative companies and leaders to flourish in Massachusetts. The approach includes a healthy mix of tax incentives, university-led partnerships with business, a strong commercialization culture, and a flexible and reputable workforce development pipeline. Long term investments are incentivized by a long-standing research and development tax credit. Like many other states, the Massachusetts R&D tax credit is designed to 'remove any obstacles to R&D investment and spur growth and innovation throughout the Commonwealth."[66] However, what is different about the credit is that the Massachusetts R&D credit is permanent, whereas in Virginia it expires in 10 years. The long-standing history and the permanence of the Massachusetts credit has thus served a dual purpose: it sends the signal that the Commonwealth is committed to innovative manufacturers and researchers over the long haul and it signals that the Commonwealth has much experience to draw from when it comes to research and development. Additional sector-specific incentives, including the Massachusetts Life Sciences Center (MLSC), help solidify that commitment, encourage further development, and create new jobs in innovative firms. The MLSC targets and supports life sciences innovation, education, research & development, and commercialization by drawing from a $1 billion, state-funded investment initiative. As of January 2015, the Massachusetts Life Sciences Center has thus far invested or committed more than $575 million in state funding and leveraged more than $1.7 billion in matching investment capital.[67] Though Virginia offers state funding for a variety of sectors, there is no singular program for life sciences like there is in Massachusetts. A dedicated fund sends a very public message that Massachusetts actively supports innovative life science companies.

A 2016 announcement regarding GE's relocation to Massachusetts quoted the GE Chairman and CEO Jeff Immelt as saying that, "Massachusetts spends more on research & development than any other region in the world, and Boston attracts a diverse, technologically-fluent workforce focused on solving challenges for the world." The combination of incentives and a diverse, technologically-fluent workforce – a by-product of world-renowned universities like MIT and Harvard – are oft-touted reasons for Massachusetts' consistently high rankings in terms of innovation. Innovation is also a focus of the Massachusetts Technology, Talent and Economic Reporting System (MATTERS), a web-based data analytics tool designed to measure and evaluate the commonwealth's talent and business competitiveness. Virginia offers the Innovation and Entrepreneurship Measurement System (IEMS),

[65] Virginia Performs. Workforce Quality (2015) Retrieved from http://vaperforms.virginia.gov/indicators/economy/workforceQuality.php
[66] Mass.gov. Research and Development Tax Credit (2017). Retrieved from http://www.mass.gov/hed/economic/eohed/bd/econ-development/r-and-d-tax-credit.html
[67] Massachusetts Life Sciences Center. Our Investments (2015). Retrieved from http://www.masslifesciences.com/about/investments/

which is a web-based portal that uses key metrics and outcomes to track the performance of Virginia's innovation economy. The IEMS, while helpful, offers a much simpler overview of the innovation economy, as opposed to the MATTERS, which is a highly interactive tool offering complex and numerous data points. The MATTERS depicts a very sophisticated and polished web presence to facilitate interactions between for investors or innovators and state development officials.

Table 9 - Science and Engineering State Profiles[68]

	Virginia		Maryland		Massachusetts		Utah		United States
Characteristic	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value
All employed SEH doctorates, 2013	23,100	8	32,600	5	39,300	4	6,500	28	717,600
S&E doctorates awarded, 2015	1,069	14	1,194	11	2,207	4	470	26	41,261
Personal income per capita, 2016 (dollars)	53,723	12	57,936	7	65,137	3	40,744	42	49,571
State R&D expenditures, 2015 ($thousands)	43,616	9	24,853	19	22,665	21	38,168	10	2,210,820
Academic research space, 2015 (thousands sq. ft.)	4,730	13	6,489	10	9,457	4	2,627	29	214,575
SBIR awards, 2015	253	3	223	4	521	2	43	24	4,534
Utility patents issued to state residents, 2015	2,057	19	1,838	22	6,777	4	1,404	23	140,958
Federal obligations for S&E R&D, by agency, 2015 ($thousands)									
All agencies	7,487,099	3	16,750,635	1	6,055,001	4	1,143,613	24	109,912,351
Department of Agriculture	22,071	35	182,450	2	26,450	30	34,495	23	2,330,823
Department of Commerce	13,533	14	707,974	1	32,541	6	494	41	1,327,712
Department of Defense	5,778,350	2	5,726,931	3	2,764,253	5	618,463	19	45,045,953
Department of Energy	152,687	12	51,546	23	140,898	13	15,009	33	11,389,089
Department of Health and Human Services	363,828	19	7,983,086	1	2,371,560	3	161,868	28	29,975,768
Department of Homeland Security	89,796	1	72,230	3	77,683	2	1,134	37	731,030
Department of the Interior	96,168	1	85,249	2	12,318	16	12,696	14	799,823
Department of Transportation	170,875	1	25,813	8	57,661	3	2,185	37	853,054
Environmental Protection Agency	59,454	4	15,913	7	16,433	6	1,661	24	515,431
National Aeronautics and Space Administration	553,979	6	1,608,470	3	177,902	11	234,518	8	11,344,243
National Science Foundation	186,359	10	290,974	5	377,301	3	61,090	23	5,599,425

[68] National Science Foundation, National Center for Science and Engineering Statistics. Retrieve from: https://www.nsf.gov/statistics/states/#ui-tabs-3

Maryland

Proximity to Washington, DC is something that Maryland has in common with Virginia. Both states also have a large share of STEM, professional, and technical workers. However, one thing that sets Maryland apart is its large proportion of employed doctoral scientists and engineers, an asset that has helped fuel biotechnology and cybersecurity innovations in Maryland. In 2015, Maryland employed 9500 more science, engineering, and health doctorates than did Virginia (see Table 9). A significant portion of that workforce are graduates from Maryland's premiere institutions of higher education, including Johns Hopkins and University of Maryland. These institutions have been a main focus of the state's economic development strategy, leading some to call Maryland an "extreme example of university-driven economic development".[69] Most of the economic development efforts have sought to leverage federal investments already existing within the state, including the National Institutes of Health, the U.S. military, and the Food and Drug Administration. Maryland's long-standing Technology Development Corporation, (TEDCO) continues to assist entrepreneurs with the commercialization of research work through their Seed Funding Program, which helps companies commercialize their products and services. Related efforts, through the Life Science Investment Fund (LSIF), provide seed-stage funding for life science companies bringing medical devices and other health technologies to market. The LSIF allows for investments of up to $200,000 for a period of 1 year to support milestone-based projects that advance a Medical Product toward commercialization.[70] By comparison, Virginia's CIT GAP BioLife Fund investments are typically smaller, with initial investments up to $100,000.[71]

The strength of Maryland's funding programs and university-led partnerships has allowed the state to maintain a high ranking in terms of research dollars per capita and in total number of research centers. The strategic investments have also encouraged the development of a diverse industrial base with strengths in innovative fields like information technology, biotechnology and biomedicine, and aerospace and defense. Firms in Maryland also take advantage of plentiful incubators, accelerators, and research parks, many of which are in close proximity to federal government institutions like the NASA Goddard Space Flight Center and Johns Hopkins University Applied Research Lab. Proximity has likely played a role in the nearly $10 billion in federal contracts that tech companies in Maryland secure annually. Maryland's large anchors like Discovery Communication and Lockheed Martin are in good company alongside plentiful startups and SMEs.

Utah

Utah has captivated economic development officials in recent years as a rising star in the innovation rankings. In Bloomberg's ranking of the most innovative U.S. states, Utah climbed six spots to reach 14th place in 2016. Much of that jump is thought to be the result of the state's focus on earlier stages in the education ladder (ie. high school internships in aerospace and software companies) and increased R&D spending through programs like the C2+E2 framework (Collaboration and Coordination + Efficiency and Effectiveness = Success) and Prosperity 2020 programs. Virginia has existing STEM pipeline programs like the Governor's STEM academies and university-based programs like Virginia Tech's Kids Tech University

[69] National Research Council. (2013). *Best practices in state and regional innovation initiatives: competing in the 21st century*. National Academies Press.
[70] TEDCO. The Life Science Investment Fund. Retrieve from http://tedco.md/program/the-life-science-investment-fund-lsif/
[71] Center for Innovative Technology. Investment Criteria. Retrieve from http://www.cit.org/service-lines/investment-criteria/

or JMU's Center for STEM Education and Outreach, but there is little coordination at the state level as compared to Utah.

Further investigation reveals there is even more to the story of Utah and its 'Silicon Slopes'. Silicon Slopes describes a corridor that extends along the Rocky Mountains from Ogden to Provo. In recent years, the corridor, and the state as a whole, has emerged as an entrepreneurial seedbed, home to intrepid start-ups and successful software companies. Like other states mentioned here, Utah actively encourages innovation through low tax rates, a business-friendly environment, and a high-tech workforce pipeline emerging from Brigham Young University, University of Utah, and Utah State. However, what distinguishes the Utah case from many others is the preeminent role that collaboration plays in the innovation story. Public-private partnerships drive many of these collaborations, including the Utah Energy Workforce Scholarship Program to expand science, technology, engineering, and math educational opportunities. The program was developed by Chevron and the Governor's Office of Energy Development. Similarly, the STEM Action Center, which was designed to drive research and implementation of STEM education best practices across Utah by coordinating STEM-related activities, works to align public STEM education with higher-education STEM activities. Innovation-specific efforts are also taking place at the University of Utah's Lassonde Entrepreneur Institute, which helps students learn how to become founders, creators, or change-makers. Collectively, it seems the efforts may be paying off. Utah has been recognized as one of the best places for tech start-ups by both the U.S. Chamber of Commerce and *CNBC*. Still, critics warn that Utah still has a way to go to overcome or compensate for its own insularity, inland location, and lack of a cohesive brand.

Possible Implications for Virginia

Improving Virginia's innovation rankings and developing a reputation that the Commonwealth is inherently supportive of entrepreneurs will require policies and programs that support innovators and cultivate innovative talent. To do so, government leaders should invite new business models, welcome and adopt forward-looking technologies, and foster business-friendly fiscal policies. Building on the many existing strengths of the Commonwealth, these changes can encourage innovators and entrepreneurs to live, work, and play here. To spur these innovative practices, Virginia leaders can learn much from their peers. Below, we offer potential policy options for Virginia leaders to consider in their quest to improve Virginia's innovation rankings.

Increase incentives and funding for R&D and commercialization. Echoing successes seen in Maryland because of TEDCO's Seed Funding Program and Life Science Investment Fund or in Massachusetts because of its permanent R&D credit, Virginia (with leadership from CIT) would be wise to consider an increase in the number and amount of seed funding it makes available to companies looking to bring their products to market. Increasing the amount available would not only allow Virginia to better compete against other states, it would also send the signal that R&D and commercialization, especially for innovative products and services, is a priority here. It would make sense to focus at least some of this expanded offerings on the cyber-security and unmanned systems industries, areas where Virginia is likely to grow in coming years. These improvements are likely to improve Virginia's ranking in the high-tech business formation and number of patents issued to residents in the longer term.

Improve upon the existing IEMS system to celebrate Virginia's strengths and to address shortcomings. Virginia leaders would be wise to continue tracking Virginia's talent/business/innovation competitiveness through the IEMS. However, technological advances – including those that are showcased in dashboards like Massachusetts MATTERS – make it possible to improve the public face of the IEMS and provide more nuanced data for current and prospective investors and talent. Comprehensive and accurate data should be widely-available and should showcase the many unique strengths of the Commonwealth, while also acknowledging when things could be improved and what it is that we are doing to improve them. Improving the IEMS will not directly improve the rankings on any of the innovation variables, but sharing accurate information and improving the public face of CIT should indirectly affect every one of the innovation variables by encouraging investors and talent to live, work, and invest in Virginia.

Expand and promote a high-tech workforce pipeline that leverages Virginia's industrial strengths. Virginia has a rich array of educational offerings from pre-Kindergarten through higher education, but the thread that links them is not entirely cohesive. Strengthening that link will require a series of flexible pathways for students to navigate. If they are to model the successes of Utah's STEM action center, these pathways will rely heavily on partnerships with public, private, and non-profit entities. Such pathways will also be multi-scalar, with contributions from local, regional, and state partners. Though educational change is often sluggish because it is so complex, the results can have significant and lasting long-term effects, especially on Virginia's rankings in high-tech industry employment and STEM workers as a percent of the larger labor force. Promoting a high-tech workforce pipeline is a long-term intervention that will support all future innovation policy and will put Virginia on the map for efforts to improve STEM/high-tech pipeline.

Continue to cultivate and expand university-driven economic development and leverage their relationships with Federal anchors. Virginia has a number of world class universities, most of which are already actively engaging in economic development. Leaders should continue to celebrate Virginia's strengths but also identify opportunities to improve upon university-related spinoffs and commercialization rates. Doing so will likely require that Virginia leaders incentivize collaborations between universities, federal labs, and commercial partners. Maryland's targeted funding programs and university-led partnerships could be a good resource for Virginia leaders looking to cultivate industrial strengths in innovative fields like information technology, biotechnology and biomedicine, and aerospace and defense. The strength of these programs and partnerships relies heavily on close proximity and strong relationships with Federal government institutions and laboratories, both of which can be helpful in securing federal research grants and improving Virginia's ranking in that category.

Table 10: Summary Recommendations and Variable Impacts

Recommendation	Affected Variables	Degree of Impact
Increase incentives and funding for R&D and commercialization	High-tech business formation; Number of patents issued to residents	Immediate impact on high-tech business formation. Longer-term impact on patenting rates.
Improve upon the existing IEMS system	All (indirectly)	Indirect effects on most innovation variables in the longer-term.
Expand and promote a high-tech workforce pipeline that leverages Virginia's industrial strengths.	High-tech industry employment; STEM workers as a percent of the larger labor force	Long-term policy that will support all future innovation policy, and put Virginia on the map for efforts to improve STEM/high-tech pipeline
Continue to cultivate and expand university-driven economic development and leverage their relationships with Federal anchors.	Federal health, science, and agriculture research grants; Number of patents issued to residents	Mid- to long-term policy change that would affect Beacon Hill and *CNBC* rankings over time

ECONOMIC GROWTH VARIABLES

Economic growth reflects increases in the number and impact of value-generating exchanges occurring in a community or region's economy. This creates higher levels of disposable income that can lead to new value generating transactions. In growing economies, consumers possess higher levels of disposable income and are often more confident in the continued availability of disposable income into the future. Such communities provide munificent environments for the growth of existing firms and the emergence of new firms that can further contribute to the volume of value generating exchanges.

During periods of economic downturn, this virtuous cycle is reversed. Whether through real changes in disposable income, as a consequence of job loss, reduced work hours, or wage reductions, consumers may possess less disposable income, resulting in fewer exchanges. This results in less value generation further limiting disposable income and value generating transactions. Such downturns can also result from reductions in consumer confidence. Even when no real reduction in disposable income occurs, factors that create uncertainty about future wages may cause consumers to forego or reduce spending in the near term in order to save their disposable income for future expenditures (or consumption).

While the Virginia economy continues to grow, its rate of growth has been surpassed by other states over the last decade, moving Virginia from a GDP growth rate more than 10% above the national average to 3% above the national average. From 2015 – 2016, Virginia's Real GDP grew at a marginal rate of around 1%; states that performed well in this category—Washington, Georgia, and Florida—experienced significant economic growth (4%, 3%, and 3% respectively).[72] As a consequence, Virginia's position in indicators of economic growth rankings has moved from consistently in the top 10 among states to positions nearer the middle ranks among states. *CNBC* currently ranked Virginia 30th on their measures of economic growth in 2016. With improved numbers in 2017, Virginia has moved up to 20th in *CNBC*'s economic growth rankings in 2017.

[72] Bureau of Economic Analysis (2016).

Table 11: *CNBC* Rankings: Top States for Business

Category\Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Overall Rank (Score)	2	1	2	1	3 (1553)	5 (1542)	8 (1538)	12 **(1420)**	13 (1435)	7 (1552)
Cost of Business	11	26	26	21	32 (152)	38 (167)	30 (226)	37 (129)	36 (142)	35 (152)
Workforce	8	8	9	12	8 (249)	6 (208)	10 (201)	6 (265)	3 (276)	2 (367)
Quality of Life	28	18	18	26	16 (222)	18 (194)	22 (172)	25 (185)	16 (204)	17 (196)
Economy	**17**	**7**	**11**	**8**	**10 (192)**	**10 (260)**	**29 (211)**	**36 (146)**	**30 (163)**	**20 (179)**
Infrastructure/ Transportation	13	10	12	10	33 (160)	21 (199)	19 (204)	25 (188)	32 (167)	25 (179)
Technology/ Innovation	14	12	10	11	14 (152)	12 (202)	10 (226)	14 (163)	15 (159)	16 (136)
Education	11	7	13	6	13 (140)	8 (101)	9 (100)	6 (140)	5 (136)	13 (128)
Business Friendly	2	2	2	2	3 (176)	6 (161)	5 (163)	3 (126)	3 120)	7 (115)
Access to Capital	13	18	9	10	9 (79)	13 (19)	19 (16)	12 (39)	15 (36)	13 (77)
Cost of Living	27	27	27	24	20 (31)	20 (31)	32 (19)	25 (39)	30 (32)	28 (23)

Part of the swing in economic performance is the Commonwealth's reliance on spending from government, particularly from the federal level. Government spending is a component of GDP, and about 18% of Virginia's GDP comes from government expenditures (including federal, state, and local government). This share is the 5th highest among states and more than 5 percentage points over the national average of 13%. Post-recession fiscal policy has led to passing of the sequestration, and state economies tied closely to budgets of the federal government are at the mercy of politicians in Washington. The total amount of contribution to GDP in Virginia from government expenditures has remained relatively flat since 2009 (index value of 100) with a 2016 index of 101.6, trailing GDP growth for all industries in Virginia that have an 2016 index value of 106.85. This is entirely due to a loss contracts (-16) and grants (-17%) Virginia received from the federal government, over the same period. The economy is more complex and dynamic than federal spending; however, Virginia stands to gain from diversifying the state's economy away from government spending.[73]

Below are descriptions of the two variables that help to comprise measures of economic growth.

Consumer Spending. Two indicators of consumer spending highlighted in the *CNBC* rankings are percent change and per capita Personal Consumption Expenditures (PCE). Data are from BEA, and described as representing the overall economic health of a state's economy. Virginia is below the

[73] Bureau of Economic Analysis (2017). Retrieved from: https://www.bea.gov/regional/.

national average in PCE growth (3.1% versus 3.6%), which ranks Virginia 26th out of 50 states, though this is a steady improvement over the states rank of 49th in 2013.

States that perform well in PCE growth, are California, Hawaii, Massachusetts, and Utah (ranked 2nd, 13th, 10th, 4thand 3rd in *CNBC* economy subindex). Alternatively the poorest performers in PCE growth are Alaska, Arizona, North Dakota, Oklahoma, and Wyoming (ranked 32nd, 38th, 21st, 40th, 47th, and 43rd). Virginia is above the national average in per capita PCE ($40,163 versus $38,196) and would rank 20th. Looking at the various components of consumer spending, Virginians spend a high proportion on housing and utilities, off-premises food and beverages and other personal consumption expenditures. Alternatively, Virginians tend to spend less of their income on healthcare, and gasoline and energy compared national spending averages.[74] The states with the highest per capita PCE are Massachusetts, Alaska, New Hampshire, and New Jersey (ranked 14th, 48th, 40th, 22nd, 31st, and 41st in the *CNBC* economy subindex). The state that have the lowest per capita PCE are Alabama, Arkansas, Kentucky, Mississippi, and South Carolina (ranked 8th, 15th, 29th, 26th, 32nd, and 47th in the *CNBC* economy subindex).

Table 12: Per Capita Personal Consumption Expenditures[75]

	Consumer Spending per Capita ($M)	Rank	Consumer Spending (% Change)	Rank
1998	21,598		5.8	
1999	23,180		7.3	
2000	24,841		7.2	
2001	25,737		3.6	
2002	26,567		3.2	
2003	27,964		5.3	
2004	29,753		6.4	
2005	31,645		6.4	
2006	33,070	17th	4.5	34th
2007	34,436	18th	4.1	19th
2008	35,222	18th	2.3	26th
2009	34,620	16th	-1.7	19th
2010	35,565	16th	2.7	22nd
2011	36,873	16th	3.7	35th
2012	37,746	16th	2.4	28th
2013	38,291	17th	1.4	49th
2014	39,278	18th	2.6	45th
2015	40,392	18th	2.8	31st
2016	41,632	20th	3.1	26th

Virginia's levels of per capital personal consumption have generally mirrored those of the rest of the US. Consequently, there has been relatively little change in Virginia's rank over the last decade. However, annual change data are far more volatile with annual percent change in per capita consumption expenditures, ranging from a low of -1.7% to high of 7.8% over the last 20 years. Since 2006, Virginia

[74] Bureau of Economic Analysis (2016). Retrieved from: https://www.bea.gov/newsreleases/regional/pce/pce_newsrelease.htm
[75] Bureau of Economic Analysis (2016). Retrieved from: https://www.bea.gov

rank on percent change in per capital personal consumption expenditures ranging from a low of 49th to a high of 19th.

Health of Residential Real Estate Market. *CNBC* also included indicators on the health of the residential real estate market as part of the measures of economic health. The methodology used a housing price index from the Federal Housing Finance Agency and the foreclosure rates from Realtytrac. The Housing Price Index (HPI) is a weighted, repeat sales index that measures the average price changes in repeat sales or refinancing of a property. This information is obtained by reviewing repeat mortgage transactions on single-family properties whose mortgages have been purchased or securitized by Fannie Mae or Freddie Mac since January 1975. Virginia is ranked 40th in terms of the HPI index, meaning that in general housing prices are lower relative other states. The top states in this index are Colorado, Idaho, Washington, New Hampshire, and Oregon (13th, 8th, 3rd, 22nd, and 10th). In terms, of foreclosure rates Virginia has one foreclosure for every 2,336 housing units, which is lower than the national average of 1 in every 1789. States that have particularly high foreclosure rates are New Jersey, Delaware, Maryland, Connecticut and Florida (ranked 31st, 39th, 7th, 41st, and 2nd in *CNBC* economy subindex).

As noted previously and highlighted by *CNBC*, the above indicators measure the overall health of the state's economy, and both are cyclical with the US economy. Therefore, we highlighted several policies tied to economic growth that may influence the *CNBC* economy subindex rankings.

Policy Examples from Other States

Virginia Tech conducted a comparison of policy initiatives for several states including:

- A number of states at the top of *CNBC*'s economic growth rankings (e.g., Florida, Georgia, Maryland, Tennessee, Utah and Washington)
- Those comparable to Virginia in *CNBC*'s economic growth rankings (e.g., Arizona, Massachusetts, Missouri, North Carolina and Ohio)

While several types of policy exist across states in all three groups, qualitatively the policies across these three groups differ in several substantive ways. First, policies related to creating support for venture capital and angel funding are more coherent and aggressive in organizations in the highly ranked groups. States that score high on economy adopt different approaches taken across states. Maryland and Massachusetts offer far programs supporting research and technology commercialization. Others like Florida, Utah, Maryland and Massachusetts offer programs that generate funding across the start-up continuum and/or provide more total dollars in direct seed and venture funding ($300 million in Utah) or leverage venture capital through Fund of Funds programs (i.e., Florida and North Carolina).

Higher scoring tend to have more programs that specifically target technology commercialization efforts in specific targeted industries. Massachusetts efforts in clean energy and Maryland focus on biotechnology, stem cell research, and cyber security are examples. The more aggressive states place significant effort in supporting and encouraging citizens to engage in these efforts through tax incentives focused on supporting research and commercialization.

Third, states that rank higher in the rankings offer more aggressive and agile programs centered on responding quickly to the needs of organizations that are considering moving operations into these states. QuickStart like those in Tennessee and Georgia create highly flexible economic response

mechanisms that can help "close the deal" to encourage location of key economic development target companies to the state.

Possible Policy Implications for Virginia

As noted previously, the business rankings incorporate several economic performance indicators. The two variables highlighted in this section—consumer spending and health of the residential real estate market—are situated within *CNBC*'s Economy subindex. Economists generally use these two measures as macro-economic performance indicators, which suggests that Virginia may not be able to directly influence these measures. However, other sections of this report examined drivers of economic growth, such as human capital accumulation (education) and technology, which may indirectly affect these measures. Moreover, as illustrated below, the changes in *CNBC*'s weighting of different subindexes also suggests the ranking system is becoming less influenced by these macro-economic indicators and preferring to rank states based more on indicators of economic drivers. Over the past several years, the weights for Cost of Doing Business (-100) and Economy (-75), once the two highest weighted elements in the *CNBC* formula, along with Technology and Innovation (-75) and Business Friendliness (-50) have lower weights in 2017 than in 2013. At the same time, the weights assigned to Infrastructure and Transportation (+50), workforce (+125), Education (+50) and access to capital (+75) have increased.

Table 13: *CNBC* Index Category Weights and Changes 2013 to 2017

Category	2013	2014	2015	2016	2017
Cost of Doing Business	450	450	350	350	350
Economy	375	375	340	340	300
Infrastructure and Transportation	350	350	350	350	400
Workforce	300	300	400	400	425
Quality of Life	300	300	325	325	300
Technology & Innovation	300	300	250	250	225
Business Friendliness	200	200	160	160	150
Education	150	150	200	200	200
Cost of Living	50	50	75	75	50
Access to Capital	25	25	50	50	100
Total	2,500	2,500	2,500	2,500	2,500

As evidenced in the review of states in *CNBC*'s Economy subindex, the highly ranked states do not necessarily address the consumer spending and residential real estate market health head-on. Rather they turn to driver variables such as access to capital. Relative to higher-ranking states, Virginia appears to offer less total support for early stage investment in high growth companies and offers fewer programs design to enhance research activity and the movement of technology toward commercialization than higher-ranking states. There exist opportunities within the state to support the entire technology development and commercialization continuum in with more total state resources targeted to key high-growth industries in the state.

To ultimately encourage consumer spending and a healthier residential market, we recommend supporting business growth by increasing funding for R&D and commercialization as well as by increasing and revising tax incentives for venture capital investment. These changes should align with

regional target industries that provide higher than median regional wages, perhaps aligning with recently establish GO Virginia target industries. These recommendations tie in heavily to the variables and goals for the innovation section.