INNOVATION and HAWAII'S ECONOMIC FUTURE

April 2007

Research and Economic Analysis Division

DBEDT

THE DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

STATE OF HAWAII

Table of Contents

TABLES

FIGURES

1. Introduction

The notion that "Innovation" is the key to economic competitiveness in the twenty-first century global economy has been generating considerable attention over the past year. BusinessWeek.com recently reported that, "The U.S. is in the midst of its third major economic transformation of the last 120 years, equivalent in scope and depth to the emergence of the factory economy in the 1890s and the mass-production, corporate economy in the 1940s and 1950s. This means states must act decisively to encourage entrepreneurship or be left behind in this New Economy."[1]

The "innovation economy" is linked to entrepreneurialism and fueled by a highly skilled, knowledge-based workforce rooted in science, technology, engineering, and math (STEM). The National Governors Association (NGA) asserts that the New Economy keys to success lie in the extent to which knowledge, technology, and innovation are embedded in products and services.

Challenges facing states include the implementation of a seamless STEM educational system, transformation to a knowledge dependant economy, realization that the economy is global, encouragement of entrepreneurial ventures, rooting the economy in information technology, and embracing a purely innovation driven economy. Innovation does not occur without talented people to generate new ideas and without an investment in the K-12, university, and community college system. Three important factors are taken into consideration when analyzing a regions capacity for innovation – available workforce, specialized or skilled workforce, and quality of educational institutions.

According to recent studies that have looked at the performance of Hawaii's economy, there are several core problem areas that are of concern:

- Per capita income (inflation adjusted) in the state has been declining for several decades.
- There is a heavy dependence on the service industry, especially the visitor industry, and DOD employment.
- Hawaii has relatively low wage structure combined with a relatively high cost of living.
- An aging workforce is accelerating retirements and creating labor shortages of education, healthcare, public safety and number of technology occupations.
- There is particularly low unemployment and workforce shortages in key areas in the past few years.

Many researchers believe that Hawaii must innovate and change in order to address these challenges and prosper. The state has relied too long on the beauty of the islands for tourism as the primary force driving the economy. This reliance will not ensure

[1] Jeffery Gangemi, *Ranking the States for the New Economy*, http://www.businessweek.com/smallbiz/content/feb2007/sb20070227_818588.htm (February 2007)

prosperity in the future. According to this view, Hawaii must restructure priorities, reduce its dependence on land, and refocus efforts to develop its people as the principal natural resource and economic driver of the economy.

According to the NGA sponsored project, *Pathways to Advancement*, the current structure of the workforce in Hawaii is lacking the necessary skills to enter and be productive in a high technology, innovation economy. In particular, Hawaii is less successful than the top states in the rate of retraining and graduation of adult students. There are several major barriers to adult degree completion:

- Inadequate financial support for low and moderate-income individuals
- Insufficient employer incentives to support employee continuing education
- Lack of affordable childcare
- Scheduling conflicts between work and school
- Lack of preparation and curricular options

Furthermore, the educational pipeline in Hawaii is not producing sufficient numbers of individuals prepared for further education or training. While Hawaii ranks close to the top state when measuring rate of high school graduation, the state is far behind when measuring actual student performance in skills critical to success in post-secondary education and the new jobs. According to the Community College, the majority of Hawaii's students entering the community college require academic remediation to be successful.

The NGA has concluded that public policy can address the needs of the state and its workforce development. NGA outlines a progressive, innovation-oriented public policy framework designed to foster success in the new global economy. [2]

The framework identifies nine key policy areas states need to address in order to be positioned to experience strong growth, particularly growth in per-capita income.

1. Align incentives behind innovation economy fundamentals
2. Co-invest in an infrastructure for innovation
3. Co-invest in the skills of the workforce
4. Cultivate entrepreneurship
5. Support industry clusters
6. Reduce business cost without reducing the standard of living
7. Help boost productivity
8. Reorganize economic development efforts
9. Enlist federal help

[2] National Governors Association, *The 2007 State New Economy Index: Benchmarking Economic Transformation in the States*, (Washington, DC: NGA Center for Best Practices, 2007), p. 7

The top 10 states adapting well to an innovation economy are, Massachusetts, New Jersey, Maryland, Washington, California, Connecticut, Delaware, Virginia, Colorado, and New York. Hawaii is ranked 41 in overall improvement for 2007. This marks a decrease in rank from 26th in 1999 and 38th in 2002.[3]

It is not enough to compete against other states. Global competition has made it much more difficult for states to retain and develop high value-added, high wage-wage establishments. The rise of Asian economies and other technology-focused nations poses a threat to U.S. manufacturing and technology-based industries. According to the Ewing Marion Kauffman Foundation's publication, *The 2007 State New Economy Index: Benchmarking Economic Transformation in the States*, Table 1, Hawaii ranks 23rd in the nation under the category of globalization. Globalization subcategories are as follows: 20th in Export Focus of Manufacturing and Services, 9th in Foreign Direct Investment, and 49th in Package Exports.

Table 1. The 2007 State New Economy Index: Benchmarking Economic Transformation in the States

Hawaii

INDICATOR	RANK	SCORE
Overall	**41**	50.9
KNOWLEDGE JOBS	**35**	7.4
IT Professionals Score *Employment in IT occupations in non-IT industries as a share of total jobs.*	**40**	0.79%
Managerial, Professional, and Technical Jobs *Managers, professionals, and technicians as a share of the total workforce.*	**44**	18.1%
Workforce Education *A weighted measure of the educational attainment (advanced degrees, bachelor's degrees, associate's degrees, or some college coursework) of the workforce.*	**17**	41.4
Immigration of Knowledge Workers *The average educational attainment of recent migrants from abroad.*	**4**	14.6
Manufacturing Value-Added *The percentage of a state's manufacturing workforce employed in sectors in which the value-added per production hour worked is above the sector's national average.*	**31**	21.3%
High-Wage Traded Services *The share of employment in traded service sectors in which the average wage is above the national median for traded services.*	**46**	8.5%

[3] Ewing Marion Kauffman Foundation, The 2007 State New Economy Index: Benchmarking Economic Transformation in the States, (Kansas City: Ewing Marion Kauffman Foundation, 2007), p.13

GLOBALIZATION	23	9.5
Export Focus of Manufacturing and Services *The value of exports per manufacturing and service worker.*	20	$22,442
Foreign Direct Investment *The percentage of each state's workforce employed by foreign companies.*	9	3.9%
Package Exports *The number of UPS packages exported per worker.*	49	0.01

ECONOMIC DYNAMISM	46	6.0
"Gazelle" Jobs *Jobs in gazelle companies (firms with annual sales revenue that has grown 20 percent or more for four straight years) as a share of total employment.*	47	4.0%
Job Churning *The number of new start-ups and business failures, combined, as a share of the total firms in each state.*	20	25.6%
Fastest Growing Firms *The number of Deloitte Technology Fast 500 and Inc. 500 firms as a share of total firms.*	46	0.000%
Initial Public Offerings *A weighted measure of the number and value of initial public stock offerings of companies as a share of total worker earnings.*	34	3.96
Entrepreneurial Activity *The adjusted number of entrepreneurs starting new businesses.*	31	0.26%
Inventor Patents *The number of independent inventor patents per 1000 people.*	43	0.051

Source: http://www.itif.org/files/Hawaii.pdf

The balance of this report will focus on Hawaii's potential for economic growth, productivity, and standard of living in relation to innovation.

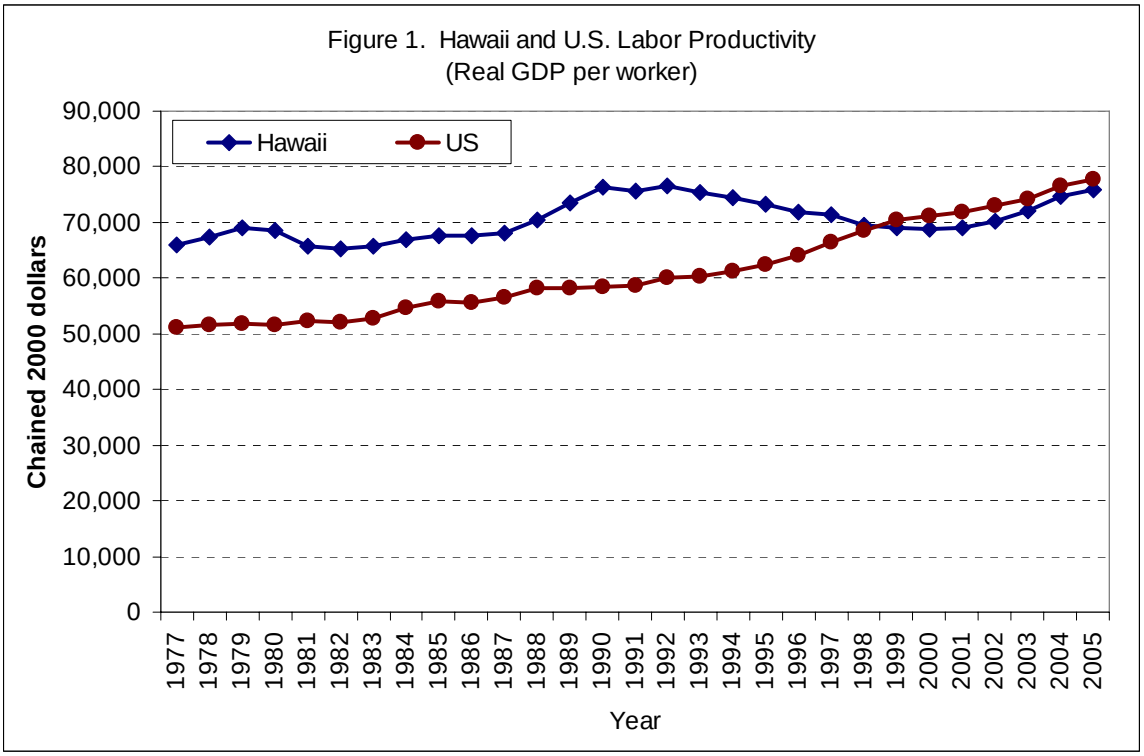
2. Economic Growth, Productivity, and Standard of Living

How has innovation contributed to Hawaii's growth and development? There are a number of ways that the contribution of innovation to Hawaii's economy can be measured and compared with the U.S. as a whole to see how the state is progressing. Over the past four decades, Hawaii has experienced three recessions. The first occurred in 1974 when GDP decreased by 0.3 percent and the second recession in 1981 when GDP declined by 2 percent. The first two recessions were short and followed by a period of rapid expansion. The third recession started in 1993 and lasted until 1998. Though the economy began to recover in 1999, the growth rate remained at 1.0 percent level until 2003.

The duration of the third recession, had a devastating impact on Hawaii's economy, real GDP in 2002 was no more than in 1990. Consequently, Hawaii's economy remained stagnant for an entire decade.

During that recession, Hawaii fell behind other states in many economic performance measures. Of particular note is the relative decline in Hawaii's productivity.
Figure 1 depicts Hawaii's labor productivity as measured by real GDP per worker as well above the U.S. level before 1990. U.S. labor productivity continued to increase while Hawaii's labor productivity started to decline in 1991. By 1999, Hawaii's labor

productivity was below the average U.S. level. Despite improvements since 2001, Hawaii's labor productivity in 2005 was still below the U.S. average.



In theory, increases in labor productivity make it profitable for firms to hire more workers, as long as they have a market for increases in their production. Other things being equal, this increased demand for labor tends to push wages up. Similarly, a decline in labor productivity makes firms less profitable or unable to compete in the global market. Demand for labor decreases. If labor supply remains the same, wage tend to decrease since there is a labor surplus. Therefore, it is not surprising that Hawaii's real compensation also fell below the U.S. average level.

Figure 2 shows that Hawaii's real compensation per employee was about the same as the U.S. average level before the 1990s, but fell below the U.S. during the 1990s, improving somewhat in the last four years.

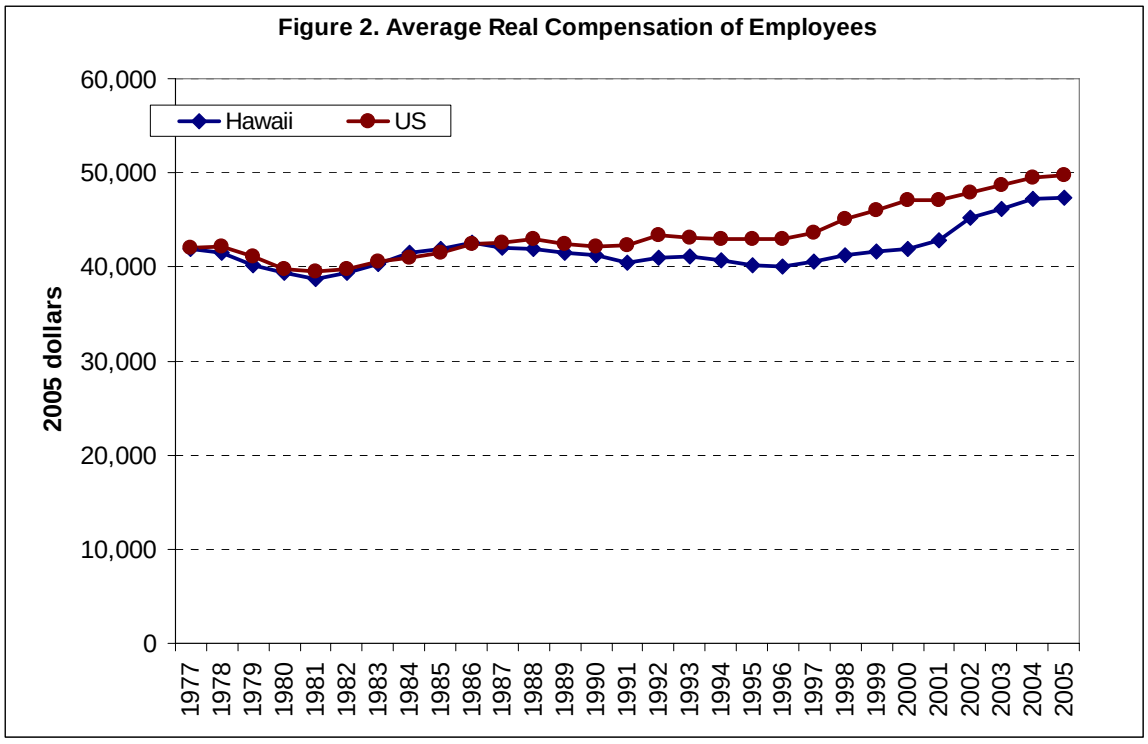
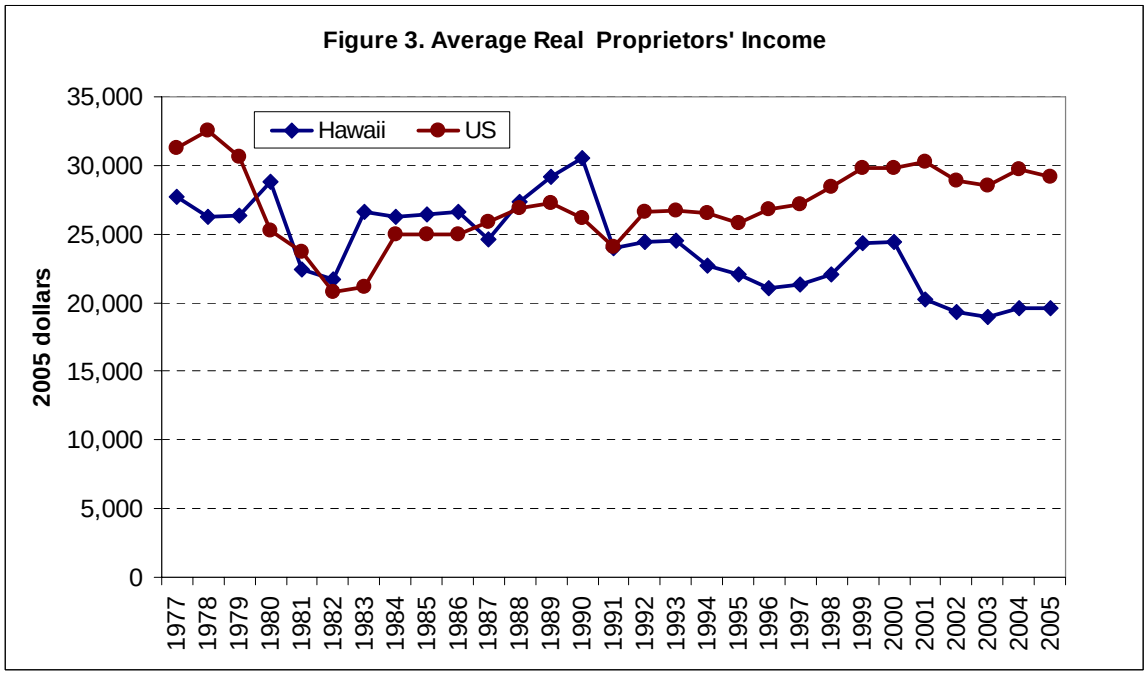
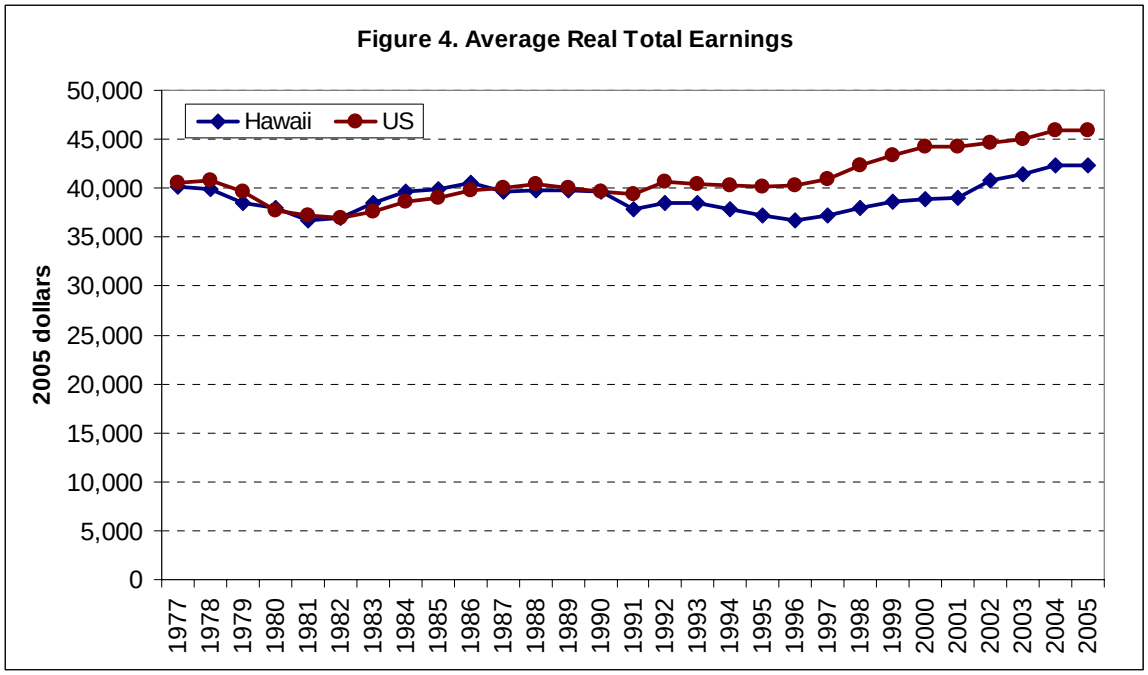


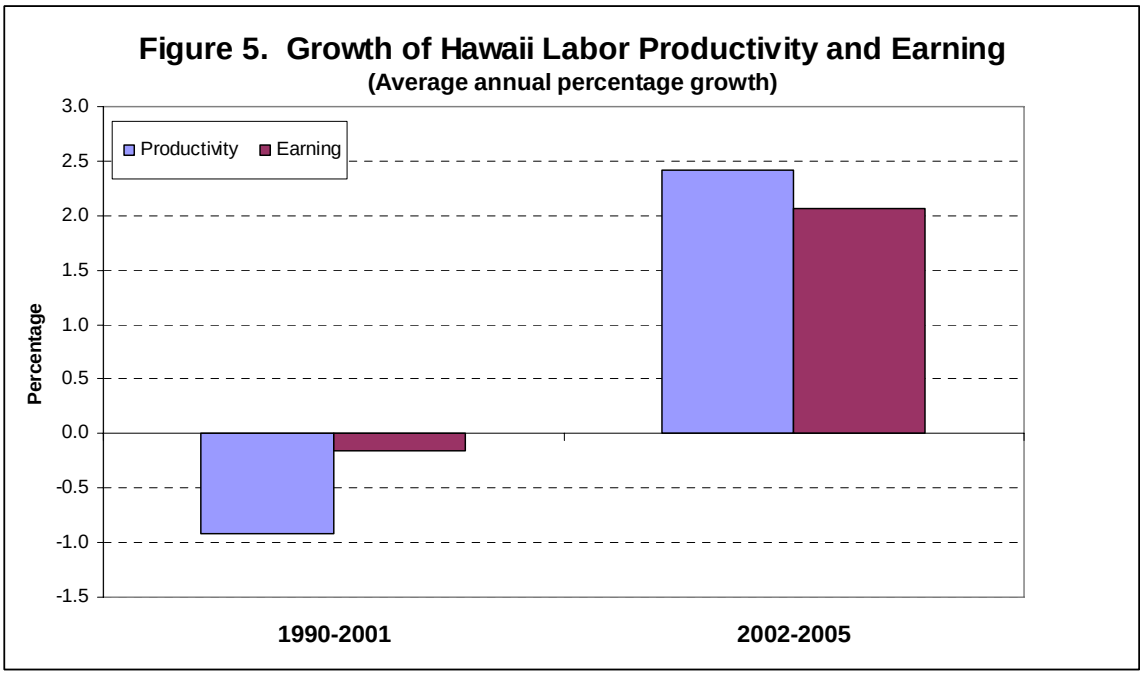
Figure 3 shows the trend of real proprietors' income for the U.S. and Hawaii. Proprietors' income is the current-production income of sole proprietorships, partnerships, and tax-exempt cooperatives. Proprietors' income followed the same pattern as employment earnings. Before 1990, Hawaii's proprietors' earnings were about the same as the national level but fell behind the U.S. level during the 1990s. Unlike employee compensation, the gap between Hawaii and U.S. proprietors' earnings has been increasing in recent years.



Adding employment compensation and proprietors' income – Hawaii average real labor income or earnings were at the same level of U.S. average during the 1980s but were 8.2 percent lower than the U.S. level since 1991.



As shown in Figure 5, the standard of living, as measured by average labor earnings, and is closely related to labor productivity. From 1990 to 2001, labor productivity decreased by 0.9 percent a year, while the standard of living declined by 0.2 percent a year. In the 2002-2005 period, labor productivity increased at an annual rate of 2.4 percent, while the standard of living improved at an annual rate of 2.1 percent.



Thus one, indirect measure of innovation is average earnings and labor productivity. The data shows that Hawaii has performed below the national average for these measures. However, labor productivity does not measure the full picture of productivity since other inputs such as capital and technology also influence production and labor productivity. To quantify the contribution of each component of the production input, economists often use a method called "growth accounting" which will be described below.

3. A Measure of Innovation

Thanks to more recent research there are more direct measures available for the contribution of innovation to Hawaii's economy and how the state compares to the nation for that measure. Fundamental economic theory states that there are only two ways to increase the output of the economy: (1) increase the amount of inputs that go into the productive process, and (2) find new ways of production such that more output can be produced from the same amount of inputs. New ways of production refers to technology and innovation; it comes from the development of new ideas on how to produce more efficiently, from more education and training and from the application of new technology to the economy.

By applying the growth theory developed by Robert Solow, a Nobel Prize winner in Economics, it can be determined how much the economy grew because of increasing inputs or by technology and innovation. Economists classify the inputs that go into the productive process into two major factors of production: capital and labor. Capital is measured by the amount of money spent on capital goods such as infrastructure,

equipment, machinery, and structures. These capital goods are used to produce other goods and have the following features:

- They can be used in the production of other goods (this is what makes it a factor of production).
- It was produced, in contrast to "land," which refers to naturally occurring resources such as geographical locations and minerals.
- It is not used up immediately in the process of production, unlike raw materials or intermediate goods.

The contracting tax base is used to approximate the value of capital input in Hawaii. As indicated in the third feature above, capital can be used for a number of years. An office building constructed 20 years ago can still be contributing to production today. Capital is calculated as the cumulative value of year-to-date investment with abolishment and depreciation adjustments. To remove the effect of inflation, capital is measured in real dollars.

Labor is a measure of the work done by human beings and it is usually measured by hours worked. In this analysis, the average number of persons employed is used to approximate labor for Hawaii. This includes people on payrolls and those who are self-employed.

After calculating the contribution of capital and labor to the growth of an economy, the residual reflects the contribution of other factors to growth. Economists often use this as a proxy for the impact of technological progress and innovation on economic growth.[4]

It has long been recognized that innovation is a major driving force in economic growth and social development for developed economies.

[4] The U.S. Bureau of Labor Statistics (BLS) calculates and reports productivity statistics for the United States since 1987. Figures from BLS are for private business only. The most recent productivity statistics release from the Bureau of Labor Statistics on March 23, 2007 reveals that innovation contributed about 18.0 percent of the private sector economic growth between 1987 and 1995. Between 1995 and 2000, the contribution increased to 27.1 percent. Between 2000 and 2005, 66.7 percent of the private sector economic growth was due to innovation.

To be consistent with the U.S. private business definition, Hawaii productivity figures are estimated excluding the three levels of governments (Federal, state and counties). Hawaii productivity figures are calculated by first estimating a production function and then applying the growth accounting technique to separate the contribution of labor, capital, and innovation, while the U.S. productivity statistics are calculated based on the indexes constructed by BLS.

Table 2. The Role of Capital, Labor, and Innovation in Private Business Economic Growth (Percentage Points Contribution to GDP growth)

	1990-2002		2002-2005	
	Hawaii	U.S.	Hawaii	U.S.
GDP	0.1	3.4	4.8	3.8
Contributors				
Capital	1.7	1.4	1.5	0.7
Labor	0.2	1.1	0.6	0.7
Innovation	-1.8*	0.9	2.7	2.4

* Innovation itself is not negative, but this negative value suggests that any innovation during the period was more than offset by inefficiencies in the economy.

Table 1 shows that between 1990 and 2002, the U.S. private business grew at an annual rate of 3.4 percent. As much as0.9 percentage points out of the 3.4 percent growth, or 26.5 percent, of U.S. private sector economic growth was due to innovation, represented by improved technology. The contribution of innovation to the U.S. private economy increased to 63.2 percent, or 2.4 percentage points of the 3.8 percent growth rate, during the 2002-2005 periods.

Hawaii's economic growth during the 1990-2002 periods was almost zero. However, capital accumulation did not stop. Private capital investment as measured by the contracting tax base increased by $36.9 billion in nominal terms. During the same period, persons employed in the private sector increased from 436,100 in 1990 to 470,230 in 2002. Yet virtually no economic growth occurred. What did the additional capital and labor do if output did not change during this period? Economists would view this as an overall reduction in efficiency, also called multifactor productivity. The negative contribution of innovation reflects the decrease in efficiency that offset any gains in innovation.

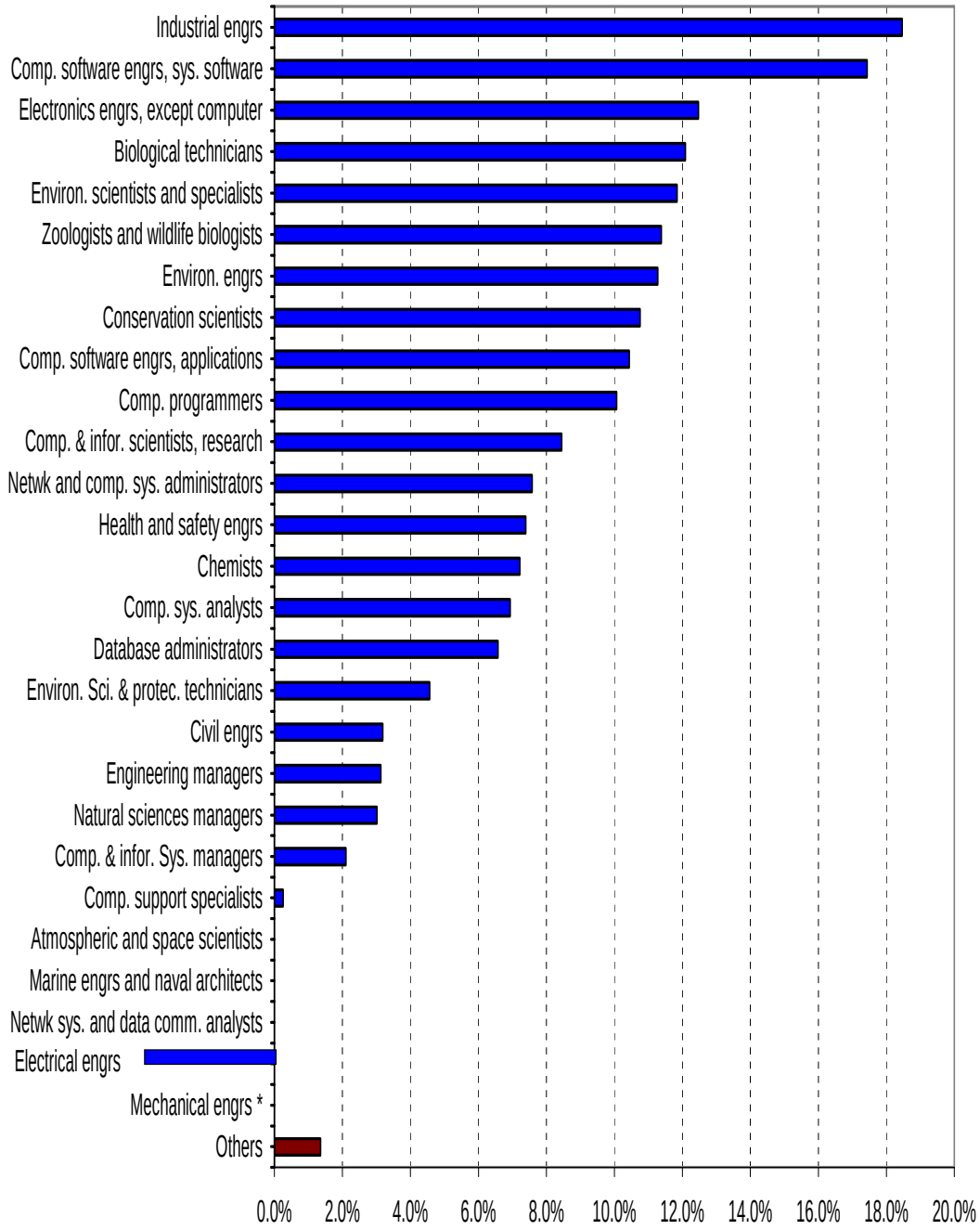
Hawaii's economy started rapid expansion in 2002, and registered an annual average growth of 4.8 percent in private business between 2002 and 2005. During this period, real private capital growth was 1.5 percent per year, and employment growth was 0.6 percent per year. The main contributor of the rapid expansion during this period was innovation, which contributed 56.3 percent of the private sector economic growth.

Due to the increase in productivity during the 2002-2005 periods, real compensation increased at an annual rate of 2.6 percent, as compared with 0.4 percent between 1990 and 2002.

Would a shift to innovation industry result in more annual growth and better jobs for Hawaii residents? Data from the U.S. Bureau of Labor Statistics suggests the answer is yes. Figure 6 depicts the Hawaii's average annual growth rate in high-tech versus other jobs defined by occupations, regardless of industry sectors, between 2000 and 2005. High-tech jobs are those with titles of scientists, engineers, and technicians. All other occupations are grouped into the "others" category. The fastest growing job in the state during the period was industrial engineers which grew at an annual rate of 18 percent, followed by computer software engineers at 17 percent annual rate. Overall high-tech

jobs grew at an annual rate of 5.2 percent between 2000 and 2005. As a contrast, low-tech jobs grew at an annual rate of 1.4 percent.

Figure 6. Growth of Employment in Science and Engineering Occupation in Hawaii
(Average annual growth rate 2000-05)



* An employment estimate for 2000 is not available

Technology sector jobs pay higher wages. According to a study completed by DBEDT on Hawaii's technology sector in 2006: Hawaii's Technology Sector: 2001-2005, the average wage of employees in the technology sector was 66 percent higher than the overall private sector employees. The 2006 DBEDT study defined the technology sector by type of business as classified by the North American Industry Classification System (NAICS). As described in the report, technology sector consists of scientific and technological research and development, manufacturing of technology products, and technology services. Jobs in these sectors were referred to technology sector jobs regardless occupation in the sectors.

The major implication of the above analysis is that technological progress and innovation, that are the greatest engine of economic growth. In recent years, technological progress and innovation is responsible for more than half of the growth of the US and Hawaii economies. Innovation not only creates more jobs but also creates high-paying jobs. Innovation increases labor productivity and thus improves standard of living.

4. Competitiveness and Innovation

According to the World Economic Forum's definition, competitiveness for a nation or state means the ability of the nation's citizens or state residents to achieve a high and rising standard of living. In most nations or state, the standard of living is determined by the productivity with which the nation's or state's resources are deployed, the output of the economy per unit of labor and/or capital employed. A high and rising standard of living for all the nation's citizens or state's residents can be sustained only by continual improvements in productivity through technology progress and innovation.

The World Economic Forum measures each country's competitiveness using the Growth Competitiveness Index (GCI). The Global Competitiveness Index (GCI) is made up of over 90 variables, of which two thirds come from the Executive Opinion Survey, and one third comes from publicly available sources. The variables are organized into nine pillars, with each pillar representing an area considered as an important determinant of competitiveness. The nine pillars are: Institutions, Infrastructure, Macroeconomy, Health and primary education, Higher education and training, Market efficiency, Technological readiness, Business sophistication, and Innovation.

These factors are inter-related and inter-acted. For countries that have reached the high-tech frontier, such as the United States, innovation is particularly important, as it is the only self sustaining driver of growth. Developing countries can still improve their productivity by increasing more capital. For an economy that reached a sustainable growth stage, adding more capital and labor becomes difficult. Innovation policy is the center of economic policy in many developed countries. The United States is one of these countries.

Though dropped to the sixth place in 2006-2007 from the first place a year earlier, U.S. is still one of the world's most highly competitive economies. The decline in competitiveness was mainly due to the federal government deficit. The efficiency of

markets, the sophistication of business community, the capacity for technical innovation which exists within a first rate constellation of universities and research centers make the U.S. highly competitive.

States enjoys the atmosphere already set up in the country, such as the political stability, federal regulation, and macroeconomic condition. However, Hawaii also faces many unique challenges due to demographical and cultural differences, location, and industry structures.

5. Hawaii's Advantages

Hawaii has built a brand that attracts people to these islands, particularly from within the creative class, for retirement and leisure. Many creative individuals draw inspiration from their surroundings. Such industries like music, digital media, and software design do not require the state to construct a large infrastructure platform; therefore, creative individuals will follow the work and such individuals place a fair amount of weight on the quality of life of a region when deciding on their place of residence. Talent is mobile, and quality of life has assumed greater importance in economic development practices as many regions have developed strategies to nurture the "creative class."[5]

Because of Hawaii's geographic location and cultural diversity, there are several unique advantages present when evaluating Hawaii's ability to compete in a global economy. Hawaii's proximity and cultural ties to Asia and the Pacific Rim allow Hawaii to serve as a bridge between Asian and mainland markets. Furthermore, its strategic location has long been of interest and importance to the Department of Defense. Therefore, several opportunities exist in regards to R&D funding, dual use technologies, and defense contracting.

The United States is one of the world's leaders in innovation, ranked first worldwide in patent registration. Importantly, intellectual property protection laws in the United States are very strong. In addition, the highly efficient and stable goods and financial markets of the United States, gives Hawaii an advantage in competing in the global economy.

The State also has some unique advantages. Natural resources make Hawaii one of the best places in the world for astronomy, ocean research and biotechnology. It is not surprising that some of the largest, most advanced telescopes in the world are located in Hawaii. To bolster its natural advantages, Hawaii maintains several excellent university programs in astronomy and space science, ocean research and technology, renewable energy, diversified agriculture, biotechnology and alternative medicine, and tourism.

Moreover, Hawaii boasts a highly educated labor force bolstered by domestic and foreign immigrants possessing advanced degrees. Hawaii ranks among the top state in educational achievement with 32% of the population aged 25 to 65 with a bachelor's

[5] Council on Competitiveness, *Measuring Regional Innovation*, (http://www.compete.org/pdf/126956_12-15.pdf ,2005) p.16

degree or higher.[6] Nearly three-quarters[7] of secondary school teachers possess an undergraduate or graduate major in the subject they are teaching, which compares favorably to the top-performing states.

The community colleges of Hawaii rank high in affordability when accessing the amount of family income needed to attend public two-year colleges after financial aid.[8] The 2007 U.S. News and World Reports Best Colleges in America ranks the University of Hawaii at West Oahu among the most affordable universities in the nation.[9] University of Hawaii at Manoa, West Oahu, and Hilo Moreover, when compared to the other states a large percent (51%)[10] of first-year students at two and four-year colleges return for their second year.

6. Hawaii's Challenges

During the 1990s, the decrease in productivity meant that Hawaii lost much of its ability to generate high-wage jobs and support a high and rising standard of living. Hawaii's per capita personal income was 20 percent above the U.S. level in 1970s; it dropped to 10% above the U.S. in 1980s due to the faster increase in U.S. competitiveness. By late 1990's Hawaii's per capital personal income was 5 percent below the U.S. level.

In 2000, 25 percent of Hawaii's workers earned a salary of $50,000 or more. That percentage improved to 27.4 percent in 2005. The U.S. figures were 26.8 percent in 2000 and 30.1 percent in 2005. Not only was Hawaii below the U.S. level in 2000, but the improvement over the five year period was slower than the U.S. average.

Hawaii faces a number of challenges. The first is our primary and secondary education. Currently, 80 percent of Hawaii's high school graduates are from public schools. While private school graduates are doing well, public school students need improvements, especially in mathematical training. The 2005 National Assessment of Educational Progress Average standardized test administered throughout Hawaii public schools indicates that Hawaii is behind the nation in math, science, and reading. Table 2, illustrates that the gap widens from a grade 4 seven point difference to an eleven point average difference in grade 8 when compared to the U.S. national average.

---

[6] The National Center for Public Policy and Higher Education, *Measuring Up 2006: The State Report Card on Higher Education*,(http://measuringup.highereducation.org/_docs/2006/statereports/HI06.pdf, 2006), p11

[7] Measuring Up 2006: p.3

[8] Measuring Up 2006, p.3

[9] Star Bulletin, Vol. 12, Issue 42 – Sunday, February 11, 2007, http://starbulletin.com/2007/02/11/news/story08.html

[10] Measuring Up 2006, p.3

Table 3. National Assessment of Educational Progress Average Scores 2005

Grade/Subject	Hawaii	U.S. Average
Grade 4 Math	230	237
Grade 8 Math	266	278
Grade 4 Science	142	149
Grade 8 Science	136	147
Grade 4 Reading	210	217
Grade 8 Reading	249	260

Source: National Center for Educational Progress

As indicated in Table 3, Hawaii public school 2006 math SAT scores are 34 points lower than the U.S. Average and 43 points lower in verbal.

Table 4. 2006 Scholastic Assessment Test Score Averages

	Hawaii Public School Seniors		U.S. Averages	
Year	Math	Verbal	Math	Verbal
2006	484	460	518	503

Source: The College Board.

Secondly, other measures of potential improvements in the economy's workforce in the future are also down. For example, graduates with Science and Engineering degrees from the University of Hawaii was down to 13.6 percent of the all graduates in the last 5 years, lower than the U.S. average of 16.4 percent.

Thirdly, as one of the indicators for workforce talent, and measured by the number of patents per 10,000 workers, Hawaii has been only a little over one fourth of the U.S. average. Between 1985 and 2005, Hawaii had an average of 1.5 patents per 10,000 Hawaii workers as compared with 5.5 for the nation.

The Corporation for Enterprise Development (CFED) has produced a Development Report Card benchmarked against 1987 data. CFED finds that Hawaii possesses a highly

educated workforce and its access to R&D funding present tremendous opportunities that are tempered by the states lack of industrial diversity and high technology employment.

Hawaii's CFED Development Report Card:[11]

1. Performance: C
   Hawaii earned an "A" in the Resource Efficiency sub-index. Hawaii ranked 25th in average annual pay, 15th in employer-provider health insurance, 20th in poverty rate, 30th in income distribution, 24th in disparity between rural and urban areas, 49th in crime rate, 50th in voting rate, and 48th in homeownership rate.

2. Business Vitality: D
   Hawaii ranked 47th in industrial diversity, 47th in technology industry employment, 42nd in strength of trade sector, 5th in manufacturing investment, 23rd in new companies, 26th in business closings, and 14th in job creation by start-up businesses.

3. Development Capacity: F
   Hawaii ranked 12th in college attainment, 15th in Ph.D. scientists and engineers, 45th in reading proficiency, 43rd in math proficiency, 20th in academic R&D, 13th in federal R&D, 37th in royalties and licenses, 47th in patents issued, 47th in businesses created via university R&D, 30th in venture capital investments, 46th in bridge deficiency, 47th in sewage treatment needs, 50th in energy costs, and 48th in cost of urban housing

7. Towards an Innovation Policy

To move Hawaii toward an innovation state, studies suggest the following elements must be pursue:

(1) Education that ensure that graduates from Hawaii's secondary education system possess a strong foundation in science, technology, engineering, math, problem-solving, and creative thinking skills.

(2) Workforce development resulting in a higher skilled workforce based on individual choice and employer needs to encourage lifetime learning and skill building.

(3) A university education system that drives human capital development and innovation

(4) Investment in innovation by deploying innovation facilities and state funding to develop innovation capacity.

[11] Corporation for Enterprise Development, *2006 Development Report Card for the States: Hawaii*, http://www.cfed.org/focus.m?parentid=34&siteid=1581&id=1600&year=2006&stateid=11 (2006)

An important compound of an innovation policy is the measures or "metrics" that will be used to determine if the programs to encourage innovation are actually affecting the economy. The following is a compilation of some major metrics that have been put forth as measures of innovation.

INNOVATION METRICS

I. STEM EDUCATION

1.Performance in Standardized Test Scores/ AP Participation

Rationale:
STEM educational progress in K-12 should raise the STEM elements of standardized test scores and AP participation. SAT and ACT scores are a key indicator of a school systems ability to prepare students for college entrance. State data should be benchmarked against national data.

- Average standardized test scores on STEM elements in public high school
- Average standardized test scores for students with FIRST participation
- Average standardized test scores for students with HiEST participation
- AP participation in math and science

Measures/ Sources:
K-12 Standardized Test Scores, National Center for Education Statistics, www.nces.ed.gov/nationsreportcard
Average Standardized Test Scores, Measuring Up, The National Center for Public Policy and Higher Education, http://www.highereducation.org/
AP Testing, The College Board, www.collegeboard.com
AP Tests by Subject, NGA Center for Best Practices, *A Competitive Benchmarking of the Hawaii Economy*, 2007
SAT/ACT Scores, College Entrance Exams, The College Board, www.collegeboard.com
SAT/ACT Scores College Entrance Exams, Education Testing Service, www.ets.org
Average SAT Score, NGA Center for Best Practices, *A Competitive Benchmarking of the Hawaii Economy*, 2007

2. Matriculation to 2 and 4 Year Degree Program

Rationale:
Efforts to improve STEM education should result in a higher number of students matriculating to 2 and 4 year degree programs.

Measures/ Sources:

Percentage of 18-24 year olds in college, Measuring Up, The National Center for Public Policy and Higher Education, http://www.highereducation.org/

3. Enrolment in STEM Majors

Rationale:
Enrollment in STEM majors should increase as a result of FIRST and HiEST Academies participation.

Measures/ Sources:
University of Hawaii stats for enrollment for Math, Science, Engineering, and Computer Science majors and Associate degree in applied technology.

4.Educational Attainment (Completion Rates)

Rationale:
Improved STEM Education should improve both high school and college graduation rates. This will enable the state to view the level of education and the state ability to sustain an innovation economy. State data should be benchmarked against national data.

a) High School Graduation Rates

b) Associate Degree in STEM related fields

c) Bachelors Degree, or Higher Awarded in STEM related fields

Measures/ Sources:
Census Bureau, American Fact-Finder, http://factfinder.census.gov
Ph.D. Graduates, National Science Foundation, http://caspar.nsf.gov
Graduation Rates, Measuring Up, The National Center for Public Policy and Higher Education, http://www.highereducation.org/
Secondary and Post Secondary Graduation Rates, NGA Center for Best Practices, *A Competitive Benchmarking of the Hawaii Economy*, 2007
Secondary and Post Secondary Graduation Rates, National Center for Education Statistics (NCES), U.S. Dept. of Education

II. INNOVATION IN ECONOMY:

1. Average Wages:

Rationale:

Efforts to improve the economy should result in higher paying jobs, as reflected by rising average wages.

Measures/ Sources:
Growth in Average Wage, Bureau of Labor Statistics, www.bls.gov/cew
Growth in Median Household Income, Census Bureau, American Fact-Finder, http://factfinder.census.gov

2. Productivity:

Rationale:
An innovation-fueled economy should experience an increase in overall productivity.

Measures/ Sources:
State Domestic Product, per worker, Economy.com, www.economy.com

3. University as a Driver of Economic Development:

a) R&D spending at the University of Hawaii

Rationale:

University Research and Development adds to the knowledge base of a region and is essential to long-term economic growth. R&D spending at universities creates opportunities for partnerships between education and industry that can significantly benefit retention of companies and talented students. Data should be compared on a per capita basis to the nation.

Measures/ Sources:
R&D Spending and Spending Per Capita, National Science Foundation, http://caspar.nsf.gov
NSF Survey of R&D Expenditures at Universities and Colleges, http://caspar.nsf.gov/

b) Technology Transfer, Rate of Public and Private Commercialization:

Rationale:
The rate of successful university commercialization is a major source of new technology products and new companies. Most private commercialization data would need to be collected from local sources, such as trade publications, business journals, or surveys and interviews at local companies to develop a system for benchmarking commercialization in the region.

Measures/ Sources:

Licensing Agreements and Commercialization, University of Hawaii, Office of Technology Transfer and Economic Development (OTTED), http://www.mic.hawaii.edu/
Public Commercialization, Association of University Technical Managers, www.autm.net
Public Commercialization, Chronicle of Higher Education, http://chronicle.com/stats/techtransfer
Private Commercialization, Gazelle Companies, Progressive Police Institute, www.neweconomyindex.org/states/2002/03_dynamism_02.html
Private Commercialization, Inc 500 Companies, Inc Magazine, www.inc.com/inc500

4. Entrepreneurship:

Rationale:
New companies are vital to developing new products and supporting number of new startups in growth industries.

Measures/ Sources:
New Firm Starts, Small Business Administration, www.sba.gov/advo/research
Patents, U.S. Patent and Trademark Office, http://patft.uspto.gov
Venture Capital Investment, PWC/Venture Economics, www.ventureeconomics.com/vec/statshome.htm
SBIR Grants, Small Business Administration, www.sba.gov/sbir/indexsbir-sttr.html

III. INNOVATION IN WORKFORCE DEVELOPMENT:

1. Percentage and Growth in the Percentage of Manager, Engineer, Scientist, and Technician Occupations in Economy:

Rationale:
Staying competitive in the modern global economy increasingly requires a greater supply of skilled labor. Innovation companies choose regions with a reliable and flexible supply of local talent.

Measures/ Sources:
Occupational Employment Statistics Survey, http://www.bls.gov/oes/home.htm
Regional Workforce, Bureau of Labor Statistics, www.bls.gov/oes/home.htm
Average Wage, Bureau of Labor Statistics, www.bls.gov/cew
Unemployment Rates, Bureau of Labor Statistics, www.bls.gov/lau

2. Retention of Skilled/Highly Educated in Hawaii:

Rationale:

Talented individuals with high technology skills migrate to where they are most likely to succeed and to where innovation prospers. We would like to minimize the loss (out migration) of such talent and maximize the acquisition (in-migration) of such occupations.

Measures/ Sources:
Migration, "Migration of the Young, Single, and College Educated: 2000-2005," http://www.census.gov/prod/2003pubs/censr-12pdf
Percentage of occupations requiring post secondary training, Workforce Development Council
U.S. Bureau of the Census: Net Migration Statistics

3. Lifelong Learning:

Rationale:
Because increasing the skill level of the workforce through new workforce entrants is a slow process it is critical to raise the skill level of the existing (incumbent) workforce to help keep the economy competitive. This is the major avenue lower-skilled individuals have to increase their earning power.

Measures/ Sources:
Percentage of working adults enrolled in post secondary training, Measuring Up, The National Center for Public Policy and Higher Education, http://www.highereducation.org/

Best practices of economic development rely on bold new policies fostering and encouraging innovation and entrepreneurship, while remaining flexible and able to adapt to structural economic change. States taking a proactive thoughtful approach will prosper in an innovation economy.

Data Source and References:

Corporation for Enterprise Development, *2006 Development Report Card for the States: Hawaii*, http://www.cfed.org/focus.m?parentid=34&siteid=1581&id=1600&year=2006&stateid=11 (2006)

The National Center for Public Policy and Higher Education, *Measuring Up 2006: The State Report Card on Higher Education*,(http://measuringup.highereducation.org/_docs/2006/statereports/HI06.pdf, 2006)

Star Bulletin, Vol. 12, Issue 42 – Sunday, February 11, 2007, http://starbulletin.com/2007/02/11/news/story08.html

Employment by Occupation Data:
U.S. Bureau of Labor Statistics, http://stats.bls.gov/oes/oes_dl.htm

Hawaii State Employment Data:
Hawaii State Department of Labor and Industrial Relations,
http://www.hiwi.org/cgi/dataanalysis/labForceReport.asp?menuchoice=LABFORCE

Gangemi, Jeffery, *Ranking the States for the New Economy,* http://www.businessweek.com/smallbiz/content/feb2007/sb20070227_818588.htm (February 2007)

National Governors Association, *The 2007 State New Economy Index: Benchmarking Economic Transformation in the States,* (Washington, DC: NGA Center for Best Practices, 2007)

Patent Data:
U.S. Patent and Trademark Office, Information Products Division/TAF Branch, *Patent Counts by Country/State and Year, All Patents, All Types, January 1, 1977 -- December 31, 2004* (April 2005) http://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_all.pdf

SAT Score:
National Center for Educational Statistics,
http://nces.ed.gov/programs/digest/d99/d99t137.asp

Graduates with Science and Engineering Degrees:
National Center for Education Statistics,
http://www.nsf.gov/statistics/nsf07307/

Science and Engineering Degree at UH
University of Hawaii, Institutional Research Office

Degrees and Certificates Earned
http://www.iro.hawaii.edu/maps/mltitles.asp

The Information Technology and Innovation Foundation
http://www.itif.org/files/Hawaii.pdf

U.S. and Hawaii Gross Domestic Product:
U.S. Bureau of Economic Analysis, http://www.bea.gov/regional/gsp/

U.S. and Hawaii Earnings:
U.S. Bureau of Economic Analysis, http://www.bea.gov/regional/spi/

U.S. Employment Data:
The U.S. Bureau of Labor Statistics, ftp://ftp.bls.gov/pub/suppl/empsit.compaeu.txt

U.S. Productivity Data:
U.S. Bureau of Labor Statistics, http://www.bls.gov/bls/productivity.htm

Wage Data (% earn $50,000 and above):
Tabulated by DBEDT from U.S. Census Bureau "American Community Survey" public use micro data.

World Competitive Index:
World Economic Forum, Global Competitiveness Report 2006-2007
http://www.weforum.org/en/initiatives/gcp/Global%20Competitiveness%20Report/index.htm

U.S. and Hawaii Per Capita Personal Income Data:
U.S. Bureau of Economic Analysis,
http://www.bea.gov/regional/spi/default.cfm?satable=summary

2005 data, DATABOOK 2005 (Table 3.21)

1995 to 2004 data, Star Bulletin
http://starbulletin.com/2000/08/29/news/story1.html
http://starbulletin.com/2004/08/31/news/story1.html

1994 data, National Center for Education Statistics
Table 137.--Scholastic Assessment Test\1\ score averages, by state: 1987-88 to 1997-98
http://nces.ed.gov/programs/digest/d99/d99t137.asp