



The Contribution of the University of Hawai'i at Mānoa to Hawai'i's Economy in 2012

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Executive Summary

The University of Hawai‘i at Manoa (UHM) generates economic activity through its purchases from local businesses, its payment to its employees, and spending by students and visitors. This report estimates UHM’s total economic activity in the state of Hawai‘i in fiscal year 2012. Following a standard approach, we define economic impact to be the direct, indirect, and induced economic activities generated by the university’s spending in the state economy.

Although one can think of the UHM as if it were one of many businesses or industries in Hawai‘i, an important difference between UHM and most private businesses is that UHM gets a substantial part of its funding from taxpayers. In FY2012, UHM and the supporting RCUH (Research Corporation of the University of Hawai‘i) spent a total of \$878 million in support of its education mission; the State General Fund paid \$198 million of the total. Adding money spent by the privately funded UH Foundation, spending by students, out-of-town visitor spending related to UHM sponsored professional meetings and conferences brings total UHM-related expenditures to \$1.40 billion in FY2012, 90% of which was spent locally.

Overall, the \$1.40 billion of education-related expenditures attributable to UHM generated \$2.45 billion in local business sales, \$735 million in employee earnings, \$131 million in state tax revenues, and slightly under 20,000 jobs in Hawai‘i in FY2012. This represented approximately 3.4% of total jobs, 2.5% of worker earnings, and 2.2% of total state tax revenues.

Looking to the future, the university’s Hawai‘i Innovation Initiative (HI2) plans to more than double the UH system’s current level of extramural research funds from less than \$500 million to an ambitious \$1 billion per annum. If the HI2 successfully doubles research expenditures, our analysis suggests more than 5,000 new jobs would be created from the ripple effects of the research spending alone, independent of any technology transfer and other jobs created as a direct result of the research.

The Contribution of the University of Hawai‘i at Mānoa to Hawai‘i’s Economy in 2012

University of Hawai‘i at Manoa: A Brief History

The University of Hawai‘i at Mānoa (UHM) was launched in 1907 as a college of agriculture and mechanical arts. In 1912, the first permanent building was erected in Mānoa valley in UHM’s current location. With the establishment of the College of Arts and Sciences in 1920, the College of Hawai‘i became a university. Statehood and the establishment of the University of Hawai‘i as the “state university” marked the beginning of a period of accelerating enrollment that led to the formation of a large diverse system. In 1965, the State Legislature created a statewide system of community colleges and placed it within the University of Hawai‘i, and in 1972, the flagship Mānoa campus became the University of Hawai‘i at Mānoa.

Today, the University of Hawai‘i system is comprised of 10 campuses—seven community colleges (four on Oahu and one each on Kauai, Maui, and Hawai‘i), University of Hawai‘i at Mānoa, University of Hawai‘i at Hilo, and the University of Hawai‘i at West Oahu. Of these ten campuses, the Mānoa campus is by far the largest, with roughly 33.9% of the total headcount of the entire system, including 90.7% of the graduate students during the fall of 2012. The second largest campus, Kapiolani Community College, had 14.7% of the total headcount.

UHM is one of only 13 institutions nationwide to hold the distinction of being a land-, sea-, and space-grant research institution. It is one of only 63 public schools that are categorized by the Carnegie Foundation as having “very high

research activity”. The National Science Foundation ranks UHM in the top 30 public universities in federal research funding for engineering and science and 49th overall. The University of Hawai‘i at Mānoa offers bachelor and master degrees in 87 fields of study, and doctoral degrees in 53 fields. In addition, the William S. Richardson School of Law and the John A. Burns School of Medicine are the only law and medical schools in Hawai‘i.

Seventy-one percent of the credit students at UHM in the fall of 2012 were undergraduates; the remaining 28.2% were graduate students. Hawai‘i residents also comprised nearly 71.0% of all credit students enrolled at the University of Hawai‘i at Mānoa. Twenty percent of the students were from the United States mainland, and together with local students represented all 50 states. The remaining eight percent of students were international students drawn to Mānoa from 103 different countries. UHM continues to be one of the nation’s more ethnically diverse universities with roughly 41.2% of the students identifying as Asian, 24.4% as Caucasian, and 16.7% as either Hawaiian or Pacific Islander.

In addition to regular and summer classes, each year thousands of students take credit and non-credit continuing education courses offered by the university for personal growth and enjoyment. The task of teaching thousands of students each year, to conduct research at the frontiers of knowledge, and to serve the needs of the community are assigned to nearly 5,000 University employees including full-time faculty members, lecturers, graduate assistants, and other student

employees.

Creating Jobs and Generating Income

One can think of the University of Hawai‘i at Mānoa as if it were one of many businesses or industries in Hawai‘i. It produces education and research services as its primary outputs. It produces entertainment and sports services, health care, housing, and food services. Its customers include students, visitors, private businesses, governments, and the general public. It attracts customers worldwide, many of whom stay for four or more years, as well as serving the local community.

An important difference between UHM and most private businesses is that UHM gets a substantial part of its funding from taxpayers. In FY2012, UHM and the supporting RCUH (Research Corporation of the University of Hawai‘i) spent a total of \$878 million in support of its education mission; the State General Fund paid \$198 million of the total. The difference between what the State General Fund paid for and the total amount spent by UHM (\$878 million - \$198 million = \$680 million) was paid for by government research and training grants, revolving funds (e.g., bookstore revenues), special funds (e.g., tuition and fees), and federal matching grants (e.g., U.S. Department of Agriculture Hatch and Smith-Lever funds).

Adding money spent by the privately funded UH Foundation, spending by students on items other than tuition, fees, dorm fees, and books¹, out-of-town visitor spending related to UHM sponsored professional meetings and confer-

1 Money spent by students for tuition, fees, dorm fees, and books were received and spent by the University and show up in the UHM expenditure data. They were excluded to avoid double counting.

ences brings total UHM-related expenditures to \$1.40 billion in FY2012, \$1.26 billion of which was spent locally. Figure 1, below, shows a breakdown of how that \$1.40 billion in direct expenditures is divided among the different UHM entities.

Non-research spending (mostly instructional expenditures) is the largest component of expenditures, comprising thirty four percent of total spending. Spending by students and on research activities were a close second at 33.4 and 28.3%, respectively. All other categories combined comprised less than five percent of the total. Table 1 details these expenditures.

These numbers can also be used to illustrate the leverage effects of State

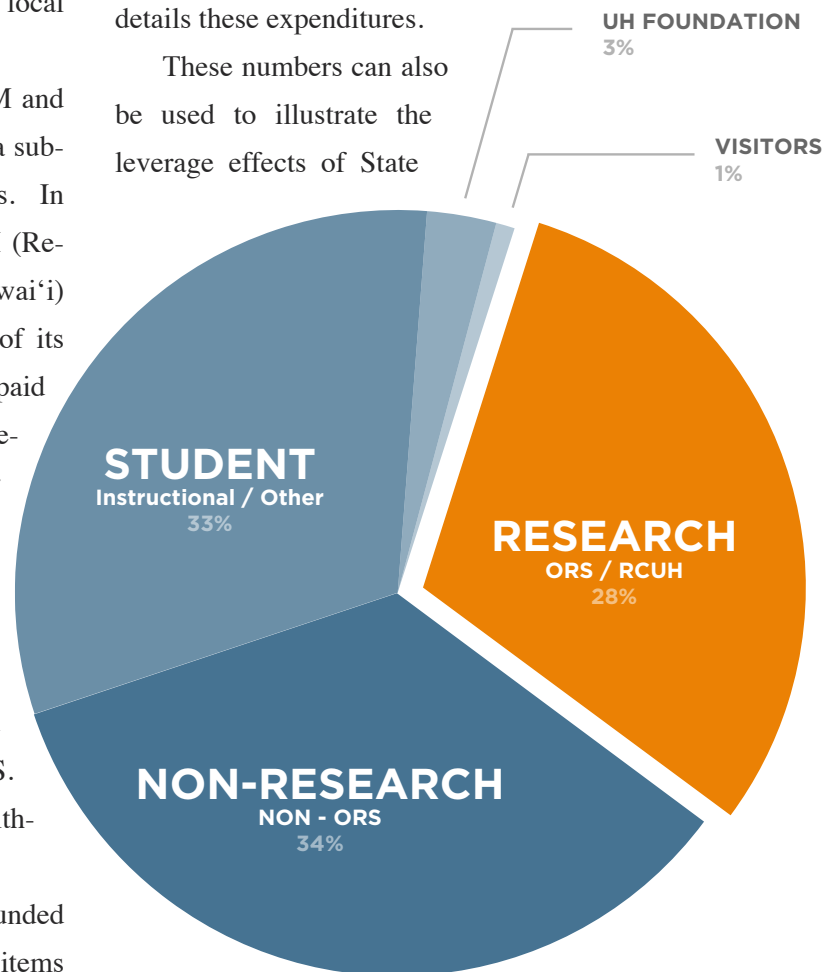


Figure 1 - Total UHM Expenditures

Table 1. UHM Expenditure Breakdown ('0000\$)

	Non-Research	Research	UH Foundation	Total UHM
Total Local Purchases of Goods and Service	\$399,337	\$266,333	\$31,029	\$696,700
Labor Income	\$7,598	\$85,626	\$7,140	\$100,364
Imports	\$73,430	\$45,293	\$5,534	\$124,258
Total Expenditures	\$480,366	\$397,253	\$43,703	\$921,323

General Fund higher education spending. In FY2012, UHM parlayed \$198 million in State General Fund expenditures into \$1,203 (=1,401 million – \$198 million) million dollars of related research and educational expenditures.

The University of Hawai‘i at Mānoa generates economic activity in the community through its purchases from local businesses, its payment to its employees, and spending by its students and visitors. The total amount of economic activity generated in Hawai‘i can be estimated using the state’s 2007 input-output (I-O) model of Hawai‘i’s economy. The model is used to quantify the economic impacts of UHM expenditures on the different industries in Hawai‘i. We first distribute the \$1.26 billion spent locally among the 20 sectors in the model. Because a substantial portion of labor earnings are injected back into the economy in the form of household purchases of goods and services, we convert labor earnings into personal consumption expenditures (PCEs), and treat PCEs as an additional producing sector. The conversion ratio between labor earnings and PCEs, 85.4%, is calculated using the 2007 Condensed Input-Output Transaction Table for Hawai‘i, and indicates that about 85% of employee’s earnings are spent in the local economy. We then multiply expenditures for each of the 20 sectors in the State I-O model by their respective

Type II “multipliers” to arrive at their total sales, employment, and earnings impacts. The Type II multipliers capture the direct, indirect, and induced effects per dollar of spending in each of the 20 sectors of Hawai‘i’s economy.²

An Overview of Hawai‘i’s Economy

Hawai‘i’s economy has long been dominated by a handful of industries ranging from whaling and sandalwood extraction to agriculture and military activities. In 2010, Hawai‘i’s tourism industry accounted for 19% of total employment, while military and federal civilian employment contributed another 12%. In contrast, the Re-

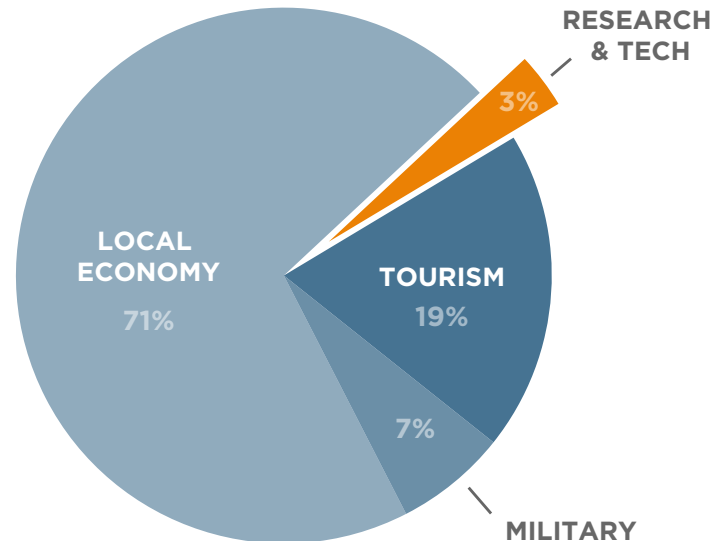


Figure 2 - 2010 Hawai‘i Employment Mix

Data is from the U.S. Bureau of Economic Analysis, State of Hawai‘i Department of Business, Economic Development and Tourism, and UHERO. Total employment includes civilian, military, part-time and self-employed workers.

² To illustrate the relationship between “direct,” “indirect,” and “induced” effects, consider the following example. I spend \$10 at a local grocery store; the “direct effect” of my expenditure on business sales in the economy is the \$10 received by the grocery store. In turn, the grocery store purchases \$5 worth of goods from its wholesaler. The additional sale in the economy by the wholesaler to the grocery store is an “indirect” effect of my grocery purchase. Both the grocery store and the wholesaler pay their employees, and with their pay the employees purchase goods and services in the economy. These are the “induced” effects. Similarly, the grocer and wholesaler pay rent, interest on loans, and take home profits; those incomes are eventually spent in the economy as well. Type II multipliers capture the “multiplier,” or sometimes referred to as the “ripple,” effects of any initial spending.

search and Technology sector accounted for only three percent of total employment (Figure 2).

While employment counts do not capture the full contribution to Hawai‘i’s economic output due to differing levels of productivity by sector, it is clear that Hawai‘i’s economy is dominated by a small number of industries. And despite the record visitor arrivals expected for 2012, tourism is not a long-run growth engine for the State. In fact, real visitor spending has declined an average of one percent per year from 1989 to 2011³.

Economic growth arises due to population growth and technical progress that leads to increasing productivity. But Hawai‘i’s economy is dominated by sectors that contribute only modest productivity growth and cannot be sources of long-term improvements in the quality of life for Hawai‘i residents. This has been true for at least the past twenty years as we have experienced the impact of military downsizing and as many as a half dozen shocks to the tourism industry, each resulting in significant downturns. Over the past forty years, Hawai‘i’s real GDP per capita has grown by less than half that of the U.S. as a whole, eking out a dismal 0.7% annual expansion.

³ Real visitor spending is calculated by deflating nominal total visitor spending by the Honolulu Consumer Price Index.

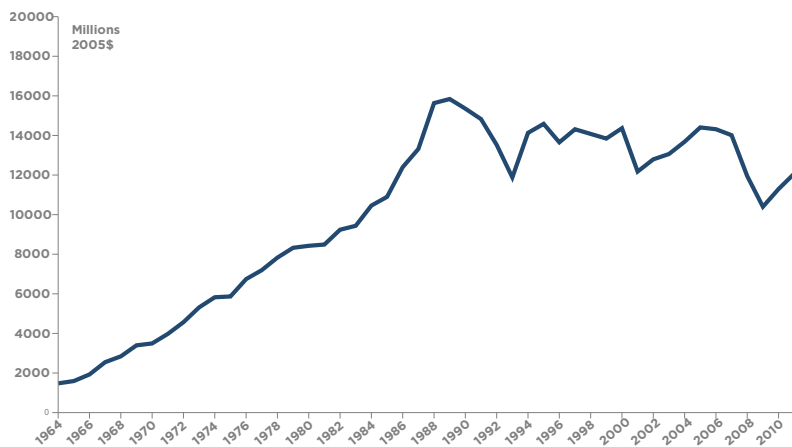


Figure 3 - Real State Visitor Spending

Real visitor spending is calculated by deflating nominal total visitor spending by the Honolulu Consumer Price Index.

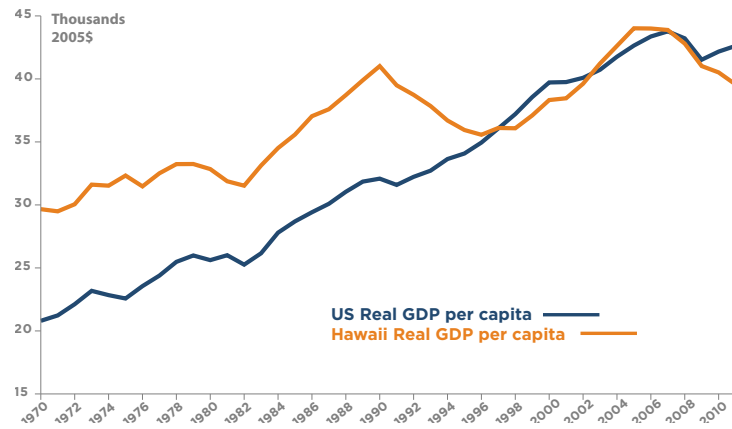


Figure 4 - Hawai‘i versus U.S. real per capita GDP

Data is from the U.S. Bureau of Economic Analysis, Bureau of Labor Statistics, and UHERO. Hawai‘i Real GDP per capita is calculated by deflating nominal GDP per capita using the Honolulu consumer price index.

Clearly if Hawai‘i is to improve the quality of life and increase living standards for its citizens, we must rely on industries that can both contribute to and benefit from technical change. At Hawai‘i’s historic per capita growth rate of 0.7% it will take 94 years to double output, while simply moving to the U.S. growth rate of 1.7% cuts that time to 40 years. This is exactly the point of the Hawai‘i Innovation Initiative (HI²) discussed in the next section. By investing in research and technology transfer, HI² intends to boost employment in the Research and Technology sector in Hawai‘i and grow the number of high value added jobs in the state, thereby raising overall productivity levels and contributing to growing living standards.

Currently, Hawai‘i lags behind the U.S. in terms of concentrations of high-skilled jobs in high-value added occupations such as Healthcare and Technical; Legal; Computer and Math; Architecture and Engineering; Business and Financial Operations (Figure 5).

There tends to be a strong connection between an area’s academic research intensity and the presence of high human capital occupations⁴. The relationship

⁴ Abel and Dietz (2009) find that a one standard deviation increase in a metropolitan area’s degree production rate is associated with a 2.2% increase in the share of workers in “high” human capital occupations, while a one standard deviation increase in research intensity is associated with a 6.2% increase in the

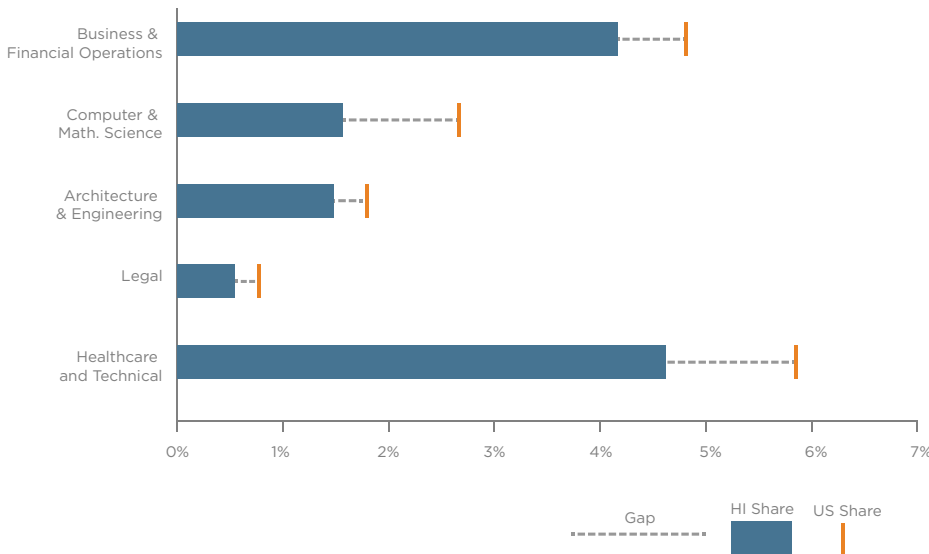


Figure 5 - 2011 High Human Capital Occupation Shares: Hawaii vs. US

Data is from the U.S. Bureau of Labor Statistics Occupational Employment Statistics

appears “to be strongest in economic activities requiring innovation and technical training such as computers, math, and science, as well as business-related fields” (Abel and Dietz, 2009. p.19). Importantly, activities in such research and technology driven occupations tend to cluster geographically and tend to be very closely associated with regional wage and productivity growth (see, Florida, Mellander, and Stolarik, 2008).

Beyond creating both a demand for and supply of high value added jobs, the activities of the university as well as various research initiatives lead to a variety of positive externalities for the Hawai‘i community. The effects of these externalities are not easy to quantify. Nevertheless, the contributions to Hawai‘i’s economy through investment in human capital and the spillovers of knowledge are important in a budding technology and innovation community and therefore have to be addressed.

share of workers in these same occupations.

First, virtually all research activities within the university include a strong educational component. Students involved in the lab and in the field accrue knowledge and experience that will translate into higher lifetime earnings. Second, education (which is one of the most important determinants of income) positively correlates with a variety of improved health outcomes as well as life expectancy. For example, more educated people are less likely to drink, smoke, and be obese. Well-educated people seem better at quitting bad habits, or at controlling their consumption⁵. Higher levels of education also correlate with lower poverty rates, unemployment rates, and crime rates and as such can affect (decrease) the state’s expenditures on means-based assistance programs. Improving education can lead to reduced crime rates. Finally, educated people are more likely to show higher levels of civic participation, including volunteer work and voting⁶.

Hawai‘i Innovation Initiative

As can be seen in Table 1, research spending makes up a significant part of UHM’s annual expenditures. The Hawai‘i Innovation Initiative is an effort led by University of Hawai‘i President M.R.C. Greenwood to more than double the UH system’s current level of extramural research funds from less than \$500 million to an ambitious \$1 billion

⁵ Cutler and Lleras-Muney (2010) provide an overview on the relationship between education and health behaviors.

⁶ A broader discussion on the benefits of higher education for individuals and society is in Baum et al (2010).

per annum. To build a research enterprise of that magnitude, the university plans to hire 50 top scientists over the next ten years. The innovation strategy was initiated by the President's Advisory Council on Hawai'i Innovation and Technology Advancement and builds on the ideas and comments shared at the [University of Hawai'i 2011 Symposium on Innovation](#) held in partnership with the National Academies Board on Science, Technology and Economic Policy.

The advisory council recognized that hiring more faculty is not sufficient to ensure a doubling of research dollars flowing into Hawai'i's economy. The council also recommended that the university make targeted structural changes in the way UH engages in technology transfer, focus on key areas of comparative advantage, and integrate entrepreneurship into its curriculum. The hiring of the best scientists from Hawai'i and around the world is a necessary but not sufficient condition for rapidly expanding the UH research enterprise. The key word is "best". To meet the HI² goals, the university will need to attract the world's best faculty in fields of study that are well funded, particularly by federal agencies. To get some idea of what a world-class principal investigator (PI) means, consider the current research funding situation at UH. Currently, 11 PIs across four general fields account for 30% of extramural funding in the UH system. And, over the past two years, four fields have generated \$248 million in research funding — \$65 million (6 PIs in Energy), \$62 million (13 PIs in Ocean Sciences), \$55 million (11 PIs in Biomedical Sciences), and \$66 million (3 PIs in cyber infrastructure). Strengthening those areas of excellence is expected to pay high dividends, but will require substantial investment. The baseline salary for a scientist of

the desired caliber is expected to be in the range of \$200,000 to \$250,000, with a start-up package of up to \$1.2 million. For comparison, researchers of a similar caliber garner salaries of roughly \$250,000 at University of Las Vegas and anywhere between \$107,000 and \$322,000 at UC San Diego, with substantial variation between fields. To attract the world's best researchers, UH will need to hire them away from their existing institutions.

To achieve the goal of doubling research funds through the hiring of leading scientists, UH is asking the state and the private sector to be partners in the funding. UH has already brought in \$47 million in funding to improve cyber infrastructure statewide and \$25 million more for workforce training in energy, agriculture, and healthcare. In addition, UH is committing significant resources to hire at least 5 researchers of the caliber outlined in HI² before asking for government support.

UHM is ranked between 101 and 150 out of 500 top international universities in the 2012 Academic Ranking of World Universities. Since 53 out of the top 100 are American universities, the second-tier ranking identifies UHM as a top 54-67 school in the United States, putting it in the same category as the University of Virginia and ahead of schools such as Oregon State University, the University of Oregon, and Notre Dame. UHM has also proven successful at securing federal research grants. A National Science Foundation report found that UHM ranked 51st out of 689 public and private universities in federal R&D expenditures for fiscal year 2009, only 11 slots lower than UC Berkeley. Much of UH's success can be attributed to cutting edge research and continuing efforts to identify new avenues for ad-

vancing the frontier of scientific knowledge. To not only remain competitive, but to surpass other top schools, UH will need to continue to expand research programs, which will require more extramural research funds.

Historical data suggests that R&D expenditures are somewhat robust to economic downturns. Aside from a few brief periods of stagnation, academic R&D expenditures have steadily increased from \$10 billion in 1972 to approximately \$50 billion in 2009, with the largest share of these dollars coming from the federal government. Over that period, the largest sources of federal funding have been the National Institute of Health, the National Science Foundation, and the Department of Defense. Expanding UH’s research programs, and the goal of doubling research dollars hinges on identifying the university’s strengths and attracting top faculty in those areas who are adept at securing resources from key funding agencies.

We should also be encouraged by the fact that other regions have launched successful research

Figure 6 - Federal Academic Funding to Research and Development since 1970*

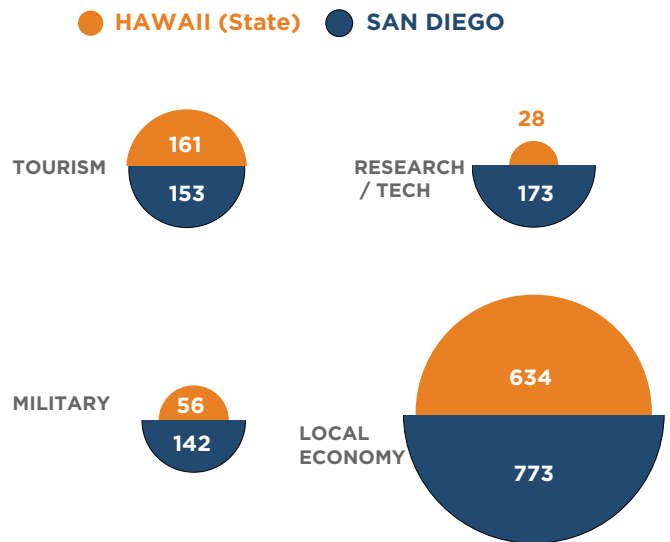
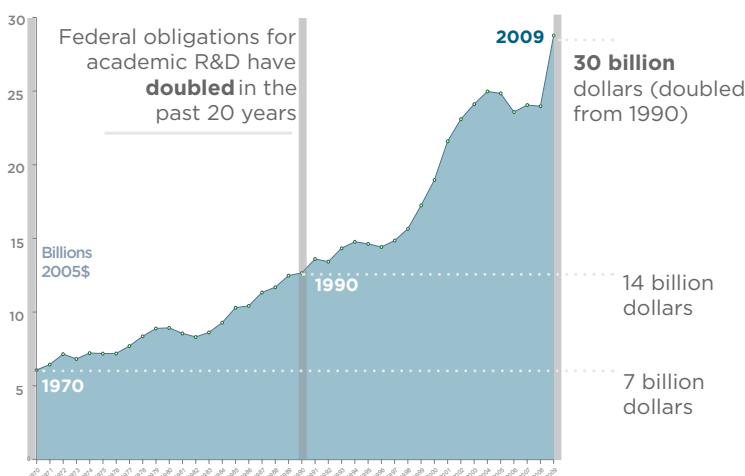


Figure 7 - Thousands of Jobs by Sector (2010)

initiatives in the past. In many ways similar to modern day Hawai‘i, San Diego in the 1960s was viewed as isolated, ill positioned for industry growth, and restricted by a narrow economy, comprised primarily of real estate, tourism, and the military. Using UC San Diego as a leverage point proved to be a sound strategy; today San Diego boasts a gross regional product of \$175 billion and a population of 3 million people. In 2010, approximately 14% of San Diego’s workers were employed in research and technology industries, compared to only 3% in Hawai‘i. The goal of HI² is to expand that portion of the pie over the next decade by strengthening our areas of proven excellence (astronomy and space sciences, ocean and earth sciences, health sciences), enhancing emerging strengths (clean energy, new agriculture, cancer research, pharmacology) and building up new areas (advance informatics and cyber infrastructure, diabetes and obesity research).

Building on Proven Areas of Excellence

The University of Hawai'i has already made significant strides nurturing world-class research, especially in the areas of astronomy and space sciences, ocean and earth sciences, and health sciences. The School of Ocean and Earth Science and Technology (SOEST) has several successful research clusters that serve as models for HI². The Pacific Island Ocean Observing System (PacIOOS) is one of eleven regional observing programs in the U.S. that support the emerging U.S. Integrated Ocean Observing System under the National Oceanographic Partnership Program. With six faculty members and federal grants in the tens of millions, PacIOOS works to develop the observational modeling, data management, and outreach components of an end-to-end ocean observing system to generate products that help to ensure a safe, clean, and productive ocean and a resilient coastal zone for the U.S. Pacific Islands.

Another successful SOEST research cluster is the Center for Microbial Oceanography: Research and Education (C-MORE) is an NSF-sponsored Science and Technology Center established in August 2006, whose objective is to develop a meaningful predictive understanding of the ocean with respect to energy transduction, carbon sequestration, bioelement cycling and the probable response of marine ecosystems to global environmental variability and climate change. C-MORE is currently operated by a faculty of four, with a budget of \$4-6 million per year over ten years. Although coordinated on the UH Mānoa campus, research activities are dispersed across five partner institutions: Massachusetts Institute of Technology, Woods Hole Oceanographic Institution, Monterey Bay Aquarium Research Institute, University of California at Santa Cruz, and Oregon State University.

This year, Edward DeLong of MIT will join UH Mānoa as a Professor of Oceanography, becoming the fifth C-MORE faculty member on campus. DeLong is

currently the Morton and Claire Goulder Professor of Bioengineering at MIT and co-Director of C-MORE. He has previously served as a researcher at Indiana University, Assistant Scientist at WHOI, Assistant Professor at UC Santa Barbara's Marine Science Institute, and Science Department Chair at the Monterey Bay Aquarium Research Institute. DeLong's work has consistently pushed the frontiers of marine microbiology, as evidenced by the many (over 100) high-profile papers published in outlets such as *Science* and *Nature*. In addition, he is a Fellow of the American Academy of Microbiology (2000), the American Academy of Arts and Sciences (2005), and the American Association for Advancement of Science (2011); a Gordon and Betty Moore Foundation Investigator in Marine Microbiology (2004); and a member of the US National Academy of Sciences (2008). DeLong's benefit package was used to inform the economic return on investment analysis presented here, as it is a good example of what it takes to attract high-research revenue earning scientists away from their institutions and into the UH system.

Hawai'i Natural Energy Institute (HNEI) is another extremely successful research unit of SOEST, which performs research, conducts testing and evaluation, and manages public-private partnerships across a broad range of renewable and enabling technologies to reduce the State's dependence on fossil fuels. From 2001-2008, HNEI experienced growth in its extramural funding from under \$2 million per year to over \$5 million per year. The growth accelerated in 2009 due to new or expanded programs in ocean energy, hydrogen, smart grids, and interest by the Office of Naval Research in using Hawai'i as a site for alternative energy testing in the Pacific region.

Extramural funding increased to over \$14 million in 2009, over \$24 million in 2010, and reached \$31 million in 2011.

Currently, HNEI has 8 state general funded (G-funded) faculty, 3 G-funded support staff, and 21-22 mostly non-tenure track positions funded on soft money. Given the current research profile above, this amounts to approximately \$3 million per G-funded faculty member over the past three years. However, more staffing is needed for both the current research portfolio and to address the next round of needs when the current projects expire. Director Rick Rocheleau suggests that a few experts in a variety of areas would be helpful in moving HNEI to the next level, but the most pressing need is an expert on power systems modeling, who would be able to examine system-wide realities of Hawai'i's energy challenges.

The Institute for Astronomy (IfA) is one of the world's leading astronomical research centers. Its broad-based program includes studies of the Sun, planets, and stars, as well as interstellar matter, galaxies, and cosmology. IfA has a total staff of over 300, including about 55 faculty. The Institute has an annual budget of \$20 million, including \$15 million in grants from the federal government.

Health sciences are another area of future growth potential. The UH Cancer Center, established in 1981 by the UH Board of Regents, is the only National Cancer Institute-designated center in Hawai'i and the Pacific. Its mission is to reduce the burden of cancer through research, education, and patient care, with an emphasis on unique ethnic, cultural, and environmental characteristics of Hawai'i and the Pacific. The research organization is affiliated with UH Mānoa and has facilities in downtown Honolulu and Kaka'ako. Currently

the Center directly employs 300 faculty and staff, who, together with 200 UH Cancer Consortium affiliate members, are conducting more than 100 cancer research projects in four interdisciplinary programs.

Technology Transfer

With a long history of challenges moving forward with technology transfer, another goal of HI² is to advance the licensing and commercialization of UH research. With less than 10% of the current research being commercialized, majority opinion at the university is that technology transfer is too much trouble, due to a lack of support in this area. HI² is planning to engage a technology transfer concierge to help research investigators partner with the business community and interact with the technology industry to get inventions out of the laboratory and into the larger economy.

There are several examples of research initiatives ripe for commercialization. For example, UH will be the first university in the world with rocket launch capability for satellites that are constructed and operated by its students and faculty. The Hawai'i Institute of Geophysics and Planetology, a research unit within SOEST, receives approximately \$15 million a year and plans to launch these satellites from the island of Kauai next fall. The Institute already partners with optics labs on instrumentation, data analysis, and software development, and there is tremendous potential here for related technology transfer. In the School of Engineering, corrosion research for the U.S. Navy and advanced tsunami research have potential to be commercialized and patented through accelerated technology transfer. Within the highly productive IfA, applied research accounts for only 10% of their \$20-\$30 million

budget, but none of it is commercialized.

Return on Investment: An Economic Analysis of HI²

While it is costly to recruit highly productive research scholars, the premise of the HI² is that this investment will both pay for itself and produce increased economic activity in the form of extramural research expenditures, jobs, technology transfer and harder-to-quantify social benefits. In this section we calculate the net present value⁷ (NPV) and internal rate of return (IRR)⁸ for HI² under various assumptions (Table 2). In the baseline scenario, we assume that each PI will require a one-time start up cost of \$1.2 million and a salary of \$233,000 per year. The annual incremental benefit is calculated as the difference between the total grant volume with and without HI². Based on the historical growth of federal R&D funds, we assume that the total grant volume will grow at a rate of 4.0% per annum. In addition to the 4.0% rate of growth, we expect HI²-hired faculty to bring in \$1.5 million in new extramural funds

⁷ Measures the net benefit of a project in today's dollar terms. Future dollars are worth less than the same number of dollars today, simply due to the time value of money—a dollar today can be invested to produce more dollars in the future. The net present value calculation discounts future cash flows to express them in today's dollars based on an assumed discount rate.

⁸ IRR (also known as rate of return) calculations are commonly used to evaluate the desirability of investments or projects. The higher a project's IRR, the more desirable it is to undertake the project. The term internal refers to the fact that its calculation does not incorporate outside economic factors such as the interest rate or inflation).

Table 2. Economic Return Scenarios for HI²

Scenario	Parameters	Gr. Vol. FY2022	Total Jobs	NPV	IRR
Baseline	g=4.0%, n=\$1.5M	\$738M	13,014	\$250.4M	96%
Low new funds	g=4.0%, n=\$1M	\$707M	12,471	\$130.3M	59%
Low growth	g=3.0%, n=\$1.5M	\$671M	11,844	\$232.1M	94%
Low new funds, Low growth	g=3.0%, n=\$1M	\$643M	11,341	\$118.1M	56%
Very Low new funds	g=4.0%, n=\$0.5M	\$688M	12,145	\$58.3M	33%
Low growth, Very Low new funds	g=3.0%, n=\$0.5M	\$626M	11,040	\$49.8M	29%

in the first year (growing at 4% thereafter), which is in line with Edward DeLong's (C-MORE) average research revenue. Although HI² stipulates the total number of scientists to be hired (50), the hiring pattern is unspecified. As a starting point, we assume that 5 PIs are hired every year for ten years. To calculate NPV, we assume a discount rate of 2.0%.

In the baseline scenario, the total grant volume grows to \$738 million by FY2022, the NPV of HI² is \$250 million, over 13,000 jobs are created from total research expenditures, and the IRR is 96.0%. Because the contribution of new hires and the actual growth of research funds are highly uncertain, we also consider several more-conservative scenarios. Reducing expected growth in extramural funds from 4.0% to 3.0% results in FY2022 total grant volume of \$671 million, a NPV of \$232 million, almost 12,000 jobs, and an internal rate of return (IRR) of 94.0%. Compared with alternative investments, this is clearly an excellent return on investment. If growth remains at 4.0% but instead new researchers are expected to contribute only \$1 million rather than \$1.5 million in research funds per year, total FY2022 grant volume is instead \$707 million, NPV is \$130 million, almost 12,500 jobs, and the IRR is 59.0%. In our worst-case scenario (both growth and contributions from new faculty are severely underestimated), the FY2022 grant volume of \$626 million falls short of the goal of doubling current grant volume by almost \$250 million, but the NPV is still positive (\$50 million), over 11,000 jobs are still created, and the IRR is 29.0%. We also find that the IRR is dependent on how the new hires are allocated over the ten-year period. All else equal, front loading the hiring results in a higher FY2022 grant volume and NPV,

primarily because the benefits of the additional research are allowed to compound over a longer period of time.

Under our baseline assumptions, UH will not reach the ambitious goal of \$1 billion of research funding in the ten-year period we considered. Reaching that goal is largely dependent on how successful PIs are conducting research and attracting extramural funds. Over the past five fiscal years, the top five PIs in the UH system have averaged almost \$17 million per year in extramural funding. If UH is able to recruit ten top research faculty that achieve this level of success, while the remaining 40 faculty in the HI² plan meet our baseline assumptions, then the target of \$1 billion in funding can be reached in just over ten years. Obviously, the success of HI² PIs and the actual growth of research funds are highly uncertain, Table 2 displays several more-conservative scenarios. These scenarios result in lower, but still impressive, rates of return on investment.

The accuracy of the projections depends largely on the accuracy of the underlying assumptions. It is difficult to predict whether the trend of federal contributions to R&D will continue given the many factors involved, and whether such a trend will be representative of the UH system as a whole. It is also difficult to determine whether the research revenue obtained by DeLong is representative of other top scientists across a variety of fields. Moreover, the \$1.5 million per year is an average estimate. In reality, the amount will vary by year, and there may be an initial lag as the new hires transition into the UH system. Note that the low scenarios presented here are based on an assumed growth in extramural research funding (predominantly federal) of only 3% that

implies a significant decline in funding relative to the overall size of the US economy. Even if it turns out that federal funding grows more slowly than this, HI² is based on the idea that UH can attract faculty away from other institutions because of the comparative advantage Hawai'i has in a number of areas ranging from astronomy and oceanography, to research on renewable energy and sustainability. The goal of HI² is to grow the university's funding by increasing its share of federal funding.

In addition to the large positive expected return on investment—as high as 96.0% in the best-case scenario, other benefits include thousands of new jobs in the state, new discoveries, new support businesses and opportunities. The Win-Win outcome for UH and the State stems from the fact that the research industry amplifies investment into multiple benefits. Research activity requires support staff, equipment, and materials, which in turn boost local businesses. At the same time, new businesses are nurtured by the Hawai'i research economy. Much of the multiplier effect, however, hinges on successful tech transfer.

Student Spending: A Significant Contributor to Hawai'i's Economy

In previous University of Hawai'i economic impact studies, student spending represented 19.3% (UHERO 2000), 18.2% (UHERO 2003), and 25.3% (UHERO 2009) of total expenditures. According to this year's survey, student spending is over 30% of total spending, with the average UH Mānoa student spending roughly \$23,575 on non-tuition expenditures. Total non-tuition expenditures were lowest for undergraduates from Oahu who spent close to \$18,700 per year on non-tuition expenditures. Graduate students

Table 3. Average Expenditures, by Student Classification

Undergraduate				
	Oahu	Neighbor Island	Mainland	International
Housing	\$5,091	\$9,827	\$11,442	\$9,062
Durables/start-up	\$1,545	\$1,842	\$1,409	\$1,120
Books and supplies	\$904	\$847	\$1,065	\$753
Utilities	\$1,937	\$1,703	\$1,395	\$1,987
Food	\$3,386	\$3,252	\$3,404	\$4,045
Local transportation	\$1,576	\$1,667	\$1,105	\$697
Recreation/entertainment	\$852	\$784	\$930	\$1,119
Personal care	\$3,034	\$2,131	\$2,366	\$6,212
Travel	\$353	\$1,028	\$748	\$1,582
Total	\$18,679	\$23,080	\$23,863	\$26,577
Graduate				
	Oahu	Neighbor Island	Mainland	International
Housing	\$10,499	\$14,585	\$9,283	\$6,784
Durables/start-up	\$5,335	\$3,223	\$1,532	\$2,891
Books and supplies	\$683	\$834	\$583	\$1,477
Utilities	\$2,920	\$3,636	\$2,059	\$1,848
Food	\$5,232	\$5,533	\$4,263	\$4,535
Local transportation	\$1,725	\$3,749	\$1,927	\$888
Recreation/entertainment	\$1,252	\$530	\$838	\$1,383
Personal care	\$5,062	\$5,630	\$4,799	\$5,680
Travel	\$729	\$1,335	\$845	\$834
Total	\$33,437	\$39,055	\$26,128	\$26,319

spent more than undergraduates, with graduate students from the neighbor islands spending the most at more than \$39,000 per year. A summary of average student expenditures by classification is provided in Table 3.

The largest percentage of non-tuition expenditures went towards housing. Food and personal care (including insurance) were also significant spending categories. The differences in Table 3 confirm that spending also varies widely by student classification. In relative terms, undergradu-

ates tend to spend more on books, supplies, recreation, and entertainment, while graduate students spend more on utilities and personal care.

UH Mānoa's Impact on Hawai'i's Economy

In FY2012, student spending; state and federal government-funded UHM spending for goods and services; out-of-state visitor spending; and UHM related expenditures totaled \$1.40 billion, \$1.26 billion of which was spent locally. Togeth-

Table 4. Multiplier Effects per Dollar of UHM-Related Expenditures

	Direct Local spending ('000\$)	Business Sales per \$ of Spending	Earnings per \$ of Spending	State Taxes per \$ of Spending	Jobs per Million \$ of Spending
Total Expenditures	\$1,260,592	1.94	0.58	0.10	15.82
Research (ORS, RCUH)	\$266,333	2.10	0.74	0.12	20.05
Non-Research (non-ORS)	\$399,338	2.08	2.08	0.70	18.75
UH Foundation	\$31,029	2.10	0.76	0.12	20.40
Visitors	\$11,827	1.96	0.57	0.12	14.84
Students	\$468,452	1.78	0.41	0.08	11.29
PCEs	\$83,614	1.65	0.46	0.08	12.07

Table 5. Economic Impacts of UHM & Related Local Expenditures

	Direct Local spending ('000\$)	Business Sales ('000\$)	Income ('000\$)	State Tax ('000\$)	Employment (jobs)
Total Expenditures	\$1,260,592	\$2,449,446	\$735,262	\$130,756	19,938
Research (ORS, RCUH)	\$266,333	\$560,295	\$196,723	\$32,533	5,340
Non-Research (non-ORS)	\$399,338	\$830,826	\$278,707	\$48,276	7,489
UH Foundation	\$31,029	\$65,129	\$23,536	\$3,878	683
Visitors	\$11,827	\$23,157	\$6,725	\$1,414	176
Students	\$468,452	\$832,076	\$191,108	\$37,714	5,290
PCEs	\$83,614	\$137,962	\$38,462	\$6,940	1010
Impact per \$ of General Fund	6.36	12.36	3.71	0.66	100.62

er with additional indirect and induced benefits from these activities, UHM had a total impact of \$2.45 billion on Hawai‘i’s economy.

Table 4 shows that each dollar spent generates \$1.94 of total business sales, \$0.58 of employee earnings, and \$0.10 of state tax revenues in Hawai‘i in FY2012; and each million dollars of spending generates about 16 jobs in Hawai‘i. Table 5 shows the total impact of each source of expenditures as well as impact per dollar of State General Funds spent. Each dollar of State General Fund spending on UHM translates into \$12.36 of

total business sales, \$3.71 of employee earnings, and 66 cents of state taxes in Hawai‘i. Every \$1 million of general funds spent on UHM generates 101 jobs. For every dollar of state money spent on the Mānoa campus, UHM was able to leverage an additional \$6.36 of spending in the state.

UHM: A Major Economic Sector in Hawai‘i

Overall, the \$1.40 billion of education-related expenditures attributable to UHM generated \$2.45 billion in local business sales, \$735 million in employee earnings, \$131 million in state tax revenues, and slightly under 20,000 jobs in Hawai‘i in FY2012. This represented approximately 3.4% of total jobs, 2.5% of worker earnings, and 2.2% of total state tax revenues in the economy of Hawai‘i. If the HI² were to successfully double research expenditures, the above analysis suggests more than 5,000 new jobs would be created from the ripple effects of the research spending alone, independent of any technology transfer and other jobs created as a direct result of the research.

Figure 9 shows the size of UHM’s contribution to Hawai‘i’s GDP compared with other sec-

Figure 8 - Leverage

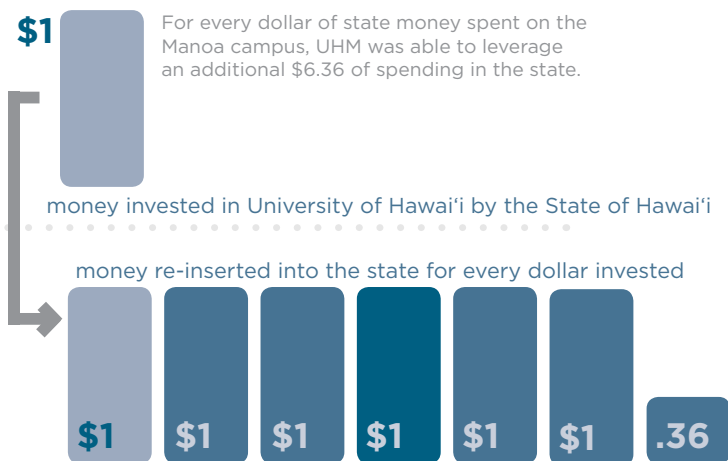
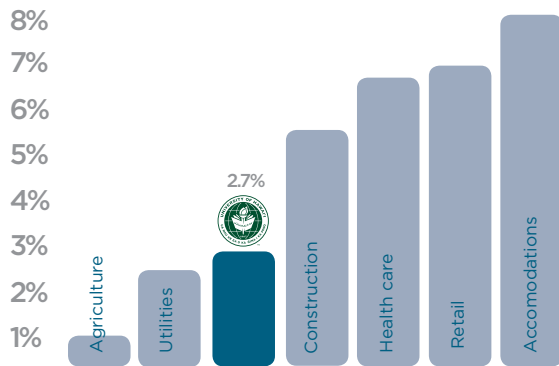


Figure 9 - Breakdown of Hawai'i's Output



tors of the economy. UHM represented about 2.7% of Hawai'i's GDP (estimated). By comparison, in 2011 retail trade's contribution to Hawai'i GDP was 6.9%; construction, 5.6%; the health care industry, 6.7%; hotels and other accommodations and food services, 8.1%; utilities, 2.3%; and agriculture, 0.7%. The University of Hawai'i at Mānoa is a major economic sector in Hawai'i, and due to the heavy proportion of spending on research, is expected to play an even larger role as the Hawai'i Innovation Initiative gets underway.

References

Baum, Sandy, Jennifer Ma, and Kathleen Payea. 2010. "Education Pays, 2010: The Benefits of Higher Education for Individuals and Society. Trends in Higher Education Series." College Board Advocacy & Policy Center.

Cutler, David M., and Adriana Lleras-Muney. 2010 "Understanding Differences in Health Behaviors by Education." *Journal of Health Economics* 29, 1-28.

Deitz, Jaison R Abel and Richard. 2009. "Do Colleges and Universities Increase Their Region's Human Capital?" *Journal of Economic Geography* (October 21): 1-35.

Florida, Richard, Charlotta Mellander, and Kevin Stolarick. 2008. "Inside the Black Box of Regional Development—Human Capital, the Creative Class, and Tolerance," *Journal of Economic Geography*, 8(5), 615-649.

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