2006

Resource Inventory and Assessment: Vision Shared Focus Team on Technology-Based Economic Development

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Technical Document Series

Resource Inventory and Assessment

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RRI Tech Doc 2006-06

Date Submitted: December, 2006

Regional Research Institute

Morgantown, WV

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Technology-Based Economic Development

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Report prepared by Randall W. Jackson, Walter R. Schwarm and Russ Lorince, in conjunction with the Focus Team, December 2006.

Executive Summary

West Virginia's overall competitive position in the area of technology-based economic development is characterized as mixed. While the state does have significant technology assets including federal research laboratories, universities and selected firms, these assets fail to produce substantial spillover benefits to the local population and state as a whole. While West Virginia has a relatively strong technological base, a number of factors serve to inhibit economic growth and technology transference.

First, despite the fact that West Virginia ranks quite high in the amount of Federal research funding and overall R&D dollars spent in the state, **only a small percentage of these R&D dollars is linked to or sponsored by industry**. A lack of substantial business and industry sponsorship and ties also characterizes other university-based research and development.

Second, **the overall educational achievement of students in West Virginia fails to provide the necessary basis for strong growth of a technology-based economy**. High school drop-out rates are among the worst in the nation and while there are improvements in the number of students obtaining post-secondary education, few of them are choosing majors in science or engineering, both of which are critical for the continued growth of a technology based economy.

Third, **the availability of investment capital in the state is constrained**. While there is an ample pool of venture capital funding at this time, funding for early stage companies (angel & seed capital) is inadequate. As a result, few companies are developing to the level where they can attract venture capital. Serious consideration must be given to the creation of a public sector seed fund.

A fourth shortfall is **the availability of technical and business support services for early stage companies** in West Virginia. An integrated network of support entities must be organized to help more promising young companies survive the challenges of their first five years.

Lastly, while much new knowledge and technology is under discovery and development within the laboratories and universities of the state, little seems to be connected to or aware of the surrounding environment. There is thus considerable room for improvement in the overall infrastructure, both physical and psychological, of knowledge transference in the state. A concerted effort to share and maximize the benefits of the technology based, “high-tech” research and development already going on in the state, is likely to be a strong first step to ensuring that West Virginia has a strong role in the industries of the future.

Introduction

West Virginia's overall future economic position is likely to be affected greatly by the changing nature of the global marketplace. To remain competitive, factors generating comparative advantage must change along with markets. Comparative advantage requires not just the cultivation of tangible assets, but also the distribution and timely disbursement of knowledge, innovation, and intellectual capital. To ensure that an effective strategy targets such areas, the contributors to those changes must be identified.

The role played by technology in regional growth and development is quite complex as technology and innovation are not black boxes that spread throughout regions, nations, or the world. Instead, they are the result of explicit and purposeful decisions of firms and individuals concerning the types of products and processes their business will include. While locational considerations are usually secondary to these strategic priorities, some regional manifestations of technology are more direct such as the concentration of innovation and facilities as a result of explicit governmental or institutional policy.

Some technology policy issues loom larger within the debate. Government involvement in innovation in the U.S. and elsewhere tends to be highly concentrated in military and energy activities. This implicitly concentrates government policy on several large firms in a few sectors in a small number of locations. However, such outcomes are considered only "incidental" to the more basic purpose of such government spending. Government policies more commonly ignore innovation explicitly simply because it is complex and not well understood, and deal instead with the general economic climate or environment. Nearly all such policies, however, are concerned primarily with R&D rather than with the broader application of new techniques via diffusion and adaptation. From a regional standpoint the competitiveness of lagging regions and areas is perhaps more important than the continued generation of innovations in a few agglomerations of R&D. One consistently promoted alternative is a focused emphasis on grants or funding to build up the technological capability of industries and firms that are internationally competitive. Variations in technology across both industries and regions add to the difficulty of creating a meaningful regional technology policy. That is to say, the region's industry and activity mix may have to be altered to achieve the expected results.

To that end, this report will compile and present an inventory and assessment of West Virginia's technology partnership resources, provide a preliminary analysis of West Virginia's economy and identify core strengths, capabilities, and weaknesses in the knowledge-based technological economy.

1 West Virginia Economic Performance and Composition

1.1 Overview and Profile

Overall the population of West Virginia in 2004 was 1,812,548 which ranks 37th in the nation including the District of Columbia.

In 2004 West Virginia had a per capita personal income (PCPI) of $25,792. This PCPI ranked 50th in the United States and was 78 percent of the national average of $33,050. The 2004 PCPI reflected an increase of 5.2 percent from 2003, which is slightly greater than the national change over the same time period of 5.0 percent. Viewing a longer time frame reveals that in 1994 the PCPI of West Virginia was $17,194, which ranks 50th again in the United States. The 1994-2004 average annual growth rate of PCPI was 4.1 percent which also is the average annual growth rate for the nation.

In 2004 West Virginia had a total personal income (TPI) of $46,749,648, which placed it 39th in the United States compared to a 1994 TPI of West Virginia of $31,301,200 which ranked 37th in the United States. The 2004 TPI reflected an increase of 5.3 percent from 2003 versus a national growth rate of 6.0 percent. The 1994-2004 average annual growth rate of TPI was 4.1 percent, while the average annual growth rate for the nation was 5.2 percent.

Total personal income includes net earnings by place of residence; dividends, interest, and rent; and total personal current transfer receipts received by the residents of West Virginia. In 2004 net earnings accounted for 60.1 percent of TPI (compared with 60.2 in 1994); dividends, interest, and rent were 13.0 percent (compared with 15.9 in 1994); and personal current transfer receipts were 26.9 percent (compared with 23.9 in 1994). From 2003 to 2004 net earnings increased 6.5 percent; dividends, interest, and rent increased 0.8 percent; and personal current transfer receipts increased 5.1 percent. From 1994 to 2004 net earnings increased on average 4.1 percent each year; dividends, interest, and rent increased on average 2.0 percent; and personal current transfer receipts increased on average 5.3 percent.

Earnings of persons employed in West Virginia increased from $29,740,318 in 2003 to $31,612,176 in 2004, an increase of 6.3 percent. The 2003-2004 national change was 6.3 percent. The average annual growth rate from the 1994 estimate of $21,818,592 to the 2004 estimate was 3.8 percent, which is considerably less than the average annual growth rate for the nation over the same period of 5.5 percent.

1.1.1 Gross State Product

A comparison of WV with its neighboring economies is given in Table, below (all values in thousands $). WV's GSP, and therefore the state's overall economy, is considerable smaller than its regional neighbors, at approximately 45% the size of Maryland's and roughly 10% the size of each of its other neighboring states. There are both advantages and disadvantages to such a relative size disparity. On the one hand, a smaller economy is less able to generate and take advantage of economies of scale and scope rendering it a less favorable location for businesses and industry relative to larger states all other things equal. Such a dismal outlook is tempered by the fact that smaller economies are usually less rigid and therefore have the potential for more dramatic shifts and rapid adaptations. Additionally, smaller economies can have their own cost advantages as congestion and local competitive costs such as labor and capital may be correspondingly lower compared to larger economies.

Table 1. Gross Product by State and Industry

INDUSTRY	WV	OH	PA	VA	MD
All Industries	49454	419866	468089	329332	227991
Private industries	41071	373496	423153	272470	189643
Agriculture, forestry, fishing, and hunting	267	1930	2468	1377	747
Mining	3462	1322	2695	1314	163
Utilities	2440	9009	12326	5384	6195
Construction	2150	16970	20398	15945	13396
Manufacturing	5470	84633	75281	38344	14062
Durable goods	3028	56984	34370	15058	6387
Nondurable goods	2441	27649	40911	23287	7675
Wholesale trade	2370	25288	26814	14237	12025
Retail trade	4032	29639	31608	20445	15358
Transportation and warehousing	1610	12477	14695	8206	4843
Information	1323	12284	17955	18396	8462
Finance and insurance	1964	32518	35707	22215	15525
Real estate, rental, and leasing	4598	44588	55986	40274	34763
Professional and technical services	1957	22368	31819	33911	22780
Management of companies and enterprises	356	10634	7756	7305	1436
Administrative and waste services	965	11384	11894	8454	6669
Educational services	234	2902	8264	2067	2574
Health care and social assistance	4757	33201	42035	17000	16815
Arts, entertainment, and recreation	534	2969	3467	1731	1718
Accommodation and food services	1363	9173	9915	7582	6106
Other services, except government	1220	10207	12068	8282	6006
Government	8383	46370	44936	56862	38348

To better determine the relative position of individual sectors within WV versus its neighboring states Table 2 shows the *relative* importance of each of the sectors and industries in terms of percentages of respective total state product. This serves to highlight those sectors that are either of more importance to WV's GSP or less relative to the economies of its regional neighbors. Those that are of higher importance tend to reflect traditional long-term economic strengths even if those industries are themselves experiencing a period of declining importance within the overall economy.

Table 2. Gross Product Relative to Total State Gross Product

INDUSTRY	WV	OH	PA	VA	MD
All Industries	100.00%	100.00%	100.00%	100.00%	100.00%
Private industries	83.05%	88.96%	90.40%	82.73%	83.18%
Agriculture, forestry, fishing, and hunting	0.54%	0.46%	0.53%	0.42%	0.33%
Mining	**7.00%**	0.31%	0.58%	0.40%	0.07%
Utilities	**4.93%**	2.15%	2.63%	1.63%	2.72%
Construction	4.35%	4.04%	4.36%	4.84%	5.88%
Manufacturing	11.06%	20.16%	16.08%	11.64%	6.17%
Durable goods	6.12%	13.57%	7.34%	4.57%	2.80%
Nondurable goods	4.94%	6.59%	8.74%	7.07%	3.37%
Wholesale trade	4.79%	6.02%	5.73%	4.32%	5.27%
Retail trade	**8.15%**	7.06%	6.75%	6.21%	6.74%
Transportation and warehousing	3.26%	2.97%	3.14%	2.49%	2.12%
Information	2.68%	2.93%	3.84%	5.59%	3.71%
Finance and insurance	3.97%	7.74%	7.63%	6.75%	6.81%
Real estate, rental, and leasing	9.30%	10.62%	11.96%	12.23%	15.25%
Professional and technical services	3.96%	5.33%	6.80%	10.30%	9.99%
Management of companies and enterprises	0.72%	2.53%	1.66%	2.22%	0.63%
Administrative and waste services	1.95%	2.71%	2.54%	2.57%	2.93%
Educational services	0.47%	0.69%	1.77%	0.63%	1.13%
Health care and social assistance	**9.62%**	7.91%	8.98%	5.16%	7.38%
Arts, entertainment, and recreation	1.08%	0.71%	0.74%	0.53%	0.75%
Accommodation and food services	2.76%	2.18%	2.12%	2.30%	2.68%
Other services, except government	2.47%	2.43%	2.58%	2.51%	2.63%
Government	16.95%	11.04%	9.60%	17.27%	16.82%

The Mining, Utilities, Retail, and Health Care sectors have significantly greater contribution to the WV economy compared with the neighboring states. Finance and Insurance, and Management on the other hand are seen to be significantly less important in the economic make-up of WV than in regional neighbors. Another sector of note is Arts, Entertainment and Recreation although the less dense population concentration in WV is likely to be a primary explanation here.

1.1.2 Employment by Major Sectors

An alternative measure of relative economic size is employment. When West Virginia is compared its regional neighbors we note only some small areas that are of interest due to their variance from the overall picture. Mining in WV is considerably more important than its regional neighbors as might be expected. Additionally the Retail Trade and Health Care sectors are generally seen to have employment levels above the states relative size.

Table 3. Employment by State, Sector and Industry

	West Virginia	Maryland	Ohio	Pennsylvania	Virginia
Total employment	898316	3245800	6733238	7026542	4594395
Nonfarm employment	875309	3228203	6638030	6947291	4534269
Private employment	724106	2703273	5788287	6136773	3696725
Forestry, fishing, related activities, and other	3768	7105	11783	17541	12849
Mining	30087	3066	21834	28257	11537
Utilities	6319	9748	21064	29736	12202
Construction	51248	229632	362099	383736	316336
Manufacturing	65672	149690	847074	718823	308436
Durable goods manufacturing	41035	79619	581135	429705	172915
Nondurable goods manufacturing	24637	70071	265939	289118	135521
Chemical manufacturing	11116	13026	49216	54388	18076
Plastics and rubber products manufacturing	4037	8121	74130	41837	21844
Wholesale trade	25544	100213	251835	250209	125477
Retail trade	112714	361141	767805	827825	502792
Transportation and warehousing	25131	90406	213431	242114	134584
Information	13279	60366	105929	126319	111950
Finance and insurance	27783	147479	304306	347810	172539
Real estate and rental and leasing	22175	130876	209498	192462	162626
Professional and technical services	37813	303262	354935	441294	417762
Management of companies and enterprises	3235	12309	95643	75927	71393
Administrative and waste services	40220	202369	398378	354794	255514
Educational services	12790	81740	121502	235719	76171
Health care and social assistance	114226	352821	751950	887837	363975
Arts, entertainment, and recreation	16225	69427	119612	133073	81860
Accommodation and food services	62278	202290	454134	430466	293798
Other services, except public administration	53599	189333	375475	412831	264924
Government and government enterprises	151203	524930	849743	810518	837544
State and local	119803	322557	735108	663580	505158

Once again while the absolute numbers can give us an idea of the employment factors in play, the analysis is enhanced by examining the relative percentage of employment in each sector, which are given in Table 4.

Table 4. Employment Relative to State Totals

	West Virginia	Maryland	Ohio	Pennsylvania	Virginia
Total employment	100.00%	100.00%	100.00%	100.00%	100.00%
Wage and salary employment	82.11%	82.21%	83.50%	83.75%	84.14%
Proprietors employment	17.89%	17.79%	16.50%	16.25%	15.86%
Farm proprietors employment	2.32%	0.37%	1.18%	0.85%	1.04%
Nonfarm proprietors employment	15.58%	17.42%	15.31%	15.40%	14.82%
Farm employment	2.56%	0.54%	1.41%	1.13%	1.31%
Nonfarm employment	97.44%	99.46%	98.59%	98.87%	98.69%
Private employment	80.61%	83.29%	85.97%	87.34%	80.46%
Forestry, fishing, related activities, and other	0.42%	0.22%	0.17%	0.25%	0.28%
Mining	3.35%	0.09%	0.32%	0.40%	0.25%
Utilities	0.70%	0.30%	0.31%	0.42%	0.27%
Construction	5.70%	7.07%	5.38%	5.46%	6.89%
Manufacturing	7.31%	4.61%	12.58%	10.23%	6.71%
Durable goods manufacturing	4.57%	2.45%	8.63%	6.12%	3.76%
Nondurable goods manufacturing	2.74%	2.16%	3.95%	4.11%	2.95%
Chemical manufacturing	1.24%	0.40%	0.73%	0.77%	0.39%
Plastics and rubber products manufacturing	0.45%	0.25%	1.10%	0.60%	0.48%
Wholesale trade	2.84%	3.09%	3.74%	3.56%	2.73%
Retail trade	12.55%	11.13%	11.40%	11.78%	10.94%
Transportation and warehousing	2.80%	2.79%	3.17%	3.45%	2.93%
Information	1.48%	1.86%	1.57%	1.80%	2.44%
Finance and insurance	3.09%	4.54%	4.52%	4.95%	3.76%
Real estate and rental and leasing	2.47%	4.03%	3.11%	2.74%	3.54%
Professional and technical services	4.21%	9.34%	5.27%	6.28%	9.09%
Management of companies and enterprises	0.36%	0.38%	1.42%	1.08%	1.55%
Administrative and waste services	4.48%	6.23%	5.92%	5.05%	5.56%
Educational services	1.42%	2.52%	1.80%	3.35%	1.66%
Health care and social assistance	12.72%	10.87%	11.17%	12.64%	7.92%
Arts, entertainment, and recreation	1.81%	2.14%	1.78%	1.89%	1.78%
Accommodation and food services	6.93%	6.23%	6.74%	6.13%	6.39%
Other services, except public administration	5.97%	5.83%	5.58%	5.88%	5.77%
Government and government enterprises	16.83%	16.17%	12.62%	11.54%	18.23%
State and local	13.34%	9.94%	10.92%	9.44%	11.00%

One consistently revealed picture is the greater *relative* importance of Farming in WV versus its neighbors, for both farm owners/proprietors and hired wage earners.

1.1.3 Employment Change by Major Sector in %

The relative change in the growth rate of employment over the previous year is given for the 2002-2004 time frame below.

Table 5. West Virginia Relative Employment Growth over the Previous Year 2002 – 2004

	2002	2003	2004
Total employment	0.06	-0.03	1.69
Farm employment	1.04	-0.23	-0.17
Non-farm employment	0.03	-0.02	1.74
Private employment	-0.21	-0.01	1.98
Forestry, fishing, related activities, and other	2.33	-11.33	-2.38
Mining	-3.37	1.73	8.50
Utilities	-2.91	-5.68	-1.47
Construction	-3.79	-0.53	4.70
Manufacturing	-4.83	-5.68	-2.22
Durable goods manufacturing	-4.83	-6.01	-0.90
Nondurable goods manufacturing	-4.81	-5.16	-4.34
Wholesale trade	-3.34	-2.17	2.47
Retail trade	-0.85	0.01	1.78
Transportation and warehousing	-2.04	-2.23	2.18
Warehousing and storage	1.60	0.07	13.47
Information	-7.68	0.48	-6.17
Finance and insurance	3.14	-1.74	-2.05
Real estate and rental and leasing	1.43	4.73	4.69
Professional and technical services	1.69	1.32	2.31
Management of companies and enterprises	4.18	-1.71	6.45
Administrative and waste services	-2.34	0.01	4.35
Educational services	2.50	2.80	2.16
Health care and social assistance	3.38	1.71	1.87
Arts, entertainment, and recreation	10.22	2.55	6.90
Accommodation and food services	1.36	3.21	1.90
Other services, except public administration	3.18	0.56	2.07
Government and government enterprises	1.19	-0.07	0.60
State and local	1.44	-0.14	0.85

Those sectors that post the strongest consistent wage growth are: Real Estate and Rental and Leasing, Health Care and Social Assistance, Arts, Entertainment and Recreation, and Services on the whole. It should be noted that this period does include a national recessionary period and may still reflect adjustments to the economy resulting from the tech expectations bust of 1999-2000 and the post-9/11 response.

1.1.4 Average Wages: WV vs. National

Examining the average wage in each of the major sectors for WV and comparing it to the national average gives an assessment of the relative strength of WV economic conditions. As is consistent with WV ranking of 50th in PCPI in the nation, wages in the state are significantly lower than those of the US on the

whole. This is true for all sectors, but is particularly true within the sectors of the economy engaged in finance, real estate, technical and managerial activities. Once again this can be seen as either a potential negative or as a positive competitive location factor.

Table 6. West Virginia and National Average Wages

Average wages 2004-Q4				
	West Virginia	US	Difference	% Difference
Ag, Forestry, fishing, related activities	$20,605	$22,360	-$1,755	-7.85%
Mining	$54,526	$66,612	-$12,086	-18.14%
Utilities	$62,825	$72,384	-$9,559	-13.21%
Construction	$32,453	$40,508	-$8,055	-19.88%
Manufacturing	$42,769	$47,840	-$5,071	-10.60%
Durable goods manufacturing	$41,123	$49,866	-$8,743	-17.53%
Nondurable goods manufacturing	$45,829	$46,685	-$856	-1.83%
Wholesale trade	$40,885	$53,300	-$12,415	-23.29%
Retail trade	$19,493	$24,440	-$4,947	-20.24%
Transportation and warehousing	$35,427	$38,844	-$3,417	-8.80%
Information	$37,867	$60,736	-$22,869	-37.65%
Finance and insurance	$34,576	$70,148	-$35,572	-50.71%
Real estate and rental and leasing	$23,749	$37,284	-$13,535	-36.30%
Professional and technical services	$37,870	$62,556	-$24,686	-39.46%
Management of companies and enterprises	$49,950	$80,028	-$30,078	-37.58%
Administrative and waste services	$19,543	$27,248	-$7,705	-28.28%
Educational services	$25,427	$35,464	-$10,037	-28.30%
Health care and social assistance	$30,812	$36,712	-$5,900	-16.07%
Arts, entertainment, and recreation	$17,097	$27,612	-$10,515	-38.08%
Accommodation and food services	$11,573	$14,716	-$3,143	-21.36%
Other services, except public administration	$21,064	$25,168	-$4,104	-16.31%
Government and government enterprises	$33,913	$40,508	-$6,595	-16.28%

1.2 Relative Strengths

The average rate of employment growth for all sectors over the 3-year period shown in Table 5 is 0.32%. Based on this we identify West Virginia sectors that have experienced higher than average growth over that time frame. These are presented in the table below.

Table 7. Better than Average Growth Sectors

Better than average employment growth sectors: 2002-04	
Mining	2.29%
Warehousing and storage	5.04%
Real estate and rental and leasing	3.61%
Professional and technical services	1.77%
Management of companies and enterprises	2.97%
Educational services	2.49%
Health care and social assistance	2.32%
Arts, entertainment, and recreation	6.56%
Accommodation and food services	2.16%
Other services, except public administration	1.94%

1.3 Relative Weaknesses

Similar calculations to those done in the previous section to identify high employment growth sectors can identify those sectors of the WV economy that are either growing at a below average rate, or even contracting. The relatively steep drop in employment within the Information sector is perhaps most problematic when considering the future of technology led innovation in WV.

Table 8. Worse than Average Growth Sectors

Worse than average employment growth sectors: 2002-04	
Farm employment	0.21%
Forestry, fishing, related activities, and other	-3.79%
Utilities	-3.35%
Construction	0.13%
Manufacturing	-4.24%
Durable goods manufacturing	-3.91%
Nondurable goods manufacturing	-4.77%
Wholesale trade	-1.01%
Retail trade	0.31%
Transportation and warehousing	-0.69%
Information	-4.46%
Finance and insurance	-0.22%

1.4 Current State of Knowledge-based Economic Contributions

If we consider the broad based economic categories examined so far a mixed picture of the West Virginia economy's knowledge based contributions emerges. While there are elements of the economy that are currently relatively strong, they tend to reflect the more traditional comparative advantage assets of natural resources and lower cost labor. When we consider the primary drivers of

a knowledge-based economy, innovation, intellectual capital and technology infrastructure, past growth trends are somewhat disappointing. These areas show roughly equivalent economic importance when compared to regional neighbors however wage and employment growth within these sectors does not match regional nor national trends. This indicates that conditions currently existing in the WV economy to maintain and promote growth within these sectors are likely less than favorable.

2. Assessment of West Virginia's Technological Position and Preparedness

Following the methodology of the U.S. Department of Commerce 2000 Office of Technology's State Science and Technology Indicator Project, West Virginia's economy is characterized by comparing WV with all other states in the US. Data used to determine the rankings are as current as possible, and are generally 2004 or 2005 values. Additionally, the WV economy is compared with its neighboring states directly in a final set of tables that rank the state based on established "new economy" indicators.

For clarity of exposition it should be noted that in the following tables data are presented in terms of quintiles, or bands of 20% ranking. When WV falls in the 5th quintile in a statistic, it is in the bottom 20% of states in the nation.

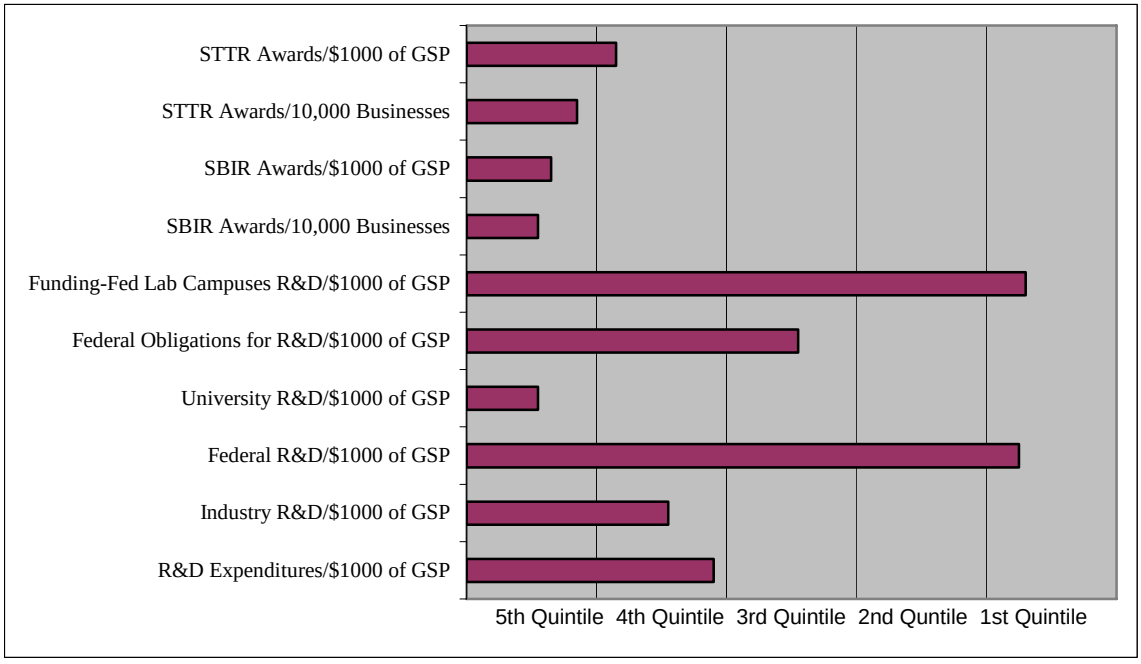
2.1 Research and Development Base and Spending on R&D by University/Federal

For most indicators presented in the next several tables, WV is either in the bottom 20% or 40% of all states. This is consistent with WV rank as 34th among the states including DC and Puerto Rico in terms of the amount of federal R&D dollars received annually. However the exceptions to this statement are notable: Federal R&D and Funding of Federal Labs at Campuses per $1000 dollars of GSP, and the percent of Workforce with a Recent Master's Degree in Science and Engineering. In these cases WV scores among the top 20% and 35% respectively. This strengthens the argument that the basis for technology based economic growth exists at some level in WV but that the ability to transfer that investment and momentum to the private sector is lacking at this time.

In recent years, the federal government has spent in the neighborhood of $261 million annually in West Virginia on research and development (R&D) activities. On average, federal R&D dollars account for approximately 7 percent of all federal funds spent in West Virginia each year on matters other than the direct support of individuals (such entitlements as retirement, disability, and housing assistance). Of the major federal agencies that currently support federal

R&D efforts, most provide funding for R&D activities in West Virginia as well. Most significant from a funding perspective is the Department of Energy (DOE), which accounts for 44 percent of all federal R&D dollars spent in the state. The Department of Health and Human Services (HHS), the National Science Foundation (NSF), and the Department of Agriculture (USDA) account for an additional 15, 14, and 9 percent of the federal R&D dollars spent in West Virginia, respectively. The Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA) each account for an additional 6 percent of the federal R&D dollars spent in the state. The remaining federal R&D dollars come collectively from the Department of Transportation (DOT) and miscellaneous other federal agencies.

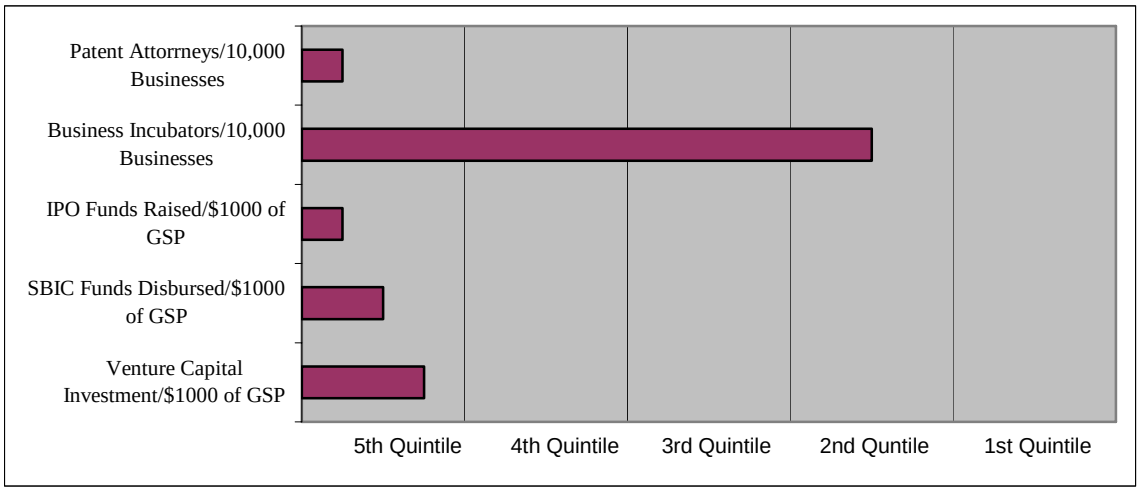
Table 9. University/Federal Research and Development Base and Spending on R&D



2.2 Capital Availability

The West Virginia Development Office website lists 12 venture capital funds which are available to invest in state businesses at present. They range from traditional, private funds located in surrounding states to the state's public fund, West Virginia Jobs Investment Trust. There also are a few with community development foci in Adena Ventures, INNOVA, the Natural Resource Capital Fund and Mountaineer Capital. Other firms listed include Anthem Capital, iNetworks, Select Capital Ventures, Toucan Capital, Walker Ventures, The Progress Fund and PA Early Stage. Combined these funds bring a substantial pool of venture capital to the West Virginia marketplace.

Table 10. Capital Availability

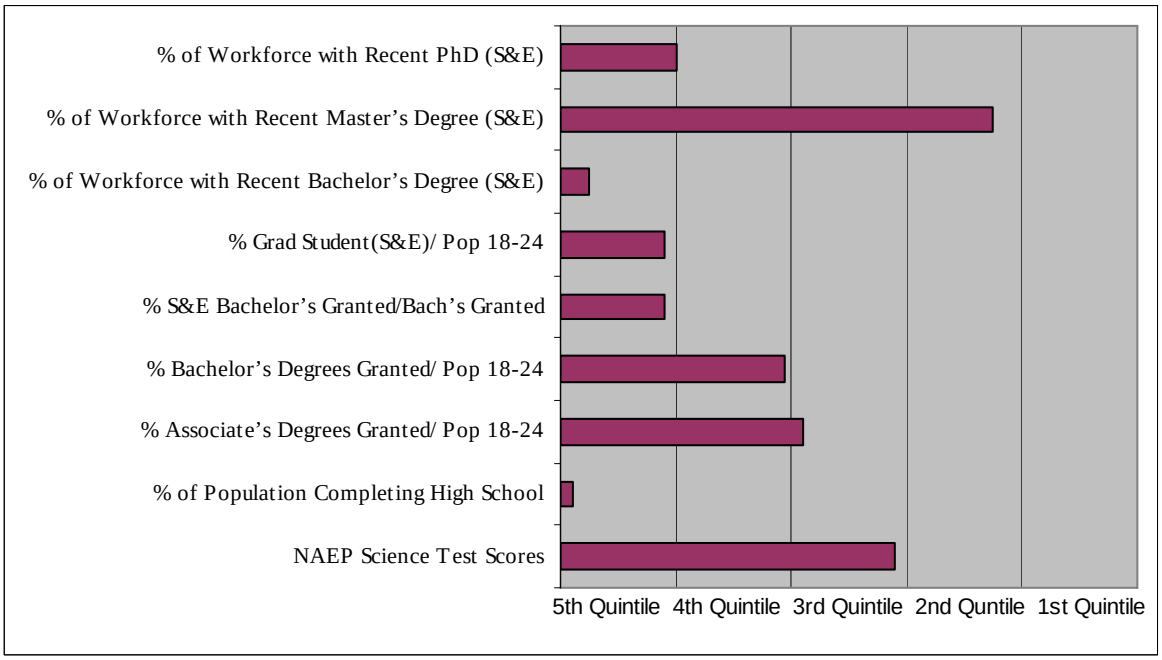


There are several points of note concerning the above table. While WV venture capital is in the 5th quintile, the state is not at the bottom of the rankings. Consistent with the interview report presented to the Focus Team, the level of venture capital and business incubators are not the limiting factors for the WV technology economy, rather opportunities to use those assets profitably are.

2.3 Labor Market Issues

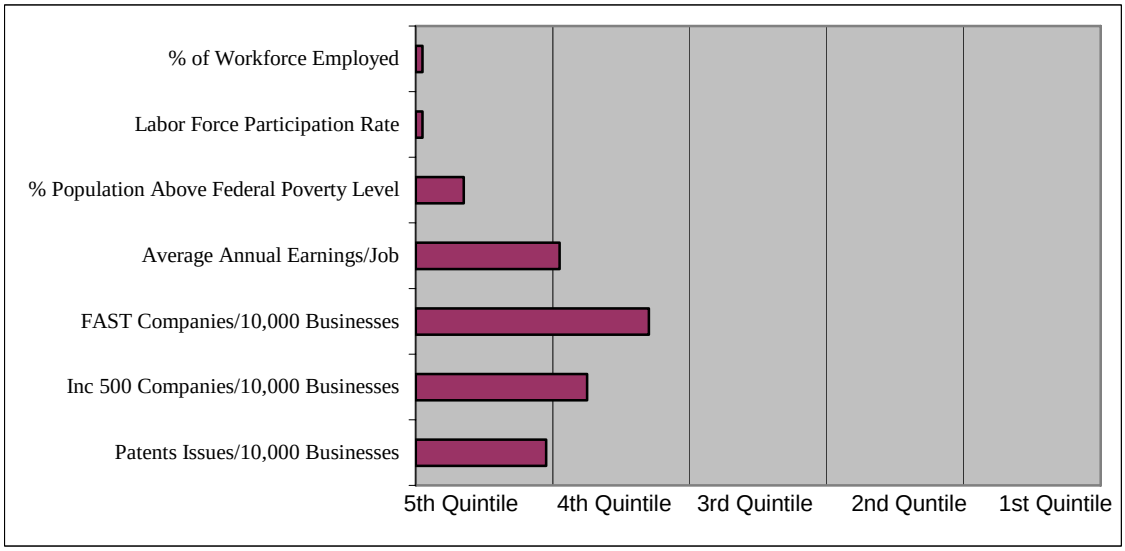
The education and skill levels of a region's labor force critically affect the ability of an economy to innovate. While nearly all of the indicators of labor market quality show West Virginia to be among the bottom 10% of the states, the percentage of the workforce with recent Master's degrees in science and engineering is high relative to other states, as are the state's science test scores. These indicators suggest that the beginnings of a foundation for technology-based development have been established.

Table 11. Overall Level of Educational Attainment



The general indicators in Table 12 describe the economy as having a very low labor force participation rate, high levels of poverty, and higher than average unemployment rates. This combination describes a relatively distressed region in which a substantial number of potential workers choose not to participate in the labor force and among those that do gainful employment is often difficult to find, hence the high levels of poverty. Note however that there is considerable geographical variation within the State of West Virginia. Distress levels tend to be much higher in the southern regions of the state.

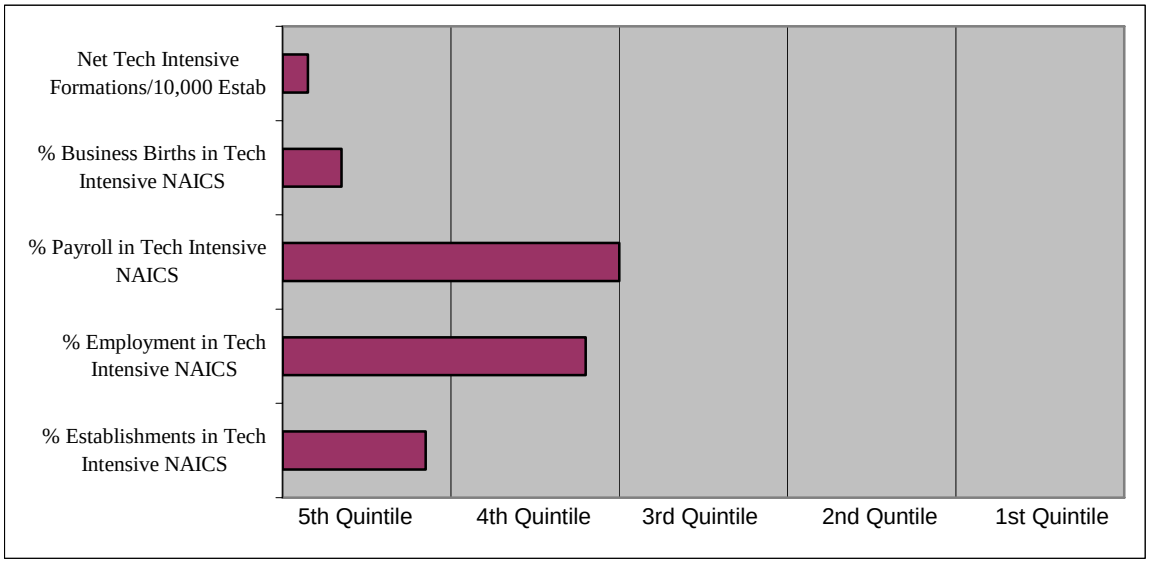
Table 12. General Indicators



2.4 New Business Starts by Area and Sector and Patent Activity

West Virginia once again ranks in the lowest quintile for measures of new tech intensive business formation. Table 13 shows that while the percentage of establishments in tech intensive sectors also ranks low among the states, payroll and employment in tech intensive sectors is relatively higher, suggesting larger institutional and establishment sizes.

Table 13. New Business Formation and Indicators of Tech Sector Participation



2.5 Comparison of WV with Regional Neighbors

Based upon and drawing in part from categories and data on the Progressive Policy Institute's New Economy Project website, Table 14 summarizes West Virginia's position relative to its neighbors in the context of the "new economy". While the education level of the manufacturing workforce is roughly equivalent to most of its neighbor states, other indicators of the quality of West Virginia's knowledge-based workforce reinforce its relative weakness.

West Virginia has a lower share of jobs in "gazelle" companies than any of his neighbors, and ranks lower than the rest in terms of initial public offerings, indicating a lack of economic dynamism. But it is among the indicators of innovation capacity where West Virginia scores more poorly than its neighboring states on each.

West Virginia's patent activity, shown in Table 15, reflects the overall size of the state's economy versus its regional neighbors. Although it is clear that Ohio and Pennsylvania contribute a greater share of patents relative to their size

than do the other neighboring states. Patent activity is therefore a somewhat crude measure of the innovativeness of the firms and research activities within a state. When the year-to-year growth rates are examined (Table 16), it can be seen that while West Virginia may have a relative smaller number of patent activities the growth rate of patents within the state is similar to if not better than that of its regional neighbors suggesting that those R&D activities that WV possesses are fairly productive.

Table 14. Overall Ranking of WV with Nation and Regional Neighbors

	WV	MD	OH	PA	VA
	Score (Rank)	Score (Rank)	Score (Rank)	Score (Rank)	Score (Rank)
Knowledge Jobs					
Information Technology Jobs: Employment in IT occupations in non-IT industries as a share of total jobs.	0.82% (**45**)	2.52% (**5**)	1.32% (**29**)	1.43% (**26**)	2.61% (**3**)
Managerial, Professional & Tech Jobs: Managers, professionals, and technicians as a share of the total workforce.	24.9% (**38**)	33.0% (**3**)	25.8% (**26**)	27.0% (**22**)	29.2% (**9**)
Workforce Education: A weighted measure of the educational attainment (advanced degrees, bachelor's degrees, associate degrees, or some college course work) of the workforce.	41.4 (**49**)	65.0 (**1**)	50.2 (**27**)	53.2(**19**)	62.8 (**3**)
Education Level of the Manufacturing Workforce: A weighted measure of the educational attainment of the manufacturing workforce.	1.01 (**30**)	0.99 (**32**)	0.99 (**31**)	0.98 (**33**)	0.49 (**44**)
Economic Dynamism					
"Gazelle" Jobs: Jobs in gazelle companies (companies with annual sales revenue that has grown 20 percent or more for four straight years) as a share of total employment.	11.2% (**45**)	14.1% (**14**)	13.3% (**27**)	13.4% (**25**)	14.7% (**7**)
Job Churning: The number of new start-ups and business failures, combined, as a share of all establishments in each state.	17.9% (**42**)	20.8% (**22**)	17.2% (**46**)	17.1% (**47**)	20.7% (**23**)
Initial Public Offerings: A weighted measure of the value and number of initial public stock offerings of companies as a share of gross state product.	3.65 (**34**)	6.82 (**7**)	3.74 (**33**)	6.72 (**12**)	6.95 (**6**)
Innovation Capacity					
High-Tech Jobs: Jobs in electronics manufacturing, software and computer-related services, telecommunications, and biomedical as a share of total employment.	2.16% (**45**)	6.93% (**8**)	3.57% (**30**)	4.72% (**23**)	7.83% (**5**)
Scientists and Engineers: Civilian scientists and engineers as a percentage of the workforce.	0.35% (**39**)	1.10% (**3**)	0.42% (**26**)	0.51% (**17**)	0.58% (**13**)
Patents: The number of patents issued to companies or individuals per 1,000 workers.	0.33 (**43**)	1.06 (**10**)	0.58 (**24**)	0.84 (**17**)	0.53 (**29**)
Industry Investment in R&D: Industry investment in research and development as a percentage of Gross State Product (GSP).	0.62% (**35**)	1.24% (**26**)	1.46% (**22**)	2.83% (**7**)	1.20% (**27**)
Venture Capital: Venture capital invested as a percentage of GSP.	0.01% (**47**)	1.37% (**6**)	0.18% (**31**)	0.55% (**17**)	1.16% (**8**)

Table 15. Patent Activity, WV and its Neighbors

	WV	MD	OH	PA	VA
Pre 1991	4447	23317	77134	85331	16835
1991	162	849	2555	2708	828
1992	181	959	2571	2679	891
1993	172	997	2531	2677	875
1994	142	1058	2593	2815	858
1995	134	985	2417	2644	822
1996	114	1101	2616	2922	859
1997	147	1171	2715	2697	818
1998	189	1443	3272	3370	1051
1999	149	1510	3360	3752	1043
2000	145	1358	3197	3640	1141
2001	148	1483	3275	3533	1114
2002	151	1460	3329	3343	1160
2003	139	1453	3184	3177	1114
2004	100	1313	2889	2883	1077
All Years	6520	40457	117638	128171	30486

Table 16. Year-to-Year Growth Rate in Patent Activity, WV and its Neighbors

	WV	MD	OH	PA	VA
1992	10.50%	11.47%	0.62%	-1.08%	7.07%
1993	-5.23%	3.81%	-1.58%	-0.07%	-1.83%
1994	-21.13%	5.77%	2.39%	4.90%	-1.98%
1995	-5.97%	-7.41%	-7.28%	-6.47%	-4.38%
1996	-17.54%	10.54%	7.61%	9.51%	4.31%
1997	22.45%	5.98%	3.65%	-8.34%	-5.01%
1998	22.22%	18.85%	17.02%	19.97%	22.17%
1999	-26.85%	4.44%	2.62%	10.18%	-0.77%
2000	-2.76%	-11.19%	-5.10%	-3.08%	8.59%
2001	2.03%	8.43%	2.38%	-3.03%	-2.42%
2002	1.99%	-1.58%	1.62%	-5.68%	3.97%
2003	-8.63%	-0.48%	-4.55%	-5.23%	-4.13%
2004	-39.00%	-10.66%	-10.21%	-10.20%	-3.44%

3.0 Core Strengths and Capabilities

3.1 Identification of the Key Current Players in the WV Knowledge-based Economy and the Sectoral Areas Related to their Strengths and Competencies

Despite general agreement on the concepts of high tech, there is no general acceptance of precisely which industries to include, because identifying "new" products or "innovative" manufacturing processes and associated industries is very subjective. The approach adopted by the Bureau of the Census uses the judgment of industry analysts to identify products embodying new or leading-edge technologies falling within 10 advanced technology areas. A more widely used approach has been to list high-tech industries based on two broad measures of resources used – employment of scientific and technical personnel and research and development intensity. In this approach, studies specify criteria for these measures, such as a specific percent of total employment in scientific and technical occupations and research and development spending, or both, as a percent of sales or value added. Industries that meet those criteria are identified as high tech. We have adopted the latter procedure and use data on the proportion of employment in an industry accounted for by scientific, technical, and engineering personnel and on the proportion of the same engaged in research and development. The industry categories shown in Tables 17 - 20 were selected because they had a proportion level 2.9 times or greater than the average. Those industries listed in bold are "Level 1" high-tech industries with proportions 5 times greater than average.

One further note concerning the information in the tables presented below: Consistent with Bureau of Labor Statistics documents and methods, Biotechnology and Nanotechnology are not explicitly on the list of high-tech industries because they are not identified separately in the NAICS. Most biotech companies are located in scientific R&D services or pharmaceutical and med-manufacturing according to a Commerce Department survey. However, no similar information exists for nanotechnology.

Table 17. High-tech Sector Employment Levels 1996-2005

Industry	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Oil/Gas Extraction	1864	1807	1748	1629	1527	1654	1747	1734	1819	1990
Electric Power Generation	5543	5464	5449	5379	5145	5073	4983	4727	4647	4607
Petroleum and Coal Products	1059	837	1073	1052	1097	1118	1160	1239	1172	1216
Chemical Manufacturing	7825	7703	7671	7401	7246	6606	5695	5037	4560	4010
Resin, Synthetic Rubber, Artificial Filament	5236	5145	4884	4642	4450	4216	3852	3623	3285	2977
Paint, coating and adhesive	269	246	236	220	226	240	239	187	183	188
Other Chemical Products	360	350	292	121	115	127	121	221	332	342
Other General Machinery	703	732	745	678	637	634	612	539	473	484
Semiconductor/Electronic Comp.	**346**	**304**	**313**	**355**	**355**	**386**	**296**	**273**	**316**	**357**
Navigational, measuring, electro-medical and control	**1126**	**1115**	**1020**	**1007**	**1029**	**930**	**910**	**870**	**890**	**970**
Electrical Equipment Manufacturing	420	396	395	369	379	0	0	0	0	0
Aerospace Products	1772	1813	1763	1809	1931	2080	2085	2080	2152	2511
Professional Commercial Equipment	1573	1592	1584	1737	1748	1693	1663	1634	1566	1571
Software	**0**	**0**	**0**	**0**	**0**	**0**	**32**	**30**	**22**	**23**
Internet Publishing	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**0**	**8**	**11**
Wired Telecom	3685	3786	4042	4122	4046	4127	3743	3407	3155	2921
Wireless Telecom	546	649	657	693	721	721	697	726	248	232
Telecom Resellers	147	130	159	170	228	361	333	337	344	354
Internet Service Providers	**95**	**154**	**271**	**316**	**348**	**210**	**181**	**183**	**170**	**159**
Data Processing	**720**	**662**	**622**	**599**	**669**	**599**	**561**	**636**	**751**	**782**
Engineering Services	**4906**	**4925**	**4978**	**5109**	**5131**	**5203**	**5365**	**5330**	**5372**	**5622**
Computer Systems Design	**980**	**1212**	**1492**	**1840**	**1808**	**1866**	**1857**	**1868**	**2033**	**2258**
Management, scientific, technical consulting	1280	1442	1496	1506	1532	1973	2171	2216	2315	2498
Scientific R&D Services	**741**	**873**	**993**	**1086**	**1117**	**1180**	**1243**	**1277**	**1295**	**1351**
Management of Companies	3814	3586	2745	2776	2738	2770	2800	2723	2927	3587
Facilities support	274	269	305	323	325	299	269	263	233	134
Higher Education	15990	15305	15506	15497	16030	16335	16506	16560	16548	16721
Electronic and Precision Equipment Service	366	342	318	306	280	301	305	292	314	290

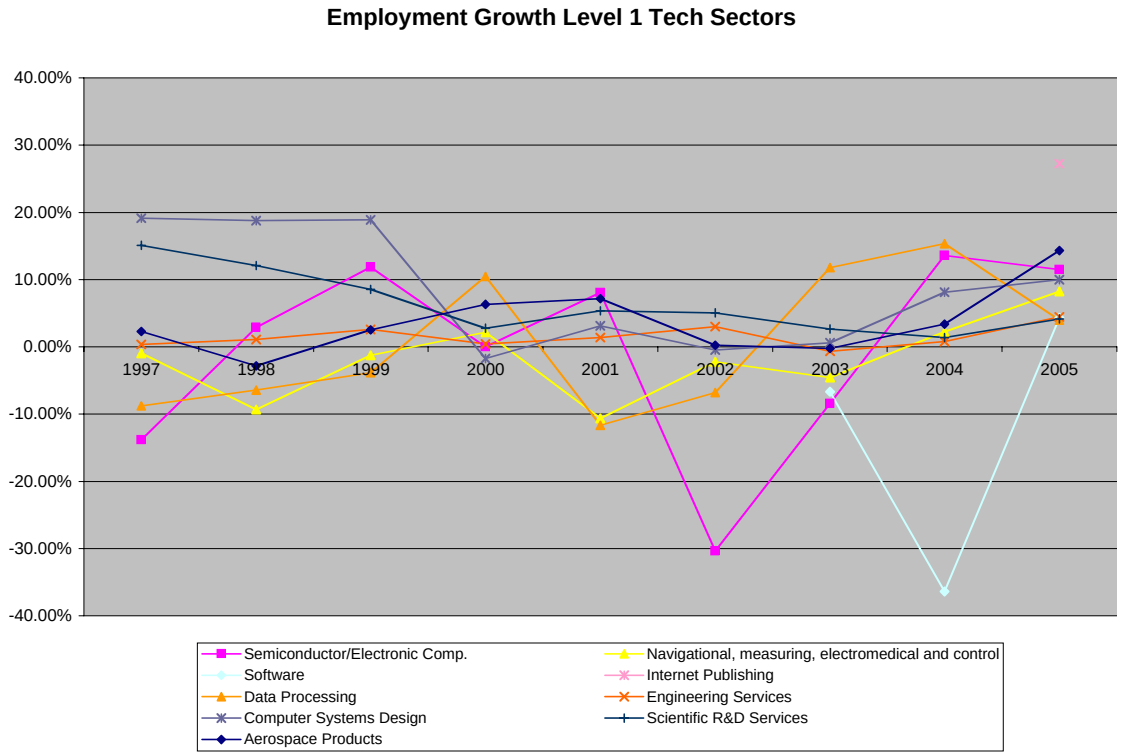
As was the case for the analysis presented in section 1 employment growth rates present a clearer picture of the relative changes that occur across time. Year-to-year growth rates for 1997-2005 are presented in Table 18.

Table 18: High-tech Sector Year-to-Year Employment Growth Rates 1997-2005 (%)

Industry	1997	1998	1999	2000	2001	2002	2003	2004	2005
Oil/Gas Extraction	-3.15	-3.38	-7.31	-6.68	7.68	5.32	-0.75	4.67	8.59
Electric Power Generation	-1.45	-0.28	-1.30	-4.55	-1.42	-1.81	-5.42	-1.72	-0.87
Petroleum and Coal Products	-26.52	21.99	-2.00	4.10	1.88	3.62	6.38	-5.72	3.62
Chemical Manufacturing	-1.58	-0.42	-3.65	-2.14	-9.69	-16.00	-13.06	-10.46	-13.72
Resin, Synthetic Rubber, Artificial Filament	-1.77	-5.34	-5.21	-4.31	-5.55	-9.45	-6.32	-10.29	-10.35
Paint, coating and adhesive	-9.35	-4.24	-7.27	2.65	5.83	-0.42	-27.81	-2.19	2.66
Other Chemical Products	-2.86	-19.86	-141.32	-5.22	9.45	-4.96	45.25	33.43	2.92
Other General Machinery	3.96	1.74	-9.88	-6.44	-0.47	-3.59	-13.54	-13.95	2.27
Semiconductor/Electronic Comp.	**-13.82**	**2.88**	**11.83**	**0.00**	**8.03**	**-30.41**	**-8.42**	**13.61**	**11.48**
Navigational, electromedical and control	**-0.99**	**-9.31**	**-1.29**	**2.14**	**-10.65**	**-2.20**	**-4.60**	**2.25**	**8.25**
Electrical Equipment Manufacturing	-6.06	-0.25	-7.05	2.64					
Aerospace Products	**2.26**	**-2.84**	**2.54**	**6.32**	**7.16**	**0.24**	**-0.24**	**3.35**	**14.30**
Professional Commercial Equipment	1.19	-0.51	8.81	0.63	-3.25	-1.80	-1.77	-4.34	0.32
Software							**-6.67**	**-36.36**	**4.35**
Internet Publishing									**27.27**
Wired Telecom	2.67	6.33	1.94	-1.88	1.96	-10.26	-9.86	-7.99	-8.01
Wireless Telecom	15.87	1.22	5.19	3.88	0.00	-3.44	3.99	-192.74	-6.90
Telecom Resellers	-13.08	18.24	6.47	25.44	36.84	-8.41	1.19	2.03	2.82
Internet Service Providers	**38.31**	**43.17**	**14.24**	**9.20**	**-65.71**	**-16.02**	**1.09**	**-7.65**	**-6.92**
Data Processing	**-8.76**	**-6.43**	**-3.84**	**10.46**	**-11.69**	**-6.77**	**11.79**	**15.31**	**3.96**
Engineering Services	**0.39**	**1.06**	**2.56**	**0.43**	**1.38**	**3.02**	**-0.66**	**0.78**	**4.45**
Computer Systems Design	**19.14**	**18.77**	**18.91**	**-1.77**	**3.11**	**-0.48**	**0.59**	**8.12**	**9.96**
Management, scientific, technical consulting	11.23	3.61	0.66	1.70	22.35	9.12	2.03	4.28	7.33
Scientific R&D Services	**15.12**	**12.08**	**8.56**	**2.78**	**5.34**	**5.07**	**2.66**	**1.39**	**4.15**
Management of Companies	-6.36	-30.64	1.12	-1.39	1.16	1.07	-2.83	6.97	18.40
Facilities support	-1.86	11.80	5.57	0.62	-8.70	-11.15	-2.28	-12.88	-73.88
Higher Education	-4.48	1.30	-0.06	3.33	1.87	1.04	0.33	-0.07	1.03
Electronic and Precision Equipment Service	-7.02	-7.55	-3.92	-9.29	6.98	1.31	-4.45	7.01	-8.28

The overall picture that emerges from examining these data is generally positive although the year-to-year variance present suggests a fairly high rate of turnover within the economy when only these sectors are considered. Table 17 and Figure 1 below identify the most consistently positive employment growth industries as Scientific R&D Services, Software Design and Aerospace Products sectors. Other allied sectors that also posted significant gains include Management, Scientific, Technical Consulting; and Other Chemical Products. These are noteworthy, as they include not only important innovational precursor activities but also pharmaceutical research and manufacturing activities.

Figure 1.



Examining relative wage changes across a similar time frame provides an additional dimension to the analysis. Tables 19 and 20 present wage levels and year-to-year growth for West Virginia's high-tech industry sectors for the 1996-2005 period. Average wages within those sectors characterized as high-tech vary widely, with 2005 values spanning the range from $19,916 for Facilities Support to $106,392 for Engineering Services.

For "level 1" industries the lower end of the range increases to $27,248 for Semiconductor/Electronic Component Manufacturing. The overall average wage for high-tech sectors in WV for 2005 was $49,835, which is considerably above the state's overall average wage of $33,608 for all sectors. While the average wage rates are favorable the year-to-year trend reveals some complicating issues.

Table 19. High-tech Sector Average Wage 1996-2005

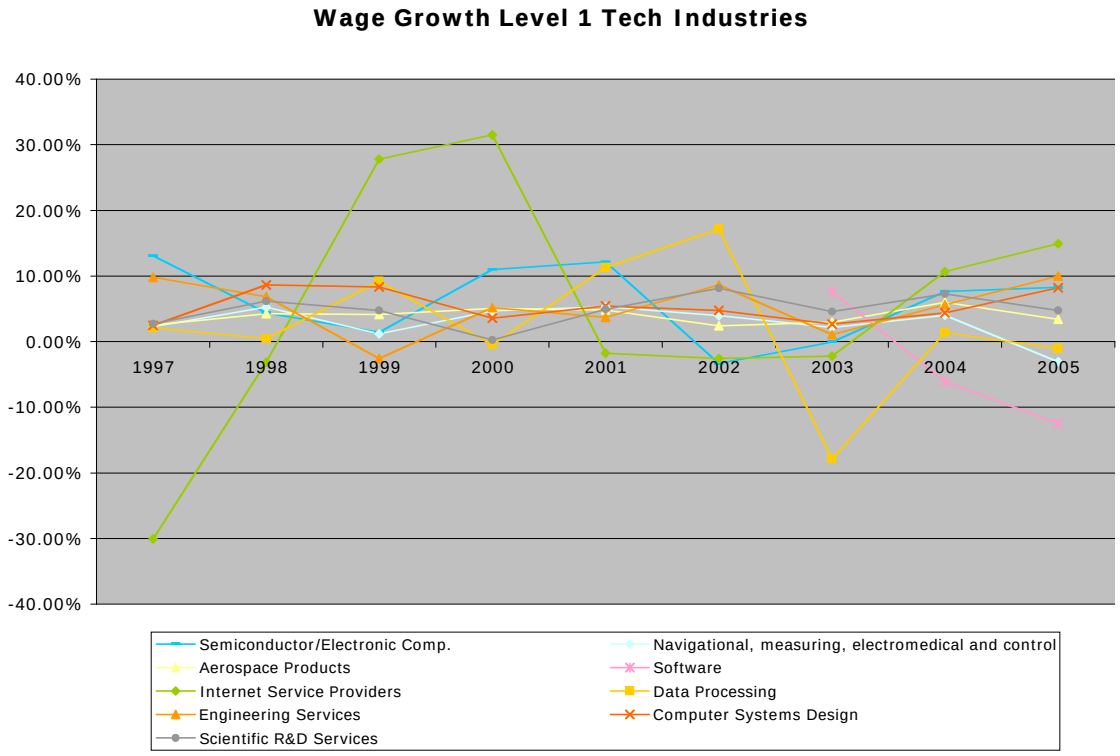
Industry	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Oil/Gas Extraction	30821	34807	31999	34568	35228	38778	39700	43169	43810	43836
Electric Power Generation	49481	49371	53192	54431	57046	63214	63023	65125	66009	68432
Petroleum and Coal Products	41638	45011	44161	45857	46152	43976	43097	44552	48472	61724
Chemical Manufacturing	57201	57720	59310	60884	63001	71456	69517	71732	73677	72592
Resin, Synthetic Rubber, Artificial Filament	55654	57128	60285	63153	66810	64492	67209	69398	74762	69316
Paint, coating and adhesive	32233	34118	35123	36628	36054	35897	36011	40917	42521	47528
Other Chemical Products	44962	42043	42754	42099	28662	30195	31329	28994	29662	34528
Other General Machinery	27048	28996	28955	29369	32078	32823	33491	33217	34799	38272
Semiconductor/Electronic Comp.	**15299**	**17598**	**18403**	**18665**	**20969**	**23863**	**23098**	**23081**	**24995**	**27248**
Navigational, measuring, electromedical and control	**25061**	**25650**	**27063**	**27380**	**28718**	**30324**	**31575**	**32276**	**33616**	**32604**
Electrical Equipment Manufacturing	29268	30841	31750	32491	32967	0	0	0		
Aerospace Products	**37007**	**37978**	**39670**	**41375**	**43568**	**45764**	**46887**	**48320**	**51382**	**53196**
Professional Commercial Equipment	34277	35541	38156	40614	42167	44115	46811	46874	47883	47840
Software						**0**	**60815**	**65803**	**62003**	**55120**
Internet Publishing						**36750**	**0**	**0**	**42424**	**39364**
Wired Telecom	43578	41975	46789	46214	49746	48957	53290	57921	58997	62712
Wireless Telecom	25267	26496	27147	28520	32888	35815	37082	38101	38840	39468
Telecom Resellers	23673	26003	25606	27266	28204	38165	39412	40696	41980	43940
Internet Service Providers	**19994**	**15369**	**14905**	**20643**	**30138**	**29601**	**28855**	**28221**	**31583**	**37128**
Data Processing	**23080**	**23577**	**23675**	**26069**	**25945**	**29244**	**35303**	**29945**	**30362**	**30056**
Engineering Services	**64388**	**71390**	**76655**	**74705**	**78761**	**81786**	**89481**	**90409**	**95751**	**106392**
Computer Systems Design	**33915**	**34774**	**38070**	**41523**	**43052**	**45517**	**47791**	**49107**	**51354**	**55952**
Management, scientific, technical consulting	34429	34076	35425	35812	39162	42274	41391	42613	44735	45656
Scientific R&D Services	**31970**	**32857**	**35018**	**36766**	**36866**	**38779**	**42214**	**44231**	**47697**	**50076**
Management of Companies	43403	47551	47456	48890	47940	45917	42959	44937	49950	54860
Facilities support	17978	17872	18691	21148	24551	22665	26020	24627	26613	19916
Higher Education	51119	53946	54686	56463	57971	59748	59246	60537	63318	67184
Electronic and Precision Equipment Service	28167	29571	29947	31257	34137	35119	34951	35409	37373	40612

Examining the year-to-year growth rates of WV wages within the high-tech sectors reveals that the strongest consistent growth occurs in the Aerospace, Engineering Services, Scientific R&D Services and Computer Systems Design sectors. Higher Education, Electronic and Precision Equipment Services, Other Chemical and Other General Machinery also post relatively consistent wage gains across the 1996-2005 time period. The consistency is particularly noteworthy since the period in question includes the 1999-2000 dot-com busts and the 2001-2002 recession, both of which affected national wages within similar sectors more significantly. Of "level 1" sectors, as can be seen in Figure 2, only the ISP and data processing sectors are seen to have impacts more closely related to the rest of the nation.

Table 20. High-tech Year-to–Year Average Wage Growth Rates 1997-2005 (%)

Industry	1997	1998	1999	2000	2001	2002	2003	2004	2005
Oil/Gas Extraction	11.45	-8.78	7.43	1.87	9.15	2.32	8.04	1.46	0.06
Electric Power Generation	-0.22	7.18	2.28	4.58	9.76	-0.30	3.23	1.34	3.54
Petroleum and Coal Products	7.49	-1.92	3.70	0.64	-4.95	-2.04	3.27	8.09	21.47
Chemical Manufacturing	0.90	2.68	2.59	3.36	11.83	-2.79	3.09	2.64	-1.49
Resin, Synthetic Rubber, Artificial Filament	2.58	5.24	4.54	5.47	-3.59	4.04	3.15	7.17	-7.86
Paint, coating and adhesive	5.52	2.86	4.11	-1.59	-0.44	0.32	11.99	3.77	10.53
Other Chemical Products	-6.94	1.66	-1.56	-46.88	5.08	3.62	-8.05	2.25	14.09
Other General Machinery	6.72	-0.14	1.41	8.45	2.27	1.99	-0.82	4.55	9.07
Semiconductor/Electronic Comp.	**13.06**	**4.37**	**1.40**	**10.99**	**12.13**	**-3.31**	**-0.07**	**7.66**	**8.27**
Navigational, measuring, electromedical and control	**2.30**	**5.22**	**1.16**	**4.66**	**5.30**	**3.96**	**2.17**	**3.99**	**-3.10**
Electrical Equipment Manufacturing	5.10	2.86	2.28	1.44					
Aerospace Products	**2.56**	**4.27**	**4.12**	**5.03**	**4.80**	**2.40**	**2.97**	**5.96**	**3.41**
Professional Commercial Equipment	3.56	6.85	6.05	3.68	4.42	5.76	0.13	2.11	-0.09
Software							**7.58**	**-6.13**	**-12.49**
Internet Publishing									**-7.77**
Wired Telecom	-3.82	10.29	-1.24	7.10	-1.61	8.13	8.00	1.82	5.92
Wireless Telecom	4.64	2.40	4.81	13.28	8.17	3.42	2.67	1.90	1.59
Telecom Resellers	8.96	-1.55	6.09	3.33	26.10	3.16	3.16	3.06	4.46
Internet Service Providers	**-30.09**	**-3.11**	**27.80**	**31.51**	**-1.81**	**-2.59**	**-2.25**	**10.64**	**14.93**
Data Processing	**2.11**	**0.41**	**9.18**	**-0.48**	**11.28**	**17.16**	**-17.89**	**1.37**	**-1.02**
Engineering Services	**9.81**	**6.87**	**-2.61**	**5.15**	**3.70**	**8.60**	**1.03**	**5.58**	**10.00**
Computer Systems Design	**2.47**	**8.66**	**8.32**	**3.55**	**5.42**	**4.76**	**2.68**	**4.38**	**8.22**
Management, scientific, technical consulting	-1.04	3.81	1.08	8.55	7.36	-2.13	2.87	4.74	2.02
Scientific R&D Services	**2.70**	**6.17**	**4.75**	**0.27**	**4.93**	**8.14**	**4.56**	**7.27**	**4.75**
Management of Companies	8.72	-0.20	2.93	-1.98	-4.41	-6.89	4.40	10.04	8.95
Facilities support	-0.59	4.38	11.62	13.86	-8.32	12.89	-5.66	7.46	-33.63
Higher Education	5.24	1.35	3.15	2.60	2.97	-0.85	2.13	4.39	5.75
Electronic and Precision Equipment Service	4.75	1.26	4.19	8.44	2.80	-0.48	1.29	5.26	7.98

Figure 2.



There are other overall conclusions that can be identified for the state of WV when examining the average high-tech wage and its growth rate. The first of these is that consistent with other sectors in the state, WV's high-tech sectors lag the nation in the overall level of employee compensation, even when adjusted for the relative cost of living. However, the tech sectors still consistently outperform the rest of the WV economy overall in both wage and employment growth. Secondly, the more moderate wage pressures present in WV's tech sectors relative to the rest of the nation would appear to provide some measure of competitive advantage for the state and insulate it somewhat from national conditions.

3.2 State Gross Product: Technology Sectors

State Gross Product (GSP) data are collected by a different agency and are subject to somewhat different disclosure rules. Therefore, the sectors used in the tables in the previous section are not all available individually within the data and a larger super-set is presented below for High-tech GSP.

Table 21. State Tech Sector GSP 1997-2004

Industry	1997	1998	1999	2000	2001	2002	2003	2004
Total Gross State Product	38795	39500	41105	41476	43365	45032	46645	49903
Oil and gas extraction	152	113	143	359	340	233	383	472
Utilities	2062	2047	1970	1999	2167	2147	2417	2414
Computer and electronic product manufacturing	**29**	**29**	**27**	**26**	**28**	**34**	**49**	**57**
Electrical equipment and appliance manufacturing	110	88	84	84	99	73	76	94
Petroleum and coal products manufacturing	102	103	75	101	126	145	173	145
Chemical manufacturing	2594	2402	2687	1909	1697	1697	1716	1602
Plastics and rubber products manufacturing	145	190	197	244	251	219	256	286
Publishing including software	**134**	**152**	**174**	**169**	**188**	**206**	**223**	**239**
Information and data processing services	**31**	**37**	**39**	**33**	**34**	**58**	**64**	**71**
Computer systems design and related services	**61**	**77**	**99**	**98**	**119**	**146**	**163**	**174**
Other professional, scientific and technical services	**707**	**760**	**806**	**789**	**886**	**935**	**982**	**1072**

Hi-tech sectors comprise a relatively small proportion of total WV GSP. They comprise approximately 14% of the states' economy across the time period shown with the bolded level 1 sectors representing approximately 3% of the states economy. The overall hi-tech sector proportion at the sectoral scale presented declines across time relative to the rest of the economy. This is not the case for "level 1" sectors which rise in importance from 2.4% in 1997 to 3.2% in 2004. The underlying forces behind such changes are seen in Table 22, below. Tech sectors as a rule have growth rates in excess of the state's. There is more volatility in the growth of these sectors relative to the state as a whole, which is consistent with the fact that the majority of the goods and services produced by these sectors are for customers outside the state. Therefore, these sectors are more significantly affected by conditions within the nation and world as whole, rather than more localized state conditions.

Level 1 sectors are seen to have growth rates both higher and more consistent than those of other sectors within the table. This reveals the underlying force between the rise of these sectors in overall importance throughout the time period. As was highlighted in the pervious section, these sectors also seem to be more insulated from the overall economic performance of the state and nation providing a measure of comparative advantage to the state of West Virginia beyond that of most other sectors.

Table 22. State Tech Sector GSP Year-to-Year Growth 1998-2004 (%)

Industry	1998	1999	2000	2001	2002	2003	2004
Total Gross State Product	1.78	3.90	0.89	4.36	3.70	3.46	6.53
Oil and gas extraction	-34.51	20.98	60.17	-5.59	-45.92	39.16	18.86
Utilities	-0.73	-3.91	1.45	7.75	-0.93	11.17	-0.12
Computer and electronic product manufacturing	**0.00**	**-7.41**	**-3.85**	**7.14**	**17.65**	**30.61**	**14.04**
Electrical equipment and appliance manufacturing	-25.00	-4.76	0.00	15.15	-35.62	3.95	19.15
Petroleum and coal products manufacturing	0.97	-37.33	25.74	19.84	13.10	16.18	-19.31
Chemical manufacturing	-7.99	10.61	-40.75	-12.49	0.00	1.11	-7.12
Plastics and rubber products manufacturing	23.68	3.55	19.26	2.79	-14.61	14.45	10.49
Publishing including software	**11.84**	**12.64**	**-2.96**	**10.11**	**8.74**	**7.62**	**6.69**
Information and data processing services	**16.22**	**5.13**	**-18.18**	**2.94**	**41.38**	**9.38**	**9.86**
Computer systems design and related services	**20.78**	**22.22**	**-1.02**	**17.65**	**18.49**	**10.43**	**6.32**
Other professional, scientific and technical services	**6.97**	**5.71**	**-2.15**	**10.95**	**5.24**	**4.79**	**8.40**

4.0 Summary and Synthesis

4.1 Overall Assessment of the WV Research and Development Base and Positioning

There are several key components to be considered when considering the state of the R&D base in WV. A usually prominent feature of regions having strong technology-intensive companies is the existence of research institutions; be they university, federal, or private. These institutions play a critical role in generating new knowledge, discoveries and potential spillover activities that allow a region to remain competitive. West Virginia's position can be characterized as mixed. It receives greater than average spending on Federal laboratories and facilities, however such spending does not seem to generate high degrees of local spillover. Federal spending on university research is also among the top 20% in the nation and would seem to generate a fair amount of regional spillover. State funding of R&D activities, both at the university and outside, presents a far less optimistic picture. West Virginia ranks among the bottom 20% of all states, and in many cases 50th, in support for research activities and grants that promote the transference of knowledge and innovation. Such lack of support results in an underdeveloped university research and development base. The lack of partnership grants detrimentally impacts the eligibility of West Virginia research facilities for STTR and SBIR grants, since these grants target partnerships.

While West Virginia's R&D base has made significant strides in recent past and has increased its overall share of GSP, the overall success and growth of the sectors that comprise it are hampered by a relative lack of seed money and the entrepreneurial culture that accompanies it. It is important to note however that money is not the only factor at play here. There are other issues and conditions

described above and further analyzed below that combine to generate an environment that while generally favorable to high-tech activities in West Virginia serve to diminish its true potential.

4.2 Labor Force Readiness and Structural Composition

The labor force within West Virginia is marked by a high degree of bi-modality. With one of the lowest high school graduation rates in the nation, the general labor force in West Virginia can be characterized as ill prepared for high-tech employment in general. However, West Virginia also has a very high percentage of recent science and engineering master degree graduates, along with reasonably favorable levels of associate, bachelor and Ph.D. graduates, although many of them are not in science and engineering. Thus, the overall picture of the West Virginia labor force is difficult to characterize and summarize. Given the relative lack or opportunity within the state, many of those science and engineering masters graduates are finding employment elsewhere in neighboring regions or the nation as a whole. Were there more occupational opportunities, it is likely that a greater proportion would continue to reside in West Virginia, and commensurately contribute to the state's economy.

More problematic for high technology industry in the state are the high rate of high school dropouts and the lack of undergraduates pursuing a course of study in science and engineering. A well-trained and knowledgeable local workforce is a prime requisite in location choices made by firms and industries in the high-tech sectors. Importing labor is both costly, disruptive, and yields less than the maximum economic benefit to a region. Therefore a paucity of locally available suitable labor forms a considerable negative to the relative attractiveness of a region or locality to new business and innovation. The only advantage that is provided by the relatively loose labor conditions in West Virginia is a mild insulation against labor cost pressures present in the rest of the nation.

4.3 Knowledge Transference Activities

While the state of West Virginia trails significantly in some areas, it is in knowledge transference activities that the state seems to have the greatest difficulties. While there is a fair amount of research undertaken at various Federal and university facilities within the state, the transference of such research, both to the private sector and between the various facilities themselves lags that observed in other states. While this would not necessarily be of concern, the relatively strong position of WV's regional neighbors compounds the problem. Rather than seeking or developing in-state partnerships, firms and consultants from regional neighbors are often used instead. While there may sometimes be sound economic reasoning behind these decisions, it would appear

both from the data and from interviews that often such decisions are made simply because of a lack of information on the existence and suitability of potential in-state partners.

Resolving this issue would provide a measurable improvement in the overall ability of West Virginia to compete on a national basis and would strengthen the relative position of its technology sectors. The promotion of mechanisms whereby technology and information is transferred from one individual or company to another is a key prerequisite for the growth of a strong technology-based economy. Not only do they generate growth on their own, but such programs provide an underlying basis for an entrepreneurial culture.

Given the levels of knowledge-based innovation already present within West Virginia at Federal labs and allied university programs the potential for economic growth given greater commingling within industry/university or research partnerships seems evident. The level of investment in high-tech sectors by the Federal government in West Virginia noted previously is among the top 20% in the nation. This exceeds levels present in several of the regional neighbors, however they seem to possess a more broadly effective and functional knowledge transference capability and infrastructure, and thus reap the economic rewards that thereby ensue.

4.4 Broadband Access

West Virginia's infrastructure for high-technology development is difficult to characterize, but in that respect, the state is not unique. Generally West Virginia can be characterized as having an adequate level of wired infrastructure with many areas having access to high-speed internet connections. Connections and bandwidth between research labs, universities and other high-tech incubators are adequate and are in some cases above levels seen in the rest of the nation.[1] While such infrastructure is vital for the growth of technology sectors, the difficulty of obtaining a clear measurement metric requires the analyst to rely on anecdotal evidence. In examining the interviews provided, nowhere was the lack of internet and informational infrastructure mentioned as a currently binding constraint on growth within technology sectors. We can therefore conclude that West Virginia is adequately served by its current level of infrastructure, at least within areas where businesses and R&D facilities are currently located. The state does, however, have infrastructure capacity problems, particularly in the distribution of high-speed access areas outside of those currently developed. This may well dissuade a firm or an entrepreneur from choosing a West Virginia location, although that is by no means certain.

[1] This is according to data from http://www.pewinternet.org/PPF/r/184/report_display.asp, Broadband Lines: Federal Communications Commission, High-Speed Services for Internet Access, (Washington, DC: 2002) although not graphed or otherwise presented elsewhere.

4.5 Business/Political Climate and its Role in Entrepreneurship and Commercialization

The business and political climate in West Virginia is generally seen to be favorable toward most potential sources of growth. However, a prevailing overall conservatism and entrenched interests can serve to provide a strong barrier to radical and quick changes within both the economic and fiscal structure of the state. Given the historical shifts within the West Virginia economy over the past 20 years, the business and political climate should well be interested in fostering and promoting future sources of economic growth potential. A continuing decline in population and general loss of competitiveness versus neighboring states is supported by the data in sections 1 and 2. Public policy decisions that support and incent economic diversity are essential. A comprehensive strategy to promote and foster technology-based economic development has been a critical building block in other states. West Virginia should review the prospect of devising and implementing such a strategy.

Appendix A: Data Sources

Information Technology Jobs
Sources: IT jobs: Bureau of Labor Statistics occupational employment data, 2005, http://www.bls.gov/oes/home.htm.

Managerial, Professional, and Technical Jobs
Source: Managerial, Professional, and Technical Jobs: Bureau of Labor Statistics occupational employment data, 2005, www.bls.gov/oes/home.htm

Workforce Education
Source: Educational Attainment: United States Census Bureau, Current Population Survey, 2004.

Education Level of the Manufacturing Workforce
Source: Educational Attainment: United States Census Bureau, Current Population Survey, 2004.

Export Focus of Manufacturing
Source: Exports: Office of Trade and Economic Analysis, International Trade Administration, United States Department of Commerce. 2004.
http://tse.export.gov/

Foreign Direct Investment
Sources: Survey of Current Business, U.S. Department of Commerce, Bureau of Economic Analysis. http://www.bea.gov/bea/pub/0205cont.htm

"Gazelle" Jobs
Source: Gazelles: David Birch, Anne Haggerty, and William Parsons, Corporate Demographics: Corporate Almanac, (Cambridge, Mass.: Cognetics, 2000).
http://www.neweconomyindex.org/

Job Churning
Source: Data compiled by the United States Census Bureau.
http://lehd.dsd.census.gov/led/datatools/qwiapp.html

IPOs
Sources: State IPO Totals: Hale and Dorr LLP, The 2003 IPO Report.
http://www.wilmerhale.com/publications/whPubsDetail.aspx?publication=2144
Gross State Product: Bureau of Economic Analysis, Regional Accounts Data.

Online Population
Source: Households Online: National Telecommunications and Information

Administration, A Nation Online: How Americans Are Expanding Their Use of the Internet (U.S. Department of Commerce: Washington, DC: 2002).

Digital Government
Sources: Darrell M. West, Brown University, Digital Government: Technology and Public Sector Performance, Princeton University Press, 2005
http://www.insidepolitics.org/egovt05us.pdf

Online Manufacturers
Source: United States Census Bureau,
http://landview.census.gov/eos/www/papers/MCDtables.pdf.

Broadband Telecommunications
Source: http://www.pewinternet.org/PPF/r/184/report_display.asp Broadband Lines: Federal Communications Commission, High-Speed Services for Internet Access, (Washington, DC: 2002).

High-Tech Jobs
Sources: High Tech Jobs: AeA, Cyberstates 2005 (Washington DC: 2005), and United States Census Bureau, County Business Patterns:2003.
http://www.census.gov/epcd/cbp/view/cbpview.html

Scientists and Engineers
Source: Scientists and Engineers: National Science Foundation, Science and Engineering Profiles, 2001-2003 Update (Arlington, Va.: 2003).
http://www.nsf.gov/statistics/nsf05301/.

Patents
Source: United States Patent and Trademark Office, Patent Counts by Country/State and Year: Utility Patents (Washington DC, 2004).
http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_utl.htm

Industry Investment in R&D
Sources: Industry Investment: totals compiled by the National Science Foundation. Gross State Product: Bureau of Economic Analysis, Regional Accounts Data. 2004.

Venture Capital
Sources: Venture Capital: totals compiled by the National Venture Capital Association.
http://www.ventureeconomics.com/vec/stats/2006q1/0MAINMENU.html Gross State Product: Bureau of Economic Analysis, Regional.