MEASURING ECONOMIC DIVERSIFICATION IN HAWAII

Research and Economic Analysis Division
Department of Business, Economic Development and Tourism
STATE OF HAWAII

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MEASURING ECONOMIC DIVERSIFICATION IN HAWAII

1. INTRODUCTION

It is widely held that a diversified economy is less sensitive to the ups and downs associated with any particular industry because risk is spread more evenly across a number of industries. With diversification, even if some industries are suffering, other stronger industries will help the economy maintain healthy growth. The presence of many industries would be expected to offer opportunities for employment in growing sectors to compensate for employment losses in declining sectors.

Some regional economists and policy makers regard diversification as employment insurance, with more diversified economies experiencing lower unemployment during cyclical downturns. It is also argued that the more diversified the economy becomes, the more resilient it becomes to external events and developments.

While diversity has often been promoted as a means to achieve the twin goals of economic stability and growth (Kort, 1979; Siegel et al., 1994), it has also been recognized that other aspects of a region's economic structure, such as regional comparative advantage and natural resources are also important. It is argued that indiscriminate diversification (i.e., diversity for the sake of diversity) will not necessarily bring economic growth and stability (Smith and Gibson, 1998). Akpadock (1996) also notes the concern of community development practitioners that economic diversity does not always promote economic stability, economic growth, or low employment.

With the demise of plantation agriculture, coupled with limited potential for much further growth in tourism due to local capacity constraints and increased competition from emerging destinations worldwide, economic diversification continues to become a topic of increasing interest in Hawaii for promoting economic growth and maintaining economic stability. The interest in diversification becomes particularly intense when uncertainties emerge over tourism and federal government activities, the two key pillars of Hawaii's economy.

Aiming to promote economic diversification and growth in order to create high paying jobs, recent development efforts in Hawaii have focused on developing high-tech, knowledge-based (computer and information related), and other emerging industries, including biotechnology, non- fossil fuel energy alternatives, ocean sciences, astronomy, and film and performing arts products.

With the development of the state's Innovation Initiative and passage of Act 148 in 2007, Hawaii has embarked on a series of measures aiming to develop foundations for an innovation economy and nurturing emerging industries. Besides several other programs, the act has mandated DBEDT to create and periodically update a database that defines and measures Hawaii's emerging industries. It also tasks DBEDT to develop appropriate outcome measures to assess the effectiveness of the state's innovation initiative and other development efforts in promoting economic diversification, growth, and stability in Hawaii.

Against this backdrop, this particular study looks at economic diversification and its impact on economic performance in Hawaii.

In 2008, DBEDT completed the first study analyzing economic diversification in Hawaii. The 2008 study examined the degree of economic diversification in Hawaii and examined some measures of diversity for Hawaii. This was followed by an update in 2011. This study is an additional update using the most recent data available.

Similar to the 2008 study and 2011 update, this study will estimate various measures of economic diversification, performance, and stability, and examine their patterns over time for Hawaii. This study will compare industries' share in total economic activity (employment and GDP) between Hawaii and the U.S. and determine how the state's economic structure has changed over time relative to the national economy.

2. METHODOLOGY

There have been numerous studies by regional economists that have attempted to develop measures of economic diversity and statistically test whether changes in a region's industrial structure are related to its economic stability and performance.[1] To test these hypotheses, researchers have constructed various scalar measures of regional economic diversity using different economic theories. Similarly, various measures of economic performance and instability have also been constructed. Variability in regional unemployment or income are the most popular measures of economic stability, while the level of unemployment and real per capita income growth are commonly used to account for regional economic performance.

2.1. Measures of Economic Diversity

Different economic theories tend to result in different concepts, terms, and measures of economic diversity. Eight measures are summarized below.

Industrial Organization Theory

Under this theory, a more diversified sector (i.e., less concentrated) is assumed to be more competitive (Scherer, 1980). A region with a greater number of sectors and/or a more even distribution of economic activity is associated with higher diversity (Malizia and Ke, 1993). Based on this definition, measures of concentration ratios, such as the Ogive and the Entropy indexes, have been used as measures of economic diversity.

Following McLaughlin (1930) and Tress (1938), the Ogive index of economic diversity can be constructed as follows:

Ogive Index

$$Ogive\ \ Index = \sum_{i=1}^{N} \frac{\left(S_i - 1/N\right)^2}{1/N}$$

where N is the number of sectors in an economy, and S_i is the sectoral share of economic activity for the ith sector, usually expressed as the employment share.[2] The more equally a region's economic activity is distributed among its sectors, the greater the diversity (Rodgers, 1957). With N sectors, an equal distribution implies that S_i is equal to $1/N$, the ideal share for each sector, and the Ogive index equals zero, meaning perfect diversity. A more unequal distribution of sectoral activity will result in a higher value of the Ogive index. It should, however, be noted that the measure is sensitive to the level of sectoral aggregation (i.e., the chosen number of sectors, N) used to organize the data. However, Grossberg (1982) and Jackson (1984) have shown that, depending

[1] *See* Izraeli and Murphy (2003) and Siegel, Johnson and Alwang (1995) for detailed reviews of these studies.

[2] Because there is no need to inflate or deflate the data as is the case with dollar values, employment has been the most commonly used indicator of economic activity over time. Some studies have also used income and GDP.

on the value of *N*, a region's economic structure can be defined as being either diverse or specialized, both relative to other regions and over time.

Following Smith and Gibson (1988), the Entropy index of economic diversity can be defined as follows:

Entropy Index

$$Entropy\ \ Index = \sum_{i=1}^{N} S_i\ ln\left(\frac{1}{S_i}\right) = -\sum_{i=1}^{n} S_i\ ln(S_i)$$

where *N* is the number of sectors, S_i is share of economic activity in *i*th industry and *ln* is natural logarithm. The Entropy measure compares the existing employment or income distributions among industries in a region to an equiproportional distribution. Higher Entropy index values indicate greater relative diversification, while lower values indicate relatively more specialization. The maximum value of the measure would result with the equal distribution of employment among all industries. The minimum value of zero (maximum specialization) would occur if employment were concentrated in one industry. On the other hand, if employment were distributed equally among the *N* sectors, the Entropy index would reach its maximum value, indicating perfect diversity. Although both Ogive and Entropy indexes yield similar diversity rankings to regions, the Entropy index is the more popular measure of sectoral concentration among the regional scientists.

Herfindahl Index

The Herfindahl index, is a widely-used measure of market concentration in the industrial organization literature (Scherer, 1980), but has also been used as a measure of economic diversity (Tauer, 1992). The Herfindahl index indicates the extent to which a particular regional economy is dominated by a few firms and can be expressed as follows:

$$Herfindahl\ \ Index = \sum_{i=1}^{n} S_i^2$$

where S_i is the share of employment in the *i*th industry. The Herfindahl index varies from 0 (when the economy has a large number of industries, with small and equal employment shares – high diversity) to 1 (when one sector accounts for all economy's employment – full specialization). Thus, a decline in the index signifies less concentration in the dominant industry or greater diversification. An increase indicates more concentration in the dominant sector or greater specialization.

Thus, according to Ogive, Entropy and Herfindahl measures, the more equal distribution of employment among a large number of industries mean higher level of economic diversity. One limitation of these indexes is that they do not tell whether total regional employment is increasing or decreasing. For example, increased diversification may come with a decrease in total

employment, which may not be a desired outcome. Ideal would be to have increased diversity with employment gains.

Following McLaughlin (1930) and Tress (1938), it has been hypothesized that the more diverse the economic activity of a region, the more stable is its economic performance. This hypothesis has been widely tested in the literature using the Ogive, Entropy and Herfindahl indexes, but the empirical findings are not robust.

Economic Base Theory

Economic base theory (also called export base theory) views regional economic growth as being driven by exogenous final demands, primarily exports. Industries contributing to exogenous (or external) final demand are termed *basic* industries and those serving primarily endogenous (or internal) demand are termed *non-basic* industries. The distinction between a region's basic and non-basic sectors is often illuminated by calculating a location quotient (*LQ*) as follows:

$$LQ_i = \frac{Si^{\mathrm{Re}g}}{S_i^{US}}$$

where $i = 1, 2, \ldots N$ sectors, S_i^{Reg} is the employment share in a region's ith industry, S_i^{US} is the corresponding share for the U.S.[3] Thus, the *LQ* compares the regional share of economic activity to the corresponding share found at the national level. A *LQ* of one indicates that the share of an industry in the regional economy and the national economy are the same; a value of the *LQ* greater (or smaller) than one means that regional economy has a greater (or smaller) share of that industry in its economy than nationally.

Sectors with *LQ* greater than 1 are defined as basic (export) sectors and part of their output is assumed to be exported outside the region, while sectors with LQ less than 1 are known as non-basic sectors and their outputs are assumed to be sold within the local economy.

LQ greater than 1 is one of the most widely used measures of specialization in a given sector and industrial concentration of a regional economy. The summation of sectoral *LQ*s, also referred to as the coefficient of specialization, is used as a measure of regional specialization (Hoover and Giarratani, 1985). Similarly, the reciprocal of the sum of location quotients (*LQ*s) weighted by industry shares gives the Hachman index of economic diversity as follows:

$$Hachman\ \ Index = \frac{1}{\sum_{i=1}^{N}\left[\left(S_i^{Reg} / S_i^{US}\right) \times S_i^{Reg}\right]} = \frac{1}{\sum_{i=1}^{N}\left[LQ_i \times S_i^{Reg}\right]}$$

where S_i^{Reg} is a region's share of employment in the ith industry, S_i^{US} is the U.S. share of employment in the ith industry, and N is the number of industries. The Hachman index is an indicator that measures how closely the region's industry employment distribution compares to

[3] Location quotient can also be calculated in terms of both output, income or value added, but it is typically calculated based on employment because the sectoral employment data are often more readily available at the local level.

that of the U.S. This measure is bounded between 0 and 1, where 1 means the region has exactly the same industrial structure as the U.S., and 0 means it has a totally different industrial structure.

Regional Business Cycle Theory

As in economic base theory, the regional economic instability in regional business cycle theory is also assumed to result from fluctuations in the demand for exports, especially those with high income elasticity of demand (such as luxury goods). It has been hypothesized that economic instability can be explained in terms of differences in the mix of stable and unstable sectors. To test this relationship, a region's share of stable or unstable sectors has been used as a measure of economic diversity.

Durable goods generally tend to have high short-run income elasticity of demand and hence it is assumed that a region will experience more cyclical fluctuations the higher the share of durable goods in its export mix or the higher the share of employment or income in durable goods sectors (Malizia and Ke, 1993). Thus, the region's employment or income share in the durable goods sectors has also been widely used as a measure of economic diversity, with a smaller share of durable goods in total economic activity indicating higher diversity or vice versa (Domazlicky, 1980).

Another hypothesis under the regional business cycle theory is that the more similar a region's sectoral composition is to that of the nation's, the higher will be the economic stability. This hypothesis is tested using the national averages index (*NAI*), calculated as follows:

$$NAI = \sum_{i=1}^{N} \frac{\left(S_i^{\mathrm{Re}g} - S_i^{US}\right)^2}{S_i^{US}}$$

where S_i^{Reg} is the *i*th sector's share of economic activity in the region, S_i^{US} is the U.S. average of share of economic activity in the *i*th sector, and *N* is the number of sectors. As the region's share of economic activity approaches the U.S. share for all sectors, the *NAI* approaches zero. As the region's shares diverge from the U.S. economy, the *NAI* becomes increasingly larger. The *NAI* can be considered a relative measure of economic diversity because it measures the amount of disparity between the U.S. and the region's industry distributions. The NAI is accepted as a more reasonable standard with which to gauge a region's industry structure than other alternatives (Sherwood-Call, 1990).

Trade Theory

According to trade theory, economic exchange is driven by regional differences in endowments, preferences and comparative advantage. Trade theory assumes that specialization in production will lead to economic growth. Regions differ in terms of natural, human and technological resources, infrastructure and other spatial factors. Institutional factors, such as tax structure, environmental regulations, education, and labor laws can also influence regional comparative advantage.

The comparison of the economic performance of a region's industrial sectors relative to a reference economy is usually determined by using a shift-share analysis. The shift-share analysis, enables the researcher to decompose employment growth or decline (CHANGE) in a particular region over a given time period into three components: (1) the national growth effect (*NGE*), which is the amount of change in the region's total employment due to national economic factors – the change that would occur if all the industries in the region grew at the same rate as the nation, (2) the industrial mix effect (*IME*), which is the amount of change the region would have experienced had each of its industries grown at their national rates, less the national growth effect, and (3) the competitive share effect (*CSE*), which is the difference between actual change in employment and the employment change to be expected if each industrial sector grew at the national rate. These components are calculated as follows:

The national growth effect for the *i*th sector (NGE_i) can be expressed as follows:

$$NGE_i = E_i^{REG} \cdot g^{US}$$

where E_i^{REG} is the region's base year employment in the ith sector and g^{US} is the growth rate during the period of analysis for all sectors in the nation. The overall national growth effect (*NGE*) for the region can be computed as the sum of the national growth effects for all sectors as:

$$NGE = \sum_{i=1}^{N} NGE_i = \sum_{i=1}^{N} E_i^{REG} \cdot g^{US}$$

Similarly, the industrial mix effect for the *i*th sector (IME_i) can be calculated as follows:

$$IME_i = E_i^{REG}\left(g_i^{US} - g^{US}\right)$$

where g_i^{US} is the growth rate during the period of analysis for the *i*th sector in the nation and the notations have been defined above. The summation of all sectors' industrial mix effect gives the overall industrial mix effect (*IME*) for the region as

$$IME = \sum_{i=1}^{N} IME_i = \sum_{i-1}^{N} E_i^{REG}\left(g_i^{US} - g^{US}\right).$$

The IME accounts for the effect of the region's industrial composition. For example, a region with a high (low) concentration of high growth industries will have a positive (negative) industrial structure effect.

Finally, the regional competitive share effect for the *i*th sector (CSE_i) can be calculated as follows:

$$CSE_i = E_i^{REG}\left(g_i^{REG} - g_i^{US}\right).$$

Thus, overall regional competitive share effect (CSE) is obtained by summing the competitive share effects for all sectors in the region as:

$$CSE = \sum_{i=1}^{N} CSE_i = \sum_{i=1}^{N} E_i^{REG}\left(g_i^{REG} - g_i^{US}\right)$$

.

A positive competitive share effect implies the region's economic performance is superior to the national average.

So, combining all three effects, actual change (CHANGE) in total employment for the region can be expressed as follows:

$$CHANGE = \sum_{i=1}^{N} E_i^{REG} \cdot g^{US} + \sum_{i-1}^{N} E_i^{REG}\left(g_i^{US} - g^{US}\right) + \sum_{i=1}^{N} E_i^{REG}\left(g_i^{REG} - g_i^{US}\right)$$

Since its introduction in the 1960s (Edwards, 1967; Steed, 1967; Brown, 1969; Stilwell, 1969), the shift-share analysis has been used extensively to analyze differences between national and regional growth rates in variables, such as, employment, exports, and productivity (Andrikopoulos et al., 1990; Peh, 1999; Coughlin and Pollard, 2001; Gabe, 2009).

Portfolio Theory

Portfolio theory was originally applied to financial assets. Using the mean return as a proxy for expected returns (*E*) and the variance (*V*) as proxy of risk, the Markowitz (1959) portfolio method determines the set of mean-variance (*E-V*) efficient portfolios.

Conroy (1974, 1975) first proposed a portfolio-theoretic approach to analyzing economic diversification. Since then numerous studies have employed the portfolio theory for the analysis of economic diversification. If every sector is considered an individual regional investment, then the bundle of sectors can be viewed as a portfolio of investments.

For financial investments, there exists a relationship (trade-off) between their expected returns and associated risk. For a regional economy with a portfolio of sectors, one could also hypothesize a similar relationship (trade-off) between risk (economic instability) and expected returns (income, employment or output growth).

Every region is endowed with a limited set of resources, producing a stream of stochastic returns (such as income, employment and output). In this context, economic diversification aims to reduce instability in aggregate income and employment growth (returns) to the region by allocating its limited resources to the portfolio of sectors. By capturing the characteristics of individual industries and inter-industry relationships on regional growth and instability, the portfolio framework assists policy makers in developing appropriate diversification strategies which can serve the twin purpose of stimulating economic growth and stabilizing the economy.
Following Markowitz (1959), a region's portfolio variance (σ_P^2) can be computed as follows:

$$\sigma_p^2 = \sum_{i=1}^{N} S_i^2 \sigma_i^2 (X_i) + \sum_{i=1}^{N} \sum_{j=1, j \neq i} S_i S_j \sigma_{ij} (X_i, X_j)$$

where S_i and S_j are the shares of economic activity (employment, income or output, X) in the ith and jth sectors, σ_i^2 is the variance of economic activity for the ith sector, σ_{ij} is the covariance of economic activities for the ith and jth sectors. Thus, the portfolio variance for any given region (i.e., regional instability) is the weighted sum of the variances (individual sectors' fluctuations) and covariances (intersectoral fluctuations) for a given economic activity. Thus, the regional economic stability is not only sensitive to fluctuations of the individual sectors, but also to the correlation of fluctuations between sectors.

Some studies have used the portfolio variance as a measure of economic diversity, with a lower σ_P^2 indicating a more diversified economy (Conroy, 1974; Brewer and Moomaw, 1985; and Wundt, 1992). These studies have also claimed that, compared to other measures of diversity (the Ogive index, Entropy index, and national average index) the portfolio variance is a superior measure of economic diversity in explaining regional economic instability. However, as pointed out by Sherwood-Call (1990), it is inappropriate to use the portfolio variance to test the hypothesized relationship between diversity and instability, because the portfolio variance does not measure diversity independent of instability.

Location Theory

Location theory looks at the spatial distribution of economic activity, including the development of spatial clusters. The theory holds that the cost of production is lower in industrial clusters and this is an important reason for specialization and regional competitive advantage (Hoover and Giarratani, 1985). Economic clusters also benefit from linkages between a region's firms and sectors. However, a diverse economy with unlinked firms and sectors may also benefit from economic clusters. For example, firms and sectors having offsetting patterns of cyclical fluctuations may operate more efficiently if they are located together, thus providing some stability to an otherwise unstable situation. The mobility of labor among the firms and sectors and a region's size are assumed to be positively related to economic stability. Earlier studies have also found a positive relationship between population mobility and economic diversity.

Economic Development Theory

According to economic development theory, economic diversification is viewed as driven by simultaneous changes in production, consumption and trade patterns (Schuh and Barghouti, 1988; Barghouti et al., 1990; and Petit and Barghouti, 1992). It has been argued that diversification may be expedited by forces of unbalanced growth, especially the faster growth of sectors with high income elasticity of demand.

To evaluate growth and instability impacts, the knowledge of the types of sectors and intersectoral linkages is needed. According to Hirschman (1989), the process of diversification can be viewed in terms of changes in an input-output (I-O) matrix. Various measures of intersectoral linkages based in the I-O matrices have been used in the literature (Deman, 1991; Jensen et al., 1991).

Similarly, Wagner and Deller (1993) suggest a measure of economic diversity based on intersectoral linkages detailed in an I-O matrix.

Input-Output Model: A Unified Framework

Recognizing the need for a better framework that is capable of combining diverse viewpoints of economic diversity and performance presented above under different economic theories, Siegel et al. (1994, 1995) have developed an alternative approach based on an I-O model for the analysis of economic diversity and diversification.[4] The I-O model provides a comprehensive framework for modeling not only a region's economic structure in terms of production, consumption, and trade relationships (including the level and mix exogenous final demands), but also the region's economic performance as a direct function of its economic structure.

The I-O framework enables the researcher to compare the growth and stability impacts of different diversification strategies involving changes in the level and mix of exogenous final demands, for example, an export promotion program. It is also possible to determine similar impacts resulting from changes in input-output relationships in the I-O matrix. Import substitution is a popular diversification strategy and its impacts can be modeled using the I-O model. These impacts can be measured for the economy as a whole as well as for specific sectors. The sectoral distribution of growth and stability impacts can also be derived. This will allow policymakers to rank different policies based on their growth and stability objectives and preferences with respect to growth and stability trade-offs.

The main limitation of using this approach on a regional basis is the lack of consistent I-O tables over time. Regional input-output models (such as IMPLAN, REMI, and RIMS models) would provide the necessary data to produce the baseline relationship between economic structure and performance, but the problem is the lack of time series data on exogenous final demands to estimate their expected growth and variance.

2.2. Measures of Economic Instability

Unemployment Instability Index (UII)

$$UII_t(\%) = \left| \frac{U_t - \hat{U}_t}{\hat{U}_t} \right| \times 100$$

where U_i is annual average monthly unemployment level for year t and $\hat{U}_t$ is an approximation of the long-term unemployment trend. The measure is an absolute percentage deviation of unemployment relative to its long-term trend value. Higher values of UII would indicate greater instability relative to the long-term trend. Some authors have used employment data instead of unemployment.

[4] For mathematical details involved in the derivation of measures of economic diversity and instability using the I-O-based approach, see Siegel, Johnson and Alwang (1995).

3. ANALYSIS AND RESULTS

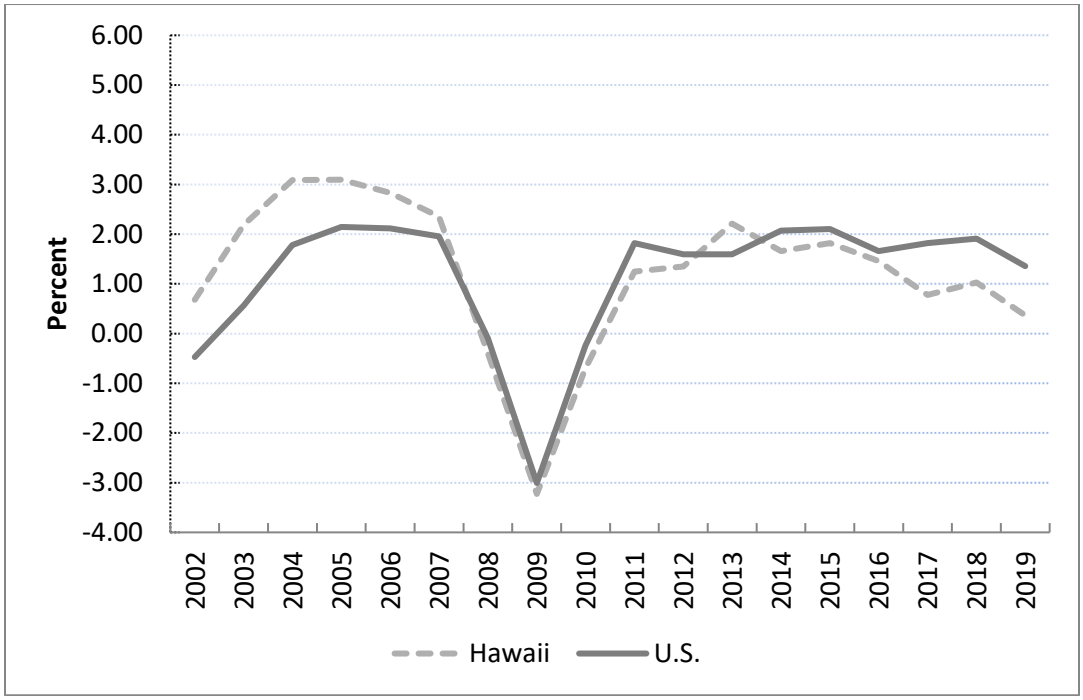
3.1. Recent Economic Trends for Hawaii and the U.S.

Most of the research on economic diversification has focused on development of measures of economic diversity and its influence on economic performance and stability. It is widely held that increased diversification leads to higher levels of economic stability and performance.

Therefore, this section examines recent trends on levels and variations of key indicators of Hawaii's economic performance, based on measures presented in the last section. Since some of the estimated measures of economic diversity for Hawaii are directly related to the overall economic structure in the U.S., key indicators of the U.S. economy are also discussed.

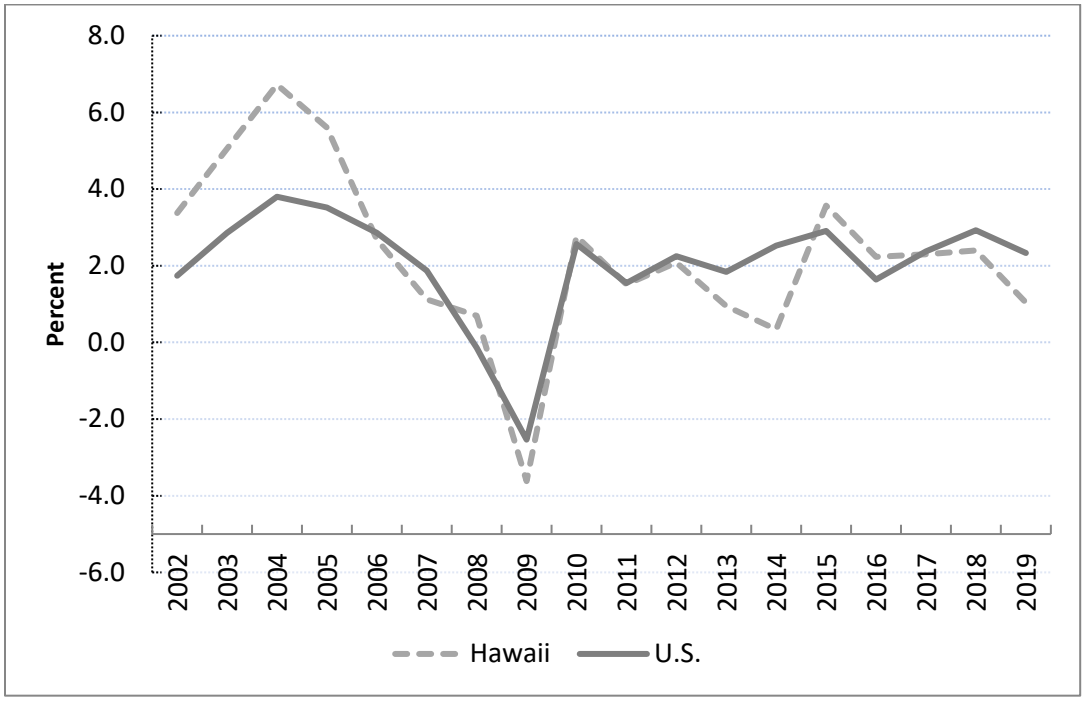
Figure 1 compares total job annual growth rate between Hawaii and the U.S. From 2002 to 2007, Hawaii's annual job growth rate was positive and higher than that of the nation. Since 2008, however, the annual growth rate of jobs in Hawaii were mostly below that of the nation.

Figure 1. Annual Total Job Growth Rate, 2002-2019



As shown in Figure 2, from 2002 to 2005, the annual growth rate of real GDP in Hawaii was above that of the nation; between 2006 and 2019, the annual growth rate of real GDP in Hawaii was mostly below or close with that of the nation.

Figure 2. Annual Real GDP Growth Rate, 2001-2019



3.2. Industrial Structure Changes in Hawaii vs. the U.S.

Because some of the estimated measures of economic diversity for Hawaii depend on the difference in industrial structure between Hawaii and the U.S. as a whole, some of the major differences between the two economies are discussed in this section.

Comparisons between industrial structures in Hawaii and in the U.S. are conducted using both employment data and real GDP data in this study. For employment, the North American Industry Classification (NAICS) data at the two-digit level from 2001 to 2019 from the Economic Modeling Specialists, Inc, (EMSI) are used in this study. For real GDP, the Bureau of Economic Analysis (BEA) data by two-digit NAICS from 2001 to 2019 are used in this study.

Table 1 compares industrial structure change based on total jobs from 2001 to 2019 between the U.S. and Hawaii. From 2001 to 2019, total job growth in Hawaii was 23.9 percent, 4.9 percent higher than the nation's 22.7 percent total job growth rate.

Table 1. Total Employment by Industry for the U.S. and Hawaii, 2001 and 2019

	Employment (total jobs)			Growth 2001-2019	% in Total Addition
	2001	2019	Change		
U.S.					
Total	165,060,824	202,604,260	37,543,436	22.7%	100.0%
Agriculture, Forestry, Fishing and Hunting	3,750,691	3,584,110	-166,581	-4.4%	-0.4%
Mining, Quarrying, and Oil and Gas Extraction	805,589	1,446,569	640,981	79.6%	1.7%
Utilities	615,697	593,113	-22,583	-3.7%	-0.1%
Construction	9,825,618	11,173,782	1,348,164	13.7%	3.6%
Manufacturing	16,912,568	13,645,001	-3,267,566	-19.3%	-8.7%
Wholesale Trade	6,195,268	6,455,543	260,275	4.2%	0.7%
Retail Trade	18,054,252	19,101,217	1,046,965	5.8%	2.8%
Transportation and Warehousing	5,434,231	9,589,081	4,154,850	76.5%	11.1%
Information	4,013,108	3,517,832	-495,276	-12.3%	-1.3%
Finance and Insurance	7,982,420	10,731,744	2,749,324	34.4%	7.3%
Real Estate and Rental and Leasing	5,637,387	9,728,801	4,091,414	72.6%	10.9%
Professional, Scientific, and Technical Services	10,217,361	14,540,231	4,322,870	42.3%	11.5%
Management of Companies and Enterprises	1,794,428	2,732,055	937,627	52.3%	2.5%
Administrative and Support and Waste Management	9,671,140	12,424,788	2,753,648	28.5%	7.3%
Educational Services	3,125,332	5,099,381	1,974,049	63.2%	5.3%
Health Care and Social Assistance	15,090,766	22,927,435	7,836,670	51.9%	20.9%
Arts, Entertainment, and Recreation	3,147,243	4,707,403	1,560,159	49.6%	4.2%
Accommodation and Food Services	10,677,839	15,142,451	4,464,612	41.8%	11.9%
Other Services (except Public Administration)	8,844,666	10,821,299	1,976,633	22.3%	5.3%
Government	23,265,223	24,642,425	1,377,202	5.9%	3.7%
Hawaii					
Total	753,738	933,568	179,829	23.9%	100.0%
Agriculture, Forestry, Fishing and Hunting	15,823	15,229	-594	-3.8%	-0.3%
Mining, Quarrying, and Oil and Gas Extraction	491	822	331	67.5%	0.2%
Utilities	2,765	4,211	1,446	52.3%	0.8%
Construction	33,073	49,840	16,768	50.7%	9.3%
Manufacturing	19,607	19,003	-603	-3.1%	-0.3%
Wholesale Trade	19,780	21,988	2,208	11.2%	1.2%
Retail Trade	82,664	91,094	8,430	10.2%	4.7%
Transportation and Warehousing	28,427	43,488	15,061	53.0%	8.4%
Information	13,348	10,999	-2,349	-17.6%	-1.3%
Finance and Insurance	23,616	30,980	7,363	31.2%	4.1%
Real Estate and Rental and Leasing	30,085	45,954	15,869	52.7%	8.8%
Professional, Scientific, and Technical Services	37,149	47,640	10,491	28.2%	5.8%
Management of Companies and Enterprises	6,096	9,836	3,739	61.3%	2.1%
Administrative and Support and Waste Management	45,574	56,910	11,337	24.9%	6.3%
Educational Services	16,592	23,371	6,779	40.9%	3.8%
Health Care and Social Assistance	59,048	85,256	26,208	44.4%	14.6%
Arts, Entertainment, and Recreation	19,212	24,663	5,450	28.4%	3.0%
Accommodation and Food Services	90,587	118,873	28,286	31.2%	15.7%
Other Services (except Public Administration)	39,069	48,638	9,569	24.5%	5.3%
Government	170,734	184,773	14,039	8.2%	7.8%

Source: EMSI

From 2001 to 2019, about 15.7 percent of the 179,829 additional jobs in Hawaii was added by the accommodation and food services sector, followed by health care and social assistance at 14.6 percent, construction at 9.3 percent, real estate and rental and leasing at 8.8 percent, and transportation and warehousing at 8.4 percent. These five sectors that added the largest number of jobs accounted for 56.8 percent of the total additional jobs between 2001 and 2019 in Hawaii.

For the U.S., the five sectors that added the largest number of jobs were health care and social assistance (20.9 percent of additional jobs from 2001 to 2019); accommodation and food services (11.9 percent); professional, scientific, and technical services (11.5 percent); transportation and warehousing (11.1 percent); and real estate and rental and leasing (10.9 percent). The top five sectors accounted for 66.2 percent of the total additional jobs between 2001 and 2019 in the nation.

Table 2 compares industrial structure change based on real GDP from 2001 to 2019 between the U.S. and Hawaii. From 2001 to 2019, real GDP in Hawaii increased 48.3 percent, 19.4 percent higher than the real GDP growth rate for the nation (40.4 percent). Higher relative GDP growth compared to relative job growth in Hawaii suggests there was higher productivity growth in Hawaii relative to the U.S. during this period.

From 2001 to 2019, the real estate and rental and leasing sector accounted for about 27.8 percent of the $27,267 million additional real GDP in Hawaii and accounted for about 14.6 percent of additional real GDP for the nation; the government and government enterprises sector accounted for 12.8 percent in Hawaii and 3.9 percent for the nation; the health care and social assistance sector accounted for 8.9 percent in Hawaii and 10.8 percent for the nation; the transportation and warehousing sector accounted for 8.7 percent in Hawaii and 3.0 percent for the nation; and the retail trade sector accounted for 7.1 percent in Hawaii and 5.1 percent for the nation.

Table 2. Real GDP by Industry for the U.S. and Hawaii, 2001 and 2019

	Real GDP (2012 $M)			Growth 2001-2019	% in Total Addition
	2001	2019	Change		
U.S.					
Total	13,569,457	19,056,767	5,487,310	40.4%	100.0%
Agriculture, forestry, fishing and hunting	156,155	239,956	83,801	53.7%	1.5%
Mining, quarrying, and oil and gas extraction	273,325	536,216	262,891	96.2%	4.8%
Utilities	215,356	289,397	74,041	34.4%	1.3%
Construction	767,199	653,837	-113,362	-14.8%	-2.1%
Manufacturing	1,607,455	2,176,996	569,541	35.4%	10.4%
Wholesale trade	824,442	1,136,843	312,401	37.9%	5.7%
Retail trade	850,113	1,131,485	281,372	33.1%	5.1%
Transportation and warehousing	396,304	561,303	164,999	41.6%	3.0%
Information	447,000	1,210,050	763,050	170.7%	13.9%
Finance and insurance	973,849	1,204,015	230,166	23.6%	4.2%
Real estate and rental and leasing	1,613,086	2,411,666	798,580	49.5%	14.6%
Professional, scientific, and technical services	871,479	1,521,642	650,163	74.6%	11.8%
Management of companies and enterprises	288,642	434,360	145,718	50.5%	2.7%
Administrative and support and waste management	342,567	579,608	237,041	69.2%	4.3%
Educational services	156,590	218,787	62,197	39.7%	1.1%
Health care and social assistance	855,535	1,448,277	592,742	69.3%	10.8%
Arts, entertainment, and recreation	129,981	199,403	69,422	53.4%	1.3%
Accommodation and food services	413,811	522,404	108,593	26.2%	2.0%
Other services	388,803	369,097	-19,706	-5.1%	-0.4%
Government and government enterprises	1,997,765	2,211,425	213,660	10.7%	3.9%
Hawaii					
Total	56,449	83,716	27,267	48.3%	100.0%
Agriculture, forestry, fishing and hunting	558	727	169	30.3%	0.6%
Mining, quarrying, and oil and gas extraction	125	122	-3	-2.6%	0.0%
Utilities	1,066	1,754	687	64.4%	2.5%
Construction	3,257	4,102	845	26.0%	3.1%
Manufacturing	1,508	1,799	291	19.3%	1.1%
Wholesale trade	2,137	2,641	504	23.6%	1.8%
Retail trade	4,099	6,025	1,927	47.0%	7.1%
Transportation and warehousing	2,035	4,413	2,378	116.8%	8.7%
Information	1,002	2,332	1,330	132.7%	4.9%
Finance and insurance	1,887	2,760	873	46.3%	3.2%
Real estate and rental and leasing	9,091	16,665	7,574	83.3%	27.8%
Professional, scientific, and technical services	2,275	3,530	1,256	55.2%	4.6%
Management of companies and enterprises	824	1,311	487	59.2%	1.8%
Administrative and support and waste management	1,497	2,859	1,362	91.0%	5.0%
Educational services	721	844	123	17.1%	0.5%
Health care and social assistance	3,500	5,919	2,420	69.1%	8.9%
Arts, entertainment, and recreation	701	907	206	29.4%	0.8%
Accommodation and food services	5,526	6,984	1,457	26.4%	5.3%
Other services	1,851	1,754	-97	-5.2%	-0.4%
Government and government enterprises	12,791	16,269	3,478	27.2%	12.8%

Source: BEA

A comparison of sectoral employment distributions between Hawaii and U.S. provides further insights into differences in the industrial structure between the two economies. As shown in Figure 3 and Figure 4, in terms of shares in total employment, the manufacturing sector was much larger

in the U.S., while the government sector was much larger in Hawaii, though both of these gaps have narrowed over time. Certain tourism-related sectors, most notably accommodation and food services and, to some extent, arts, entertainment, and recreation had larger shares in total employment in Hawaii than in the U.S. The employment shares in the other sectors were similar between the U.S. and Hawaii.

Figure 3. Employment Shares by Industry for the U.S. and Hawaii, 2001

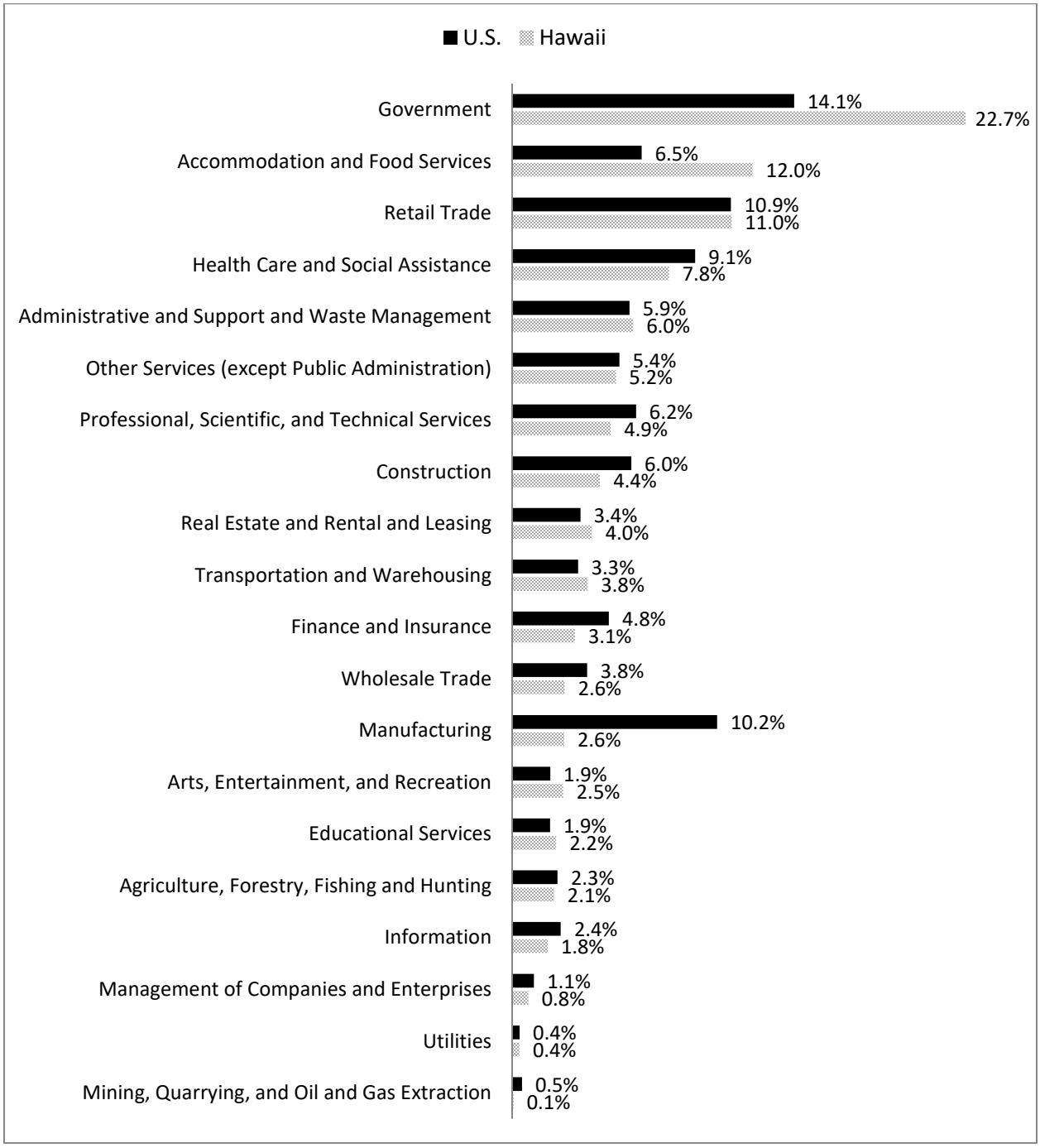
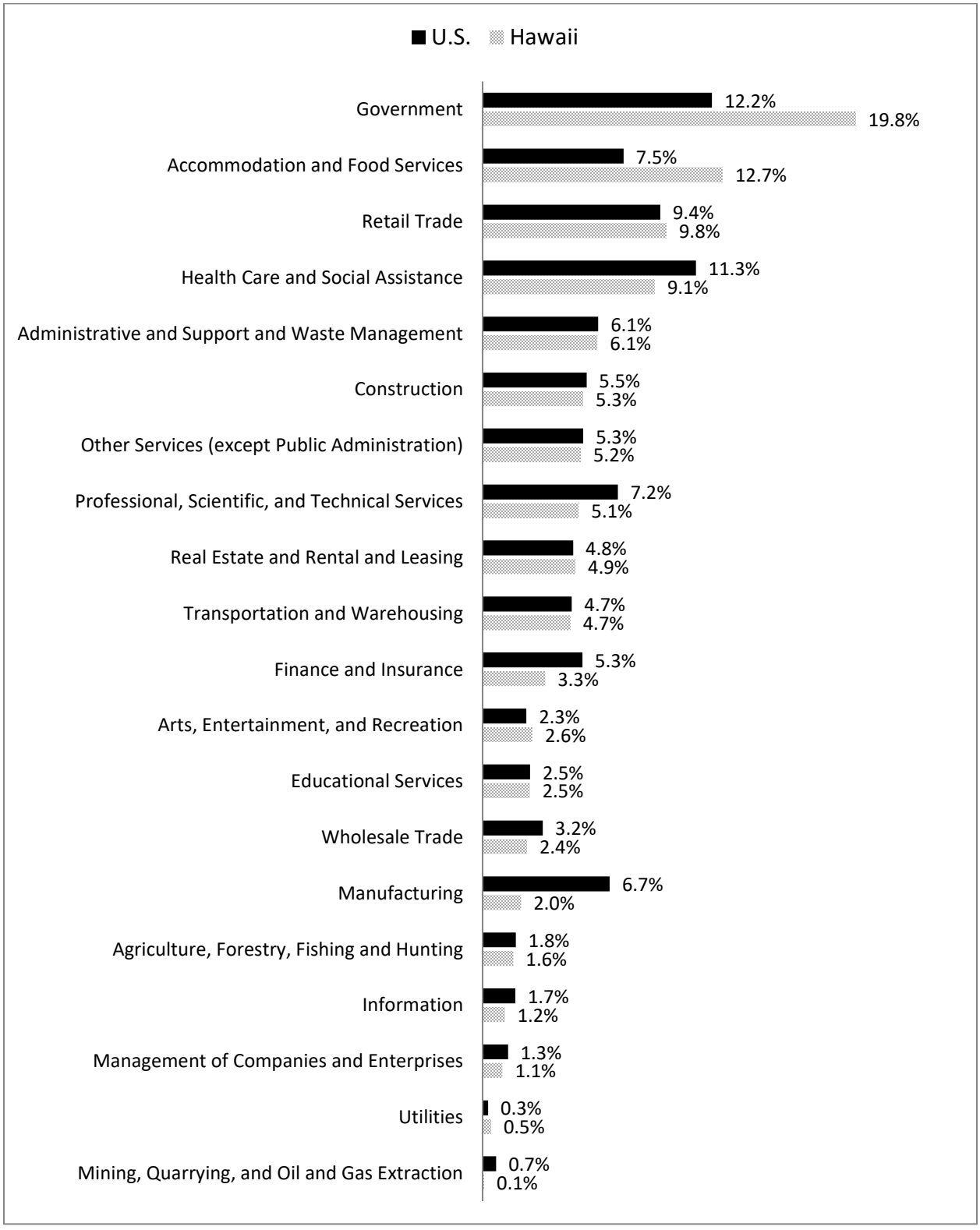
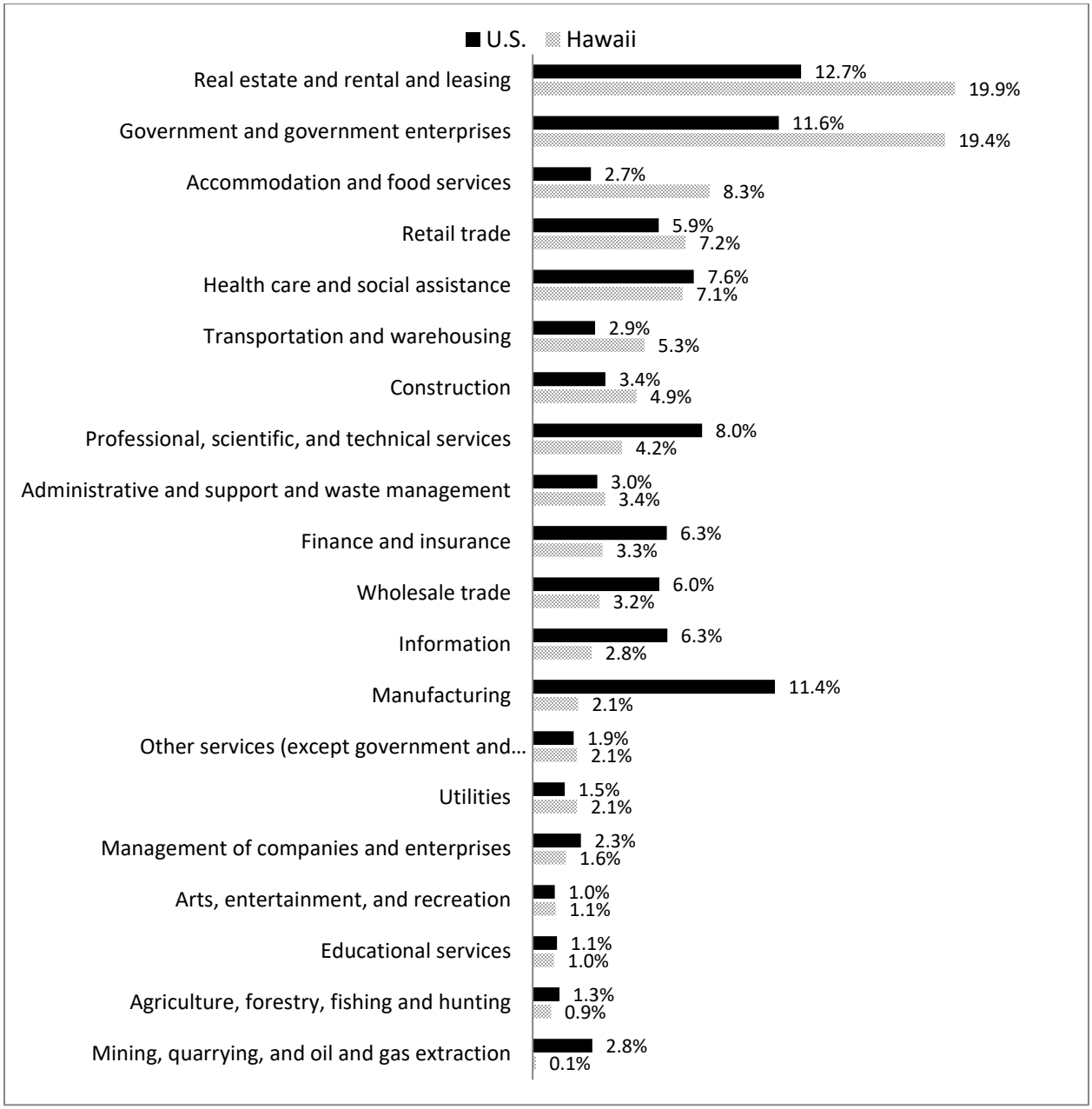


Figure 4. Employment Shares by Industry for the U.S. and Hawaii, 2019



The industrial distributions of 2019 real GDP in the U.S. and Hawaii shown in Figure 5 can be used to compare shares of industries in total employment relative to total GDP. Notably, the share of real estate in real GDP was about 4 times higher than that sector's share in total employment. One of the reasons for this is the inclusion of imputed value of owner-occupied dwellings in total GDP, even if it makes no contribution to total employment. Similarly, the GDP share of the utilities sector was about 4 times higher than their respective employment share. On the other hand, the GDP shares of accommodation and food service and retail trade were considerably smaller than their respective employment shares. This could perhaps be due to higher proportions of part-time jobs and generally lower wages in these sectors.

Figure 5. Real GDP Shares by Industry for the U.S. and Hawaii, 2019

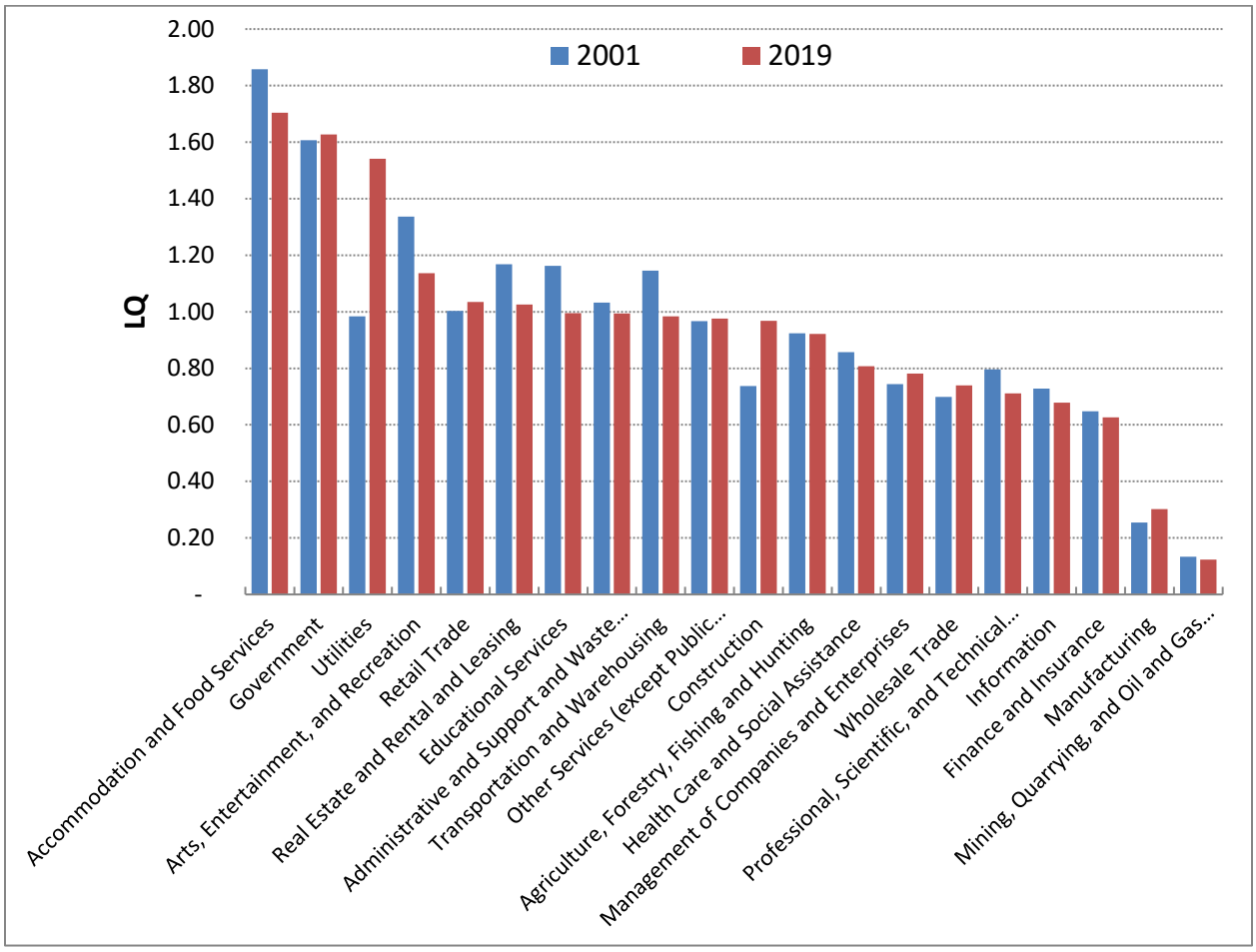


3.3. Location Quotients (LQ)

As mentioned previously, location quotients (LQs) are used as a tool to target industrial sectors to promote regional economic growth by expanding exports. The LQs are calculated as industries' employment shares for a region divided by the corresponding industries' shares in the U.S. as a whole. A LQ greater than 1.0 indicates a higher local employment concentration of an industry relative to the U.S. Sectors with a LQ greater than 1.0 are known as basic sectors, and it is assumed that part of their output is exported outside the region. Sectors with a LQ less than 1.0 are defined as non-basic sectors and part of their regional demand is expected to be met by imports. Values less than 1.0 indicate a lower local employment concentration in that industry. The LQ greater than 1.0 suggests a comparative advantage, while LQ less than 1.0 suggests a comparative disadvantage.

As expected, most of the tourism-related sectors, including accommodation and food service; arts, entertainment and recreation; retail trade; and real estate were found to be basic sectors in Hawaii. Because of large federal government activity, the government sector also had a LQ of greater than one. From 2001 to 2019, utilities changed from a non-basic to a basic sector. All other sectors in Hawaii were mostly non-basic in 2019 (Figure 6).

Figure 6. Hawaii's Employment Location Quotients by Industry, 2001 and 2019



3.4. Measures of Economic Diversity for Hawaii

In this report, 2001-2019 EMSI data on total jobs (wage and salary plus proprietors' jobs) by two-digit NAICS industry were utilized to compute the various indexes of economic diversity for Hawaii. This report also examined the diversification patterns over time using 2001-2019 BEA data on real GDP by two-digit NAICS.

Among the various indexes proposed under different economic theories presented in Section 2 of this report, the Entropy, Herfindahl (HHI), and Hachman indexes were computed. A higher Entropy index means that the shares of all sectors in total employment or real GDP are more equal (more diversification), while a lower HHI means more diversification.

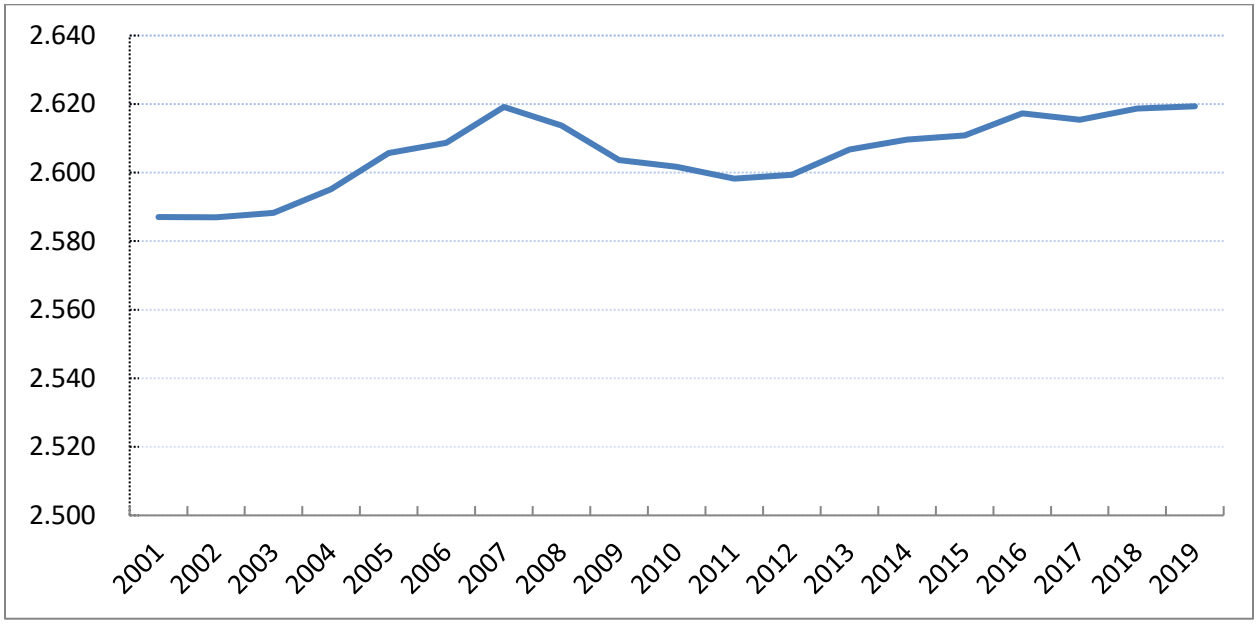
Since the Hachman index tells how similar or dissimilar a regional economy is relative to the national economy, this index is perhaps a more suitable measure for comparing diversity among regions or states. A Hachman index that equals one means that the region has exactly the same industrial structure as the U.S.

Entropy Index and Herfindahl Index

The Entropy index of economic diversity for Hawaii are shown in Figures 7 and 8. The Entropy index for total job are shown in Figure 7 and those for real GDP are shown in Figure 8.

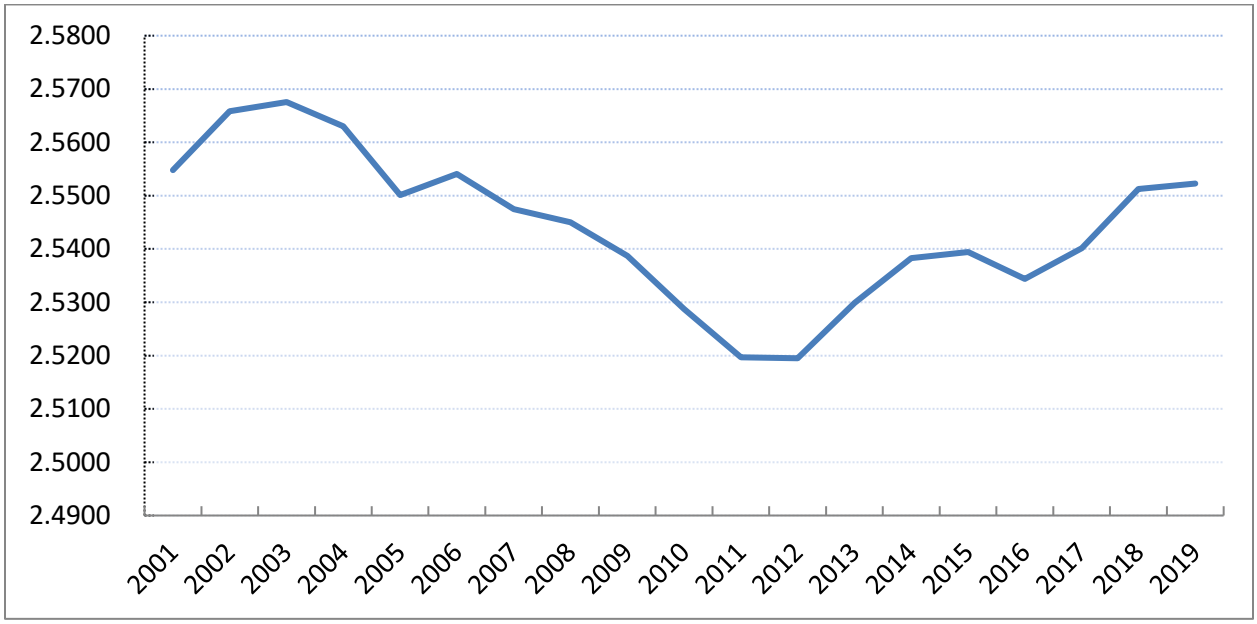
As shown in Figure 7, the Entropy index for total job in Hawaii increased from 2001 to 2007, decreased from 2007 to 2011, and then increased from 2011 to 2019. From 2001 to 2019, Hawaii became diversified based on total jobs, though the increased diversification was somewhat limited.

Figure 7. Hawaii Entropy Index of Employment, 2001-2019



Based on the Entropy index of real GDP, however, Hawaii became less diversified from 2001 to 2019. As shown in Figure 8, based on Entropy index of real GDP, Hawaii grew more diversified from 2001 to 2003, lost diversification from 2003 to 2012, and increased economic diversity from 2012 to 2019.

Figure 8. Hawaii Entropy Index of Real GDP, 2001-2019



In all cases the Entropy values were estimated to be larger than zero (the Entropy value of zero would imply the maximum specialization), indicating that Hawaii's economy is a fairly diversified economy (using 20 industries, a perfectly diverse economy where all the industries had the same share of employment or GDP would have an Entropy index of close to 3).

The sector's contributions to the employment Entropy index are provided in Table 3. From 2001 to 2019, Hawaii's employment Entropy index increased 1.2 percent from 2.587 to 2.619 (more diversification). The increased job shares in real estate and rental and leasing, construction, transportation and warehousing, health care and social assistance, and management of companies and enterprises were mostly offset by decreased shares in wholesale trade, agriculture, forestry, fishing and hunting, retail trade, manufacturing, government, and information.

Table 3. Industry Contribution to Employment Entropy Index in 2001 and 2019

	Share in Total Jobs (%)		Components of Entropy		
			Index	Index	Change
	2001	2019	2001	2019	01-19
Real Estate and Rental and Leasing	4.0	4.9	0.129	0.148	0.020
Construction	4.4	5.3	0.137	0.156	0.019
Transportation and Warehousing	3.8	4.7	0.124	0.143	0.019
Health Care and Social Assistance	7.8	9.1	0.200	0.219	0.019
Management of Companies and Enterprises	0.8	1.1	0.039	0.048	0.009
Educational Services	2.2	2.5	0.084	0.092	0.008
Accommodation and Food Services	12.0	12.7	0.255	0.262	0.008
Finance and Insurance	3.1	3.3	0.109	0.113	0.005
Utilities	0.4	0.5	0.021	0.024	0.004
Professional, Scientific, and Technical Services	4.9	5.1	0.148	0.152	0.003
Arts, Entertainment, and Recreation	2.5	2.6	0.094	0.096	0.002
Mining, Quarrying, and Oil and Gas Extraction	0.1	0.1	0.005	0.006	0.001
Administrative and Support and Waste Management	6.0	6.1	0.170	0.171	0.001
Other Services (except Public Administration)	5.2	5.2	0.153	0.154	0.001
Wholesale Trade	2.6	2.4	0.096	0.088	-0.007
Agriculture, Forestry, Fishing and Hunting	2.1	1.6	0.081	0.067	-0.014
Retail Trade	11.0	9.8	0.242	0.227	-0.015
Manufacturing	2.6	2.0	0.095	0.079	-0.016
Government	22.7	19.8	0.336	0.321	-0.016
Information	1.8	1.2	0.071	0.052	-0.019
Total	**100.0**	**100.0**	**2.587**	**2.619**	**0.032**

Source: EMSI and DBEDT READ

The sector's contributions to the real GDP Entropy index are provided in Table 4. From 2001 to 2019, Hawaii's real GDP Entropy index decreased 0.1 percent from 2.555 to 2.552 (becoming less diverse). The increased real GDP shares in transportation and warehousing, information, real estate and rental and leasing, administrative and support and waste management, and health care and social assistance were more than offset by decreased shares in manufacturing, wholesale trade, construction, government and government enterprises, accommodation and food services, and other services.

Table 4. Industry Contribution to Real GDP Entropy Index in 2001 and 2019

	Share in Real GDP		Components of Entropy Index		
	2001	2019	2001	2019	Change 01-19
Transportation and warehousing	0.036	0.053	0.120	0.155	0.035
Information	0.018	0.028	0.072	0.100	0.028
Real estate and rental and leasing	0.161	0.199	0.294	0.321	0.027
Administrative and support and waste management	0.027	0.034	0.096	0.115	0.019
Health care and social assistance	0.062	0.071	0.172	0.187	0.015
Utilities	0.019	0.021	0.075	0.081	0.006
Professional, scientific, and technical services	0.040	0.042	0.129	0.134	0.004
Management of companies and enterprises	0.015	0.016	0.062	0.065	0.003
Retail trade	0.073	0.072	0.190	0.189	-0.001
Finance and insurance	0.033	0.033	0.114	0.113	-0.001
Mining, quarrying, and oil and gas extraction	0.002	0.001	0.014	0.009	-0.004
Agriculture, forestry, fishing and hunting	0.010	0.009	0.046	0.041	-0.004
Arts, entertainment, and recreation	0.012	0.011	0.054	0.049	-0.005
Educational services	0.013	0.010	0.056	0.046	-0.009
Manufacturing	0.027	0.021	0.097	0.083	-0.014
Wholesale trade	0.038	0.032	0.124	0.109	-0.015
Construction	0.058	0.049	0.165	0.148	-0.017
Government and government enterprises	0.227	0.194	0.336	0.318	-0.018
Accommodation and food services	0.098	0.083	0.228	0.207	-0.020
Other services	0.033	0.021	0.112	0.081	-0.031
Total	**1.000**	**1.000**	**2.555**	**2.552**	**-0.003**

Source: BEA and DBEDT READ

An alternative measure of diversification is the Herfindahl index or HHI. Unlike the Entropy index, a lower value of HHI means more diversification of the economy. Based on employment HHI, Hawaii was more diversified from 2001 to 2007, less diversified from 2007 to 2011, and more diversified from 2011 to 2019. This pattern is the same as the pattern based on the Entropy index using total jobs. As shown in Table 5, from 2001 to 2019, Hawaii's employment HHI decreased 8.1 percent from 1,019.5 to 936.6 (increased diversification).

Table 5. Industry Contribution to Employment HHI in 2001 and 2019

	Share in Total Jobs		Components of HHI		
			Index	Index	Change
	2001	2019	2001	2019	01-19
Government	22.7	19.8	513.1	391.7	-121.4
Retail Trade	11.0	9.8	120.3	95.2	-25.1
Manufacturing	2.6	2.0	6.8	4.1	-2.6
Information	1.8	1.2	3.1	1.4	-1.7
Agriculture, Forestry, Fishing and Hunting	2.1	1.6	4.4	2.7	-1.7
Wholesale Trade	2.6	2.4	6.9	5.5	-1.3
Mining, Quarrying, and Oil and Gas Extraction	0.1	0.1	0.0	0.0	0.0
Utilities	0.4	0.5	0.1	0.2	0.1
Other Services (except Public Administration)	5.2	5.2	26.9	27.1	0.3
Management of Companies and Enterprises	0.8	1.1	0.7	1.1	0.5
Arts, Entertainment, and Recreation	2.5	2.6	6.5	7.0	0.5
Administrative and Support and Waste Management	6.0	6.1	36.6	37.2	0.6
Finance and Insurance	3.1	3.3	9.8	11.0	1.2
Educational Services	2.2	2.5	4.8	6.3	1.4
Professional, Scientific, and Technical Services	4.9	5.1	24.3	26.0	1.7
Transportation and Warehousing	3.8	4.7	14.2	21.7	7.5
Real Estate and Rental and Leasing	4.0	4.9	15.9	24.2	8.3
Construction	4.4	5.3	19.3	28.5	9.2
Accommodation and Food Services	12.0	12.7	144.4	162.1	17.7
Health Care and Social Assistance	7.8	9.1	61.4	83.4	22.0
Total	**100.0**	**100.0**	**1,019.5**	**936.6**	**-82.9**

Source: EMSI and DBEDT READ

As shown in Table 6, from 2001 to 2019, Hawaii's real GDP HHI decreased 1.1 percent from 1,085.7 to 1,073.9, indicating increased diversification. This is a different result from the Entropy index using real GDP.

Table 6. Industry Contribution to Real GDP HHI in 2001 and 2019

	Share in Real GDP		Components of HHI		
			Index	Index	Change
	2001	2019	2001	2019	01-19
Government and government enterprises	22.7	19.4	513.4	377.7	-135.7
Accommodation and food services	9.8	8.3	95.8	69.6	-26.3
Construction	5.8	4.9	33.3	24.0	-9.3
Other services	3.3	2.1	10.7	4.4	-6.4
Wholesale trade	3.8	3.2	14.3	10.0	-4.4
Manufacturing	2.7	2.1	7.1	4.6	-2.5
Retail trade	7.3	7.2	52.7	51.8	-0.9
Educational services	1.3	1.0	1.6	1.0	-0.6
Arts, entertainment, and recreation	1.2	1.1	1.5	1.2	-0.4
Finance and insurance	3.3	3.3	11.2	10.9	-0.3
Agriculture, forestry, fishing and hunting	1.0	0.9	1.0	0.8	-0.2
Mining, quarrying, and oil and gas extraction	0.2	0.1	0.0	0.0	0.0
Management of companies and enterprises	1.5	1.6	2.1	2.5	0.3
Utilities	1.9	2.1	3.6	4.4	0.8
Professional, scientific, and technical services	4.0	4.2	16.2	17.8	1.5
Information	1.8	2.8	3.2	7.8	4.6
Administrative and support and waste management	2.7	3.4	7.0	11.7	4.6
Health care and social assistance	6.2	7.1	38.4	50.0	11.6
Transportation and warehousing	3.6	5.3	13.0	27.8	14.8
Real estate and rental and leasing	16.1	19.9	259.3	396.3	136.9
Total	**100.0**	**100.0**	**1,085.7**	**1,073.9**	**-11.8**

Source: BEA and DBEDT READ

A comparison of the Entropy index and the Herfindahl index (HHI) using total jobs in Hawaii from 2001 to 2019 is provided in Table 7. A comparison of the Entropy index and HHI using real GDP in Hawaii from 2001 to 2019 are provided in Table 8. Note that because a lower HHI indicates increased diversification, the last column of the following tables (HHI scaled to HHI in 2001) will have a value of less than 100 when there is more economic diversification.

Table 7. Entropy and Herfindahl Index of Employment in Hawaii, 2001-2019

	Diversification Index		2001=100	
	Entropy	HHI	Entropy	HHI
2001	2.587	1,019	100.0	100.0
2002	2.587	1,022	100.0	100.2
2003	2.588	1,013	100.0	99.4
2004	2.595	997	100.3	97.8
2005	2.606	972	100.7	95.3
2006	2.609	963	100.8	94.5
2007	2.619	947	101.2	92.9
2008	2.614	962	101.0	94.4
2009	2.604	986	100.6	96.7
2010	2.602	990	100.6	97.1
2011	2.598	990	100.4	97.1
2012	2.599	987	100.5	96.8
2013	2.607	972	100.8	95.3
2014	2.610	965	100.9	94.6
2015	2.611	960	100.9	94.2
2016	2.617	945	101.2	92.7
2017	2.615	943	101.1	92.5
2018	2.619	936	101.2	91.8
2019	2.619	937	101.2	91.9

Source: EMSI and DBEDT READ

Table 8. Entropy and Herfindahl Index of Real GDP in Hawaii, 2001-2019

	Diversification Index		2001=100	
	Entropy	HHI	Entropy	HHI
2001	2.555	1,086	100.0	100.0
2002	2.566	1,070	100.4	98.6
2003	2.568	1,059	100.5	97.5
2004	2.563	1,058	100.3	97.4
2005	2.550	1,067	99.8	98.3
2006	2.554	1,062	100.0	97.8
2007	2.547	1,073	99.7	98.8
2008	2.545	1,091	99.6	100.5
2009	2.539	1,118	99.4	103.0
2010	2.529	1,132	99.0	104.2
2011	2.520	1,140	98.6	105.0
2012	2.519	1,137	98.6	104.8
2013	2.530	1,118	99.0	102.9
2014	2.538	1,105	99.4	101.8
2015	2.539	1,098	99.4	101.1
2016	2.534	1,106	99.2	101.9
2017	2.540	1,090	99.4	100.4
2018	2.551	1,073	99.9	98.8
2019	2.552	1,074	99.9	98.9

Source: BEA and DBEDT READ

Hachman Index

The Hachman index accounts for disparity between the economic structure of a region and that of a reference economy. In estimating the Hachman measure of economic diversity for a state or a region, it has been a standard practice to use the U.S. as the reference economy.[5] The Hachman index shows how similar or dissimilar a given region's economic structure is relative to that of the U.S. Hachman index values closer to one would mean that the region's economic structure is very similar to that of the nation. Values closer to zero would mean that the region has a very different industrial structure as compared to the nation.

Figure 9 shows the results for the Hachman index of total job diversification for Hawaii, while Figure 10 shows the corresponding results for real GDP diversification. For total jobs, the estimated Hachman values were closer to one than to zero, meaning that Hawaii's total job structure is relatively similar to that of the U.S. as a whole. For real GDP, the estimated Hachman values were significantly lower than the corresponding Hachman indexes for total jobs, meaning that Hawaii's real GDP structure is relatively less similar to the U.S. compared with the total job structure.

[5] Studies involving counties have also used the state as the reference in computing the Hachman index.

In addition, the trends of total job Hachman index and real GDP Hachman index are different. From 2001 to 2019, the Hachman total job index increased while the Hachman real GDP index decreased. This means that while Hawaii job structure is becoming more similar to the U.S. over time, the real GDP structure has generally become less similar to the U.S. over time.

Figure 9. Hawaii Hachman Index of Employment, 2001-2019

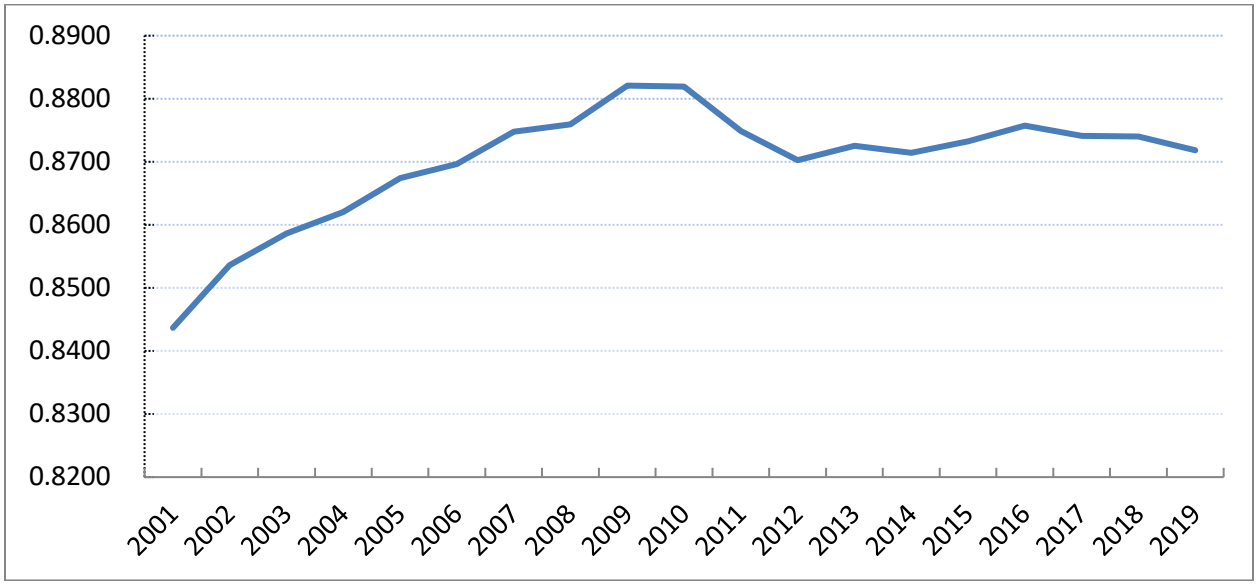
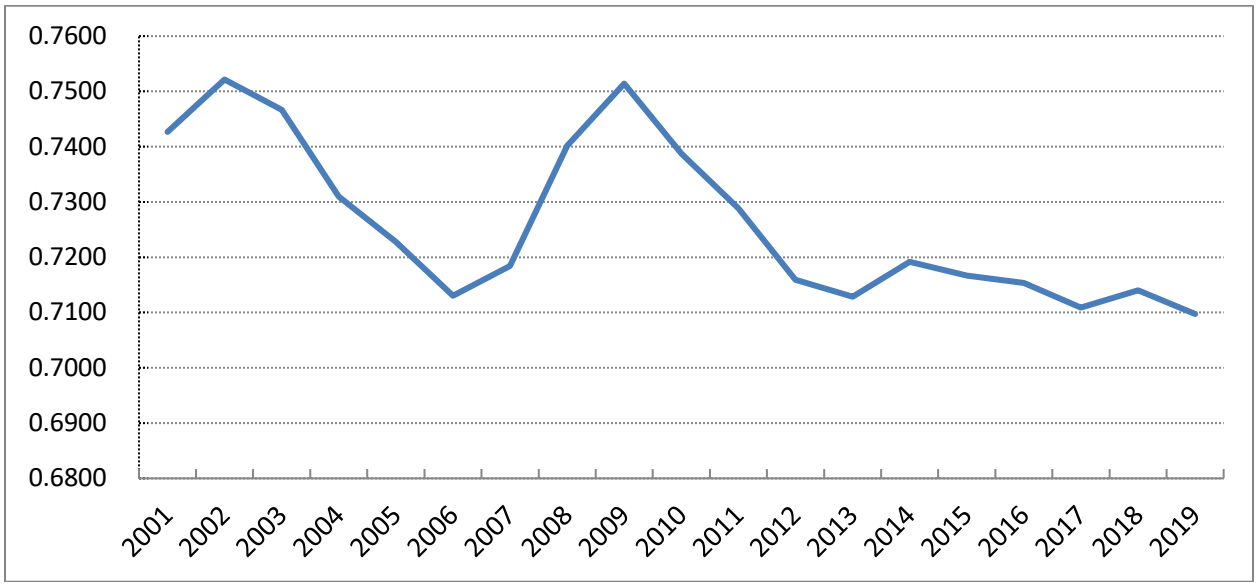


Figure 10. Hawaii Hachman Index of Real GDP, 2001-2019



The Hawaii Hachman index of employment and real GDP are provided in Table 9.

Table 9. Hawaii Hachman Index of Employment and Real GDP

	Hachman Index	
	Total Job	Real GDP
2001	0.844	0.743
2002	0.854	0.752
2003	0.859	0.747
2004	0.862	0.731
2005	0.867	0.723
2006	0.870	0.713
2007	0.875	0.718
2008	0.876	0.740
2009	0.882	0.751
2010	0.882	0.739
2011	0.875	0.729
2012	0.870	0.716
2013	0.873	0.713
2014	0.871	0.719
2015	0.873	0.717
2016	0.876	0.715
2017	0.874	0.711
2018	0.874	0.714
2019	0.872	0.710

Source: EMSI, BEA, DBEDT READ

3.5. Shift-Share Analysis

A problem with indexes of diversification is their lack of diagnostic information. Since most diversity indexes found in the literature are aggregate measures and provide little information about the performance of individual industries, the results may have very limited use in understanding root economic problems or formulating policy. Most of the recent literature on industrial organization and regional economics relate to shift-share analysis as opposed to computing indexes for diversity. By decomposing a region's sector-specific growth in economic activity into three components, namely the national effect, industrial-mix effect and competitive share effect, the shift share analysis provides much more useful information about the substructure of the regional economy and for advancing development policies.

In this report, a dynamic shift-share analysis is applied to annual total job growth between 2001 and 2019.[6] To account for different economic conditions, the study period is broken down to two sub-periods – 2001 to 2007 (Table 10) and 2007 to 2019 (Table 11).

Hawaii added 179,829 jobs between 2001 and 2019, an increase of 23.9 percent. Of this, 113,496 jobs were added between 2001 and 2007 and 66,333 jobs were added between 2007 and 2019.

Table 10. Dynamic Shift-Share Analysis of Employment by Industry, 2001-2007

	Change (2001-2007)	National growth effect	Industrial mixed effect	Competitive Share effect
Agriculture, Forestry, Fishing and Hunting	-168	1,325	-2,336	843
Mining, Quarrying, and Oil and Gas Extraction	276	41	86	149
Utilities	496	232	-396	660
Construction	18,451	2,769	2,532	13,150
Manufacturing	-559	1,642	-4,500	2,300
Wholesale Trade	2,356	1,656	-590	1,290
Retail Trade	5,546	6,922	-3,572	2,197
Transportation and Warehousing	5,472	2,380	215	2,877
Information	-372	1,118	-2,550	1,060
Finance and Insurance	4,943	1,977	798	2,167
Real Estate and Rental and Leasing	10,227	2,519	8,734	-1,027
Professional, Scientific, and Technical Services	7,978	3,111	3,086	1,782
Management of Companies and Enterprises	1,680	510	-22	1,192
Administrative and Support and Waste Management	11,432	3,816	2,708	4,908
Educational Services	5,279	1,389	2,316	1,574
Health Care and Social Assistance	11,040	4,944	5,871	225
Arts, Entertainment, and Recreation	3,528	1,609	1,652	268
Accommodation and Food Services	10,973	7,585	4,486	-1,098
Other Services (except Public Administration)	5,713	3,271	952	1,489
Government	9,205	14,296	-7,005	1,914
Total	**113,496**	**63,112**	**12,465**	**37,920**

Source: EMSI and DBEDT READ

[6] Most shift-share applications to regional employment changes have examined changes between the beginning and end years of the time interval, thereby failing to account for changes in industrial mix. The results obtained from this comparative static approach can be problematic if there are significant changes in industrial structure over time. This problem can be eliminated by calculating the national growth effect, the industrial mix effect, and the competitive effect in an annual basis and then summing the results over the study period. This approach is called dynamic shit-share analysis (Barff and Knight, 1988).

Table 11. Dynamic Shift-Share Analysis of Employment by Industry, 2007-2019

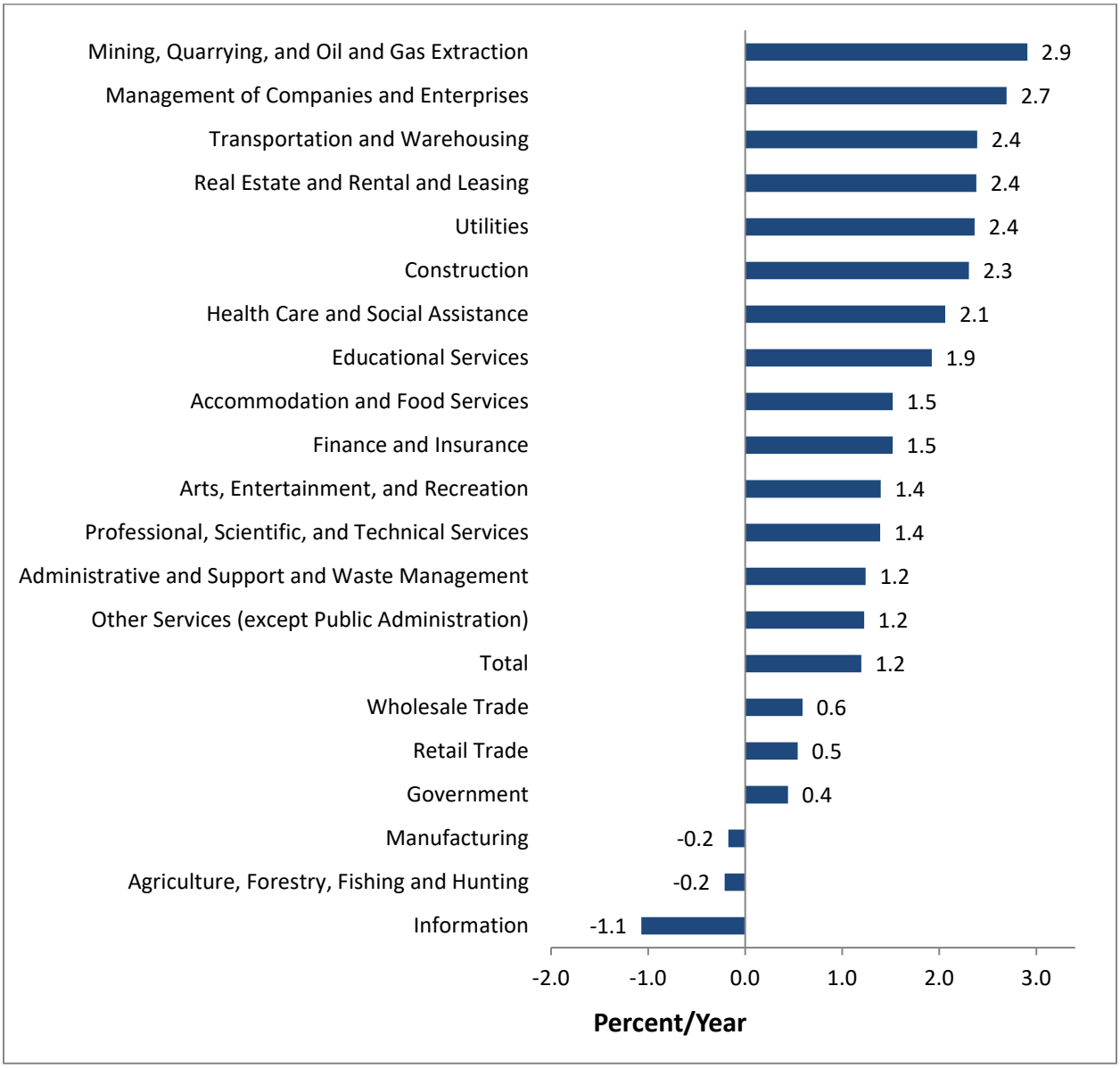
	Change (2007-2019)	National growth effect	Industrial mixed effect	Competitive Share effect
Agriculture, Forestry, Fishing and Hunting	-426	2,076	-1,750	-752
Mining, Quarrying, and Oil and Gas Extraction	55	102	225	-271
Utilities	950	432	-354	871
Construction	-1,683	6,833	-7,857	-658
Manufacturing	-45	2,526	-3,584	1,013
Wholesale Trade	-148	2,936	-3,185	102
Retail Trade	2,884	11,698	-10,217	1,403
Transportation and Warehousing	9,589	4,496	16,418	-11,325
Information	-1,977	1,721	-1,955	-1,742
Finance and Insurance	2,420	3,787	2,011	-3,378
Real Estate and Rental and Leasing	5,643	5,346	4,972	-4,676
Professional, Scientific, and Technical Services	2,513	5,985	3,928	-7,400
Management of Companies and Enterprises	2,059	1,031	2,154	-1,126
Administrative and Support and Waste Management	-95	7,560	-500	-7,155
Educational Services	1,500	2,900	4,399	-5,800
Health Care and Social Assistance	15,167	9,295	10,618	-4,746
Arts, Entertainment, and Recreation	1,922	3,016	3,322	-4,416
Accommodation and Food Services	17,313	13,469	12,061	-8,217
Other Services (except Public Administration)	3,857	5,939	-1,276	-806
Government	4,834	23,863	-21,016	1,988
Total	66,333	115,009	8,414	-57,091

Source: EMSI and DBEDT READ

3.6. *Hawaii Economic Performance by Industry*

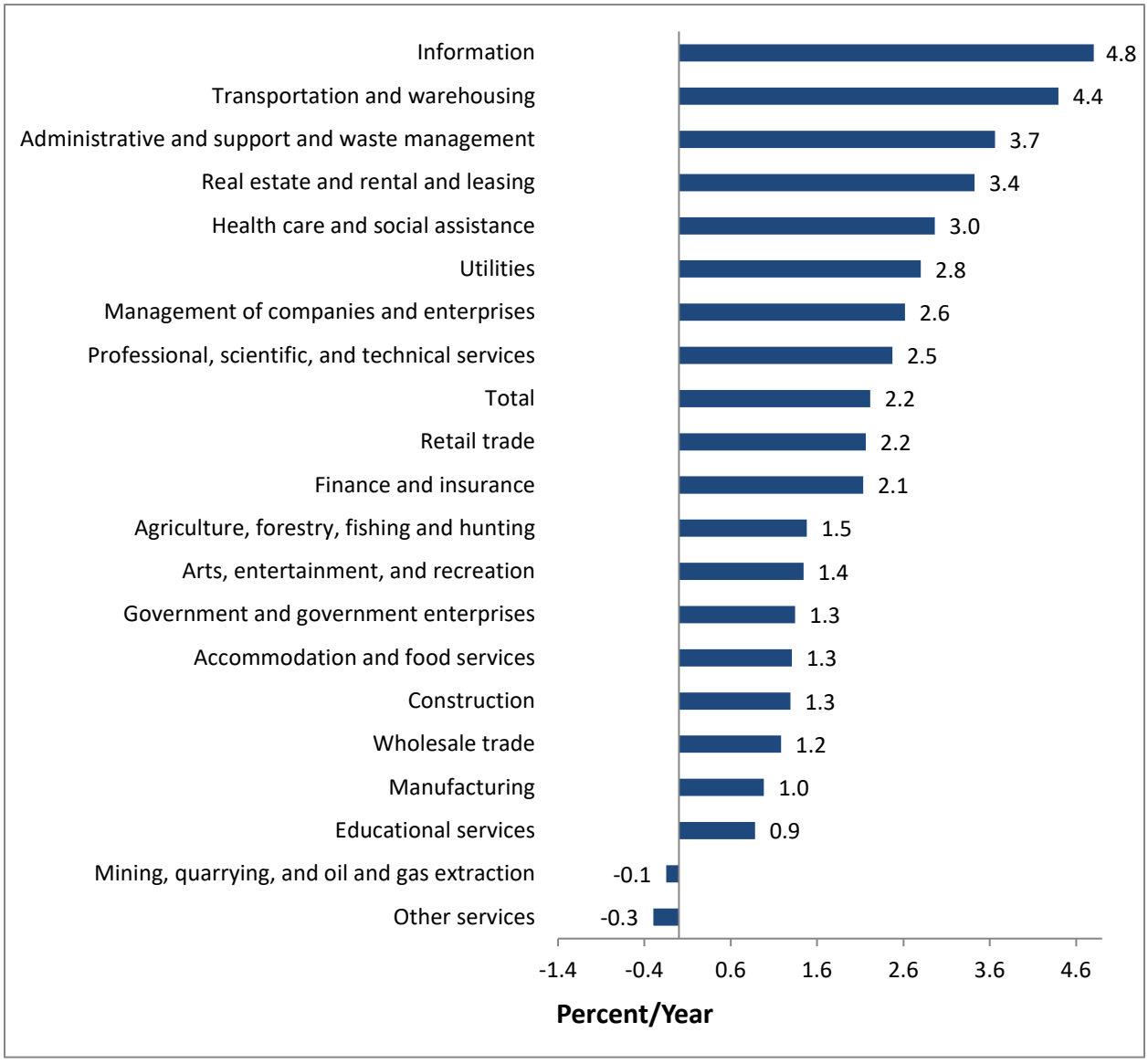
The economic performance of different sectors in Hawaii has some variation. Figure 11 shows the employment annual average growth rate from 2001 to 2019 by sectors in Hawaii. For employment, the mining sector experienced the fastest growth at 2.9 percent, followed by management of companies & enterprises at 2.7 percent, and transportation and warehousing, real estate and rental and leasing, and retail trade at 2.4 percent each. Information had the most negative growth at -1.1 percent, followed by agriculture, forestry, fishing and hunting at -0.2 percent and manufacturing at -0.2 percent.

Figure 11. Hawaii Employment Annual Average Growth Rate by Industry, 2001-2019



Economic growth based on real GDP contrasts significantly from that of the employment. As shown in Figure 12, despite job growth in the other service sector and mining sector, these two sectors had the lowest GDP growth rate from 2001 to 2019 at -0.3 percent and -0.1 percent, respectively. For real GDP, the information sector experienced the fastest growth at 4.8 percent, followed by transportation and warehousing at 4.4 percent, administrative support & waste management at 3.7 percent, and real estate and rental and leasing at 3.4 percent.

Figure 12. Hawaii Real GDP Annual Average Growth Rate by Industry, 2001-2019



Sectors with high growth rate but a small share of the economy only have limited contribution on the total economy. Figure 13 shows the contributions to total additional jobs from 2001 to 2019 by sector. The top five sectors that contributed the most on total additional jobs in Hawaii are accommodation and food Services (15.6%), health care and social assistance (14.5%), construction (9.3%), real estate and rental and leasing (8.8%), and transportation and warehousing (8.3%). The top sectors that lost the most jobs are information (-1.3%), manufacturing (-0.3%), and agriculture, forestry, fishing and hunting (-0.3%).

Figure 13. Hawaii Industry Contributions to Additional Jobs from 2001 to 2019

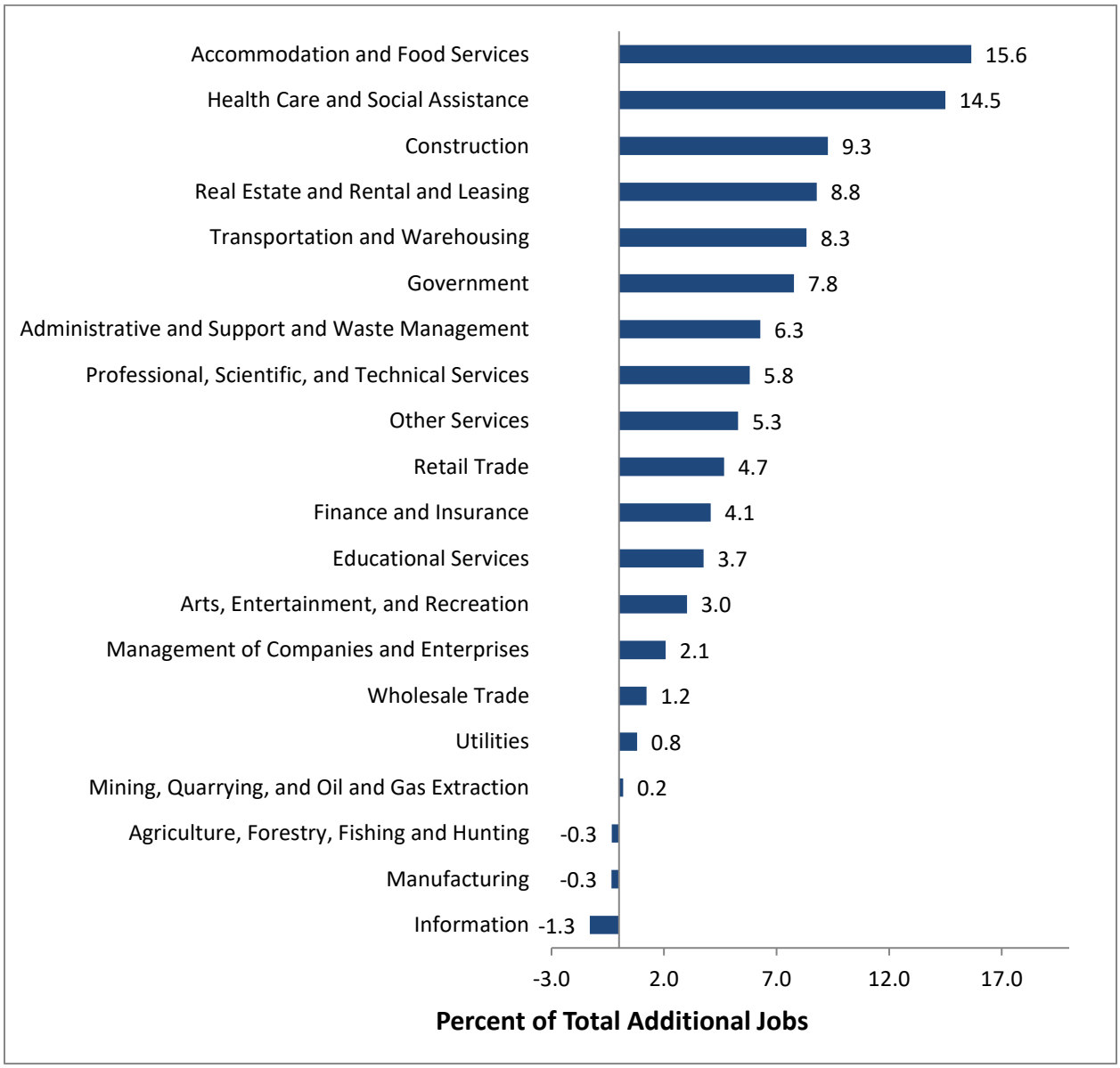


Figure 14 shows the contributions to total additional real GDP from 2001 to 2019 by sector. The top five sectors that contributed the most on total additional real GDP in Hawaii are real estate and rental and leasing (29.0%), government and government enterprises (13.1%), health care and social assistance (8.8%), retail trade (8.3%), and accommodation & food services (5.9%). The only sector that lost real GDP relative to the others is other services (-0.9%).

Figure 14. Hawaii Industry Contributions to Additional Real GDP from 2001 to 2019

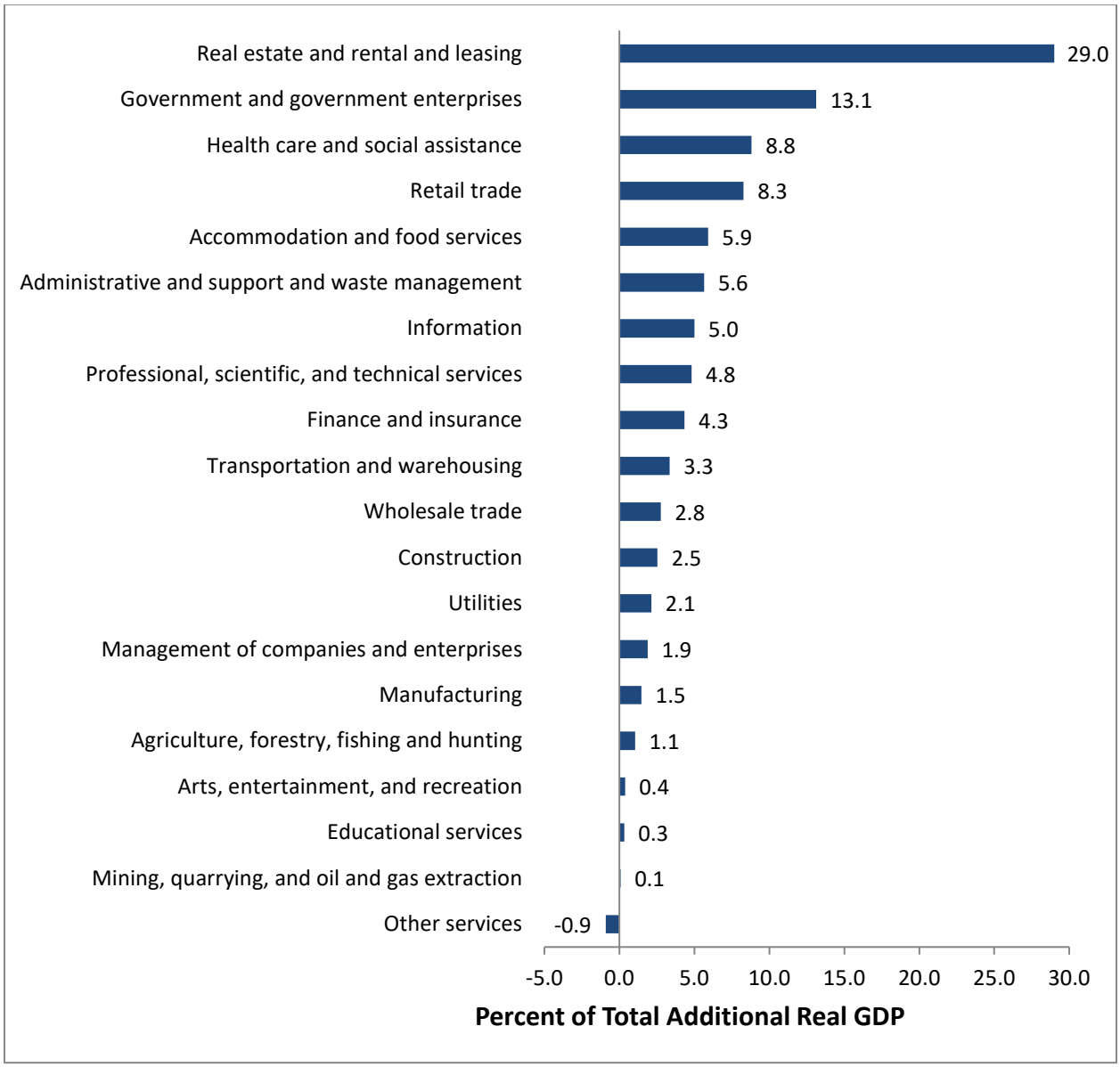


Figure 15 compares Hawaii's employment shares by sector in 2001 and 2019. The top five sectors that increased the job shares the most from 2001 to 2019 are health care and social assistance (1.3 percentage point), construction (1.0 percentage point), real estate and rental and leasing (0.9 of a percentage point), transportation and warehousing (0.9 of a percentage point), and accommodation and food services (0.7 of a percentage point). The top sectors that decreased their jobs shares the most are government (-2.9 percentage points), retail trade (-1.2 percentage point), information (-0.6 of a percentage point), manufacturing (-0.6 of a percentage point), and agriculture, forestry, fishing and hunting (-0.5 of a percentage point).

Figure 15. Hawaii Employment Shares by Industry, 2001 and 2019

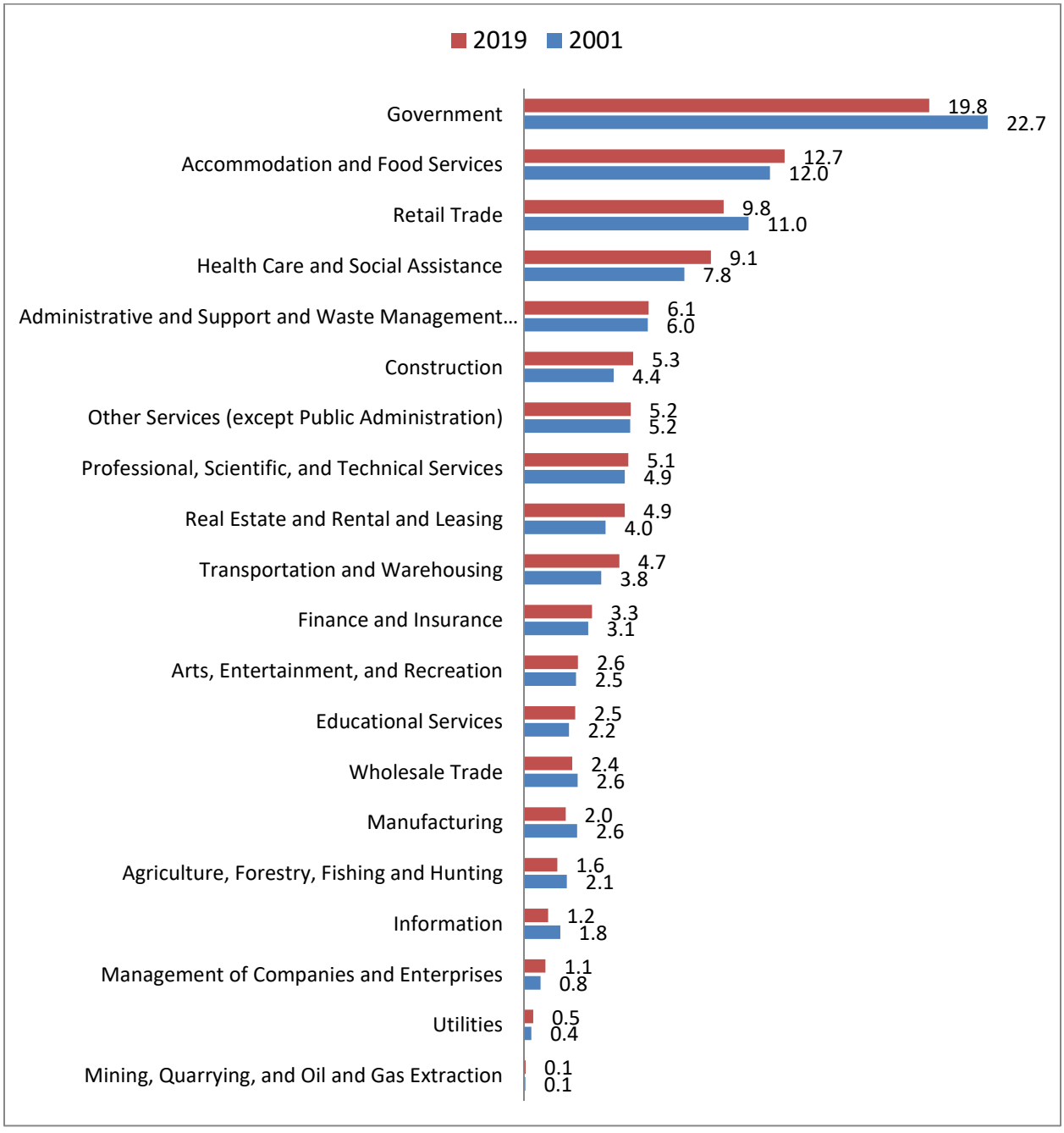
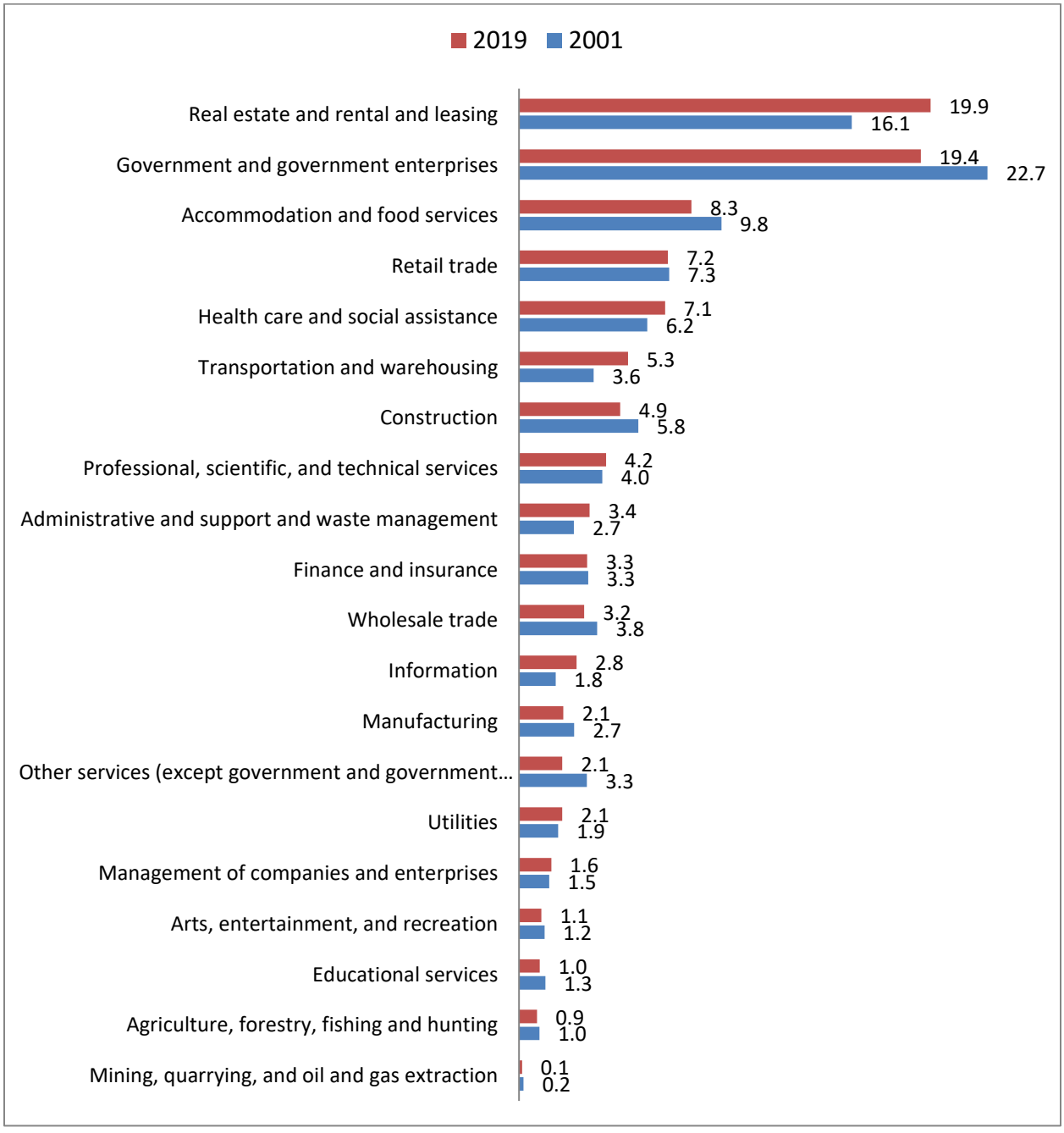


Figure 16 compares Hawaii's real GDP shares by sector in 2001 and 2019. The top five sectors that increased the real GDP shares the most from 2001 to 2019 are real estate and rental and leasing (3.8 percentage points), transportation and warehousing (1.7 percentage point), information (1.0 percentage point), health care and social assistance (0.9 of a percentage point), and administrative and support and waste management (0.8 of a percentage point). The top sectors that decreased their real GDP shares the most are government (-3.2 percentage points), accommodation and food services (-1.4 percentage point), other services (-1.2 percentage point), construction (-0.9 of a percentage point), and wholesale trade (-0.6 of a percentage point).

Figure 16. Hawaii Real GDP Shares by Industry, 2001 and 2019



4. Conclusions

With the decline in plantation agriculture (sugar and pineapple) and limited prospects for long-term growth in the tourism sector due to local capacity constraints and increased competition from emerging destinations worldwide, Hawaii's economic development efforts continue to embrace economic diversification as a means to promote economic growth and stability

One of the objectives of the report was to develop an appropriate measure for tracking the effectiveness of development efforts on diversification and its impact on economic performance to guide and develop appropriate diversification strategies. This research utilized three measures of economic diversity that have been established in the literature: the Entropy index, Herfindahl index (HHI), and Hachman index. Employment diversification between 2001 and 2019 was estimated using employment data from EMSI for 2001-2019. The real GDP diversification was estimated using real GDP data from BEA for 2001-2019.

Based on the Entropy index and HHI, Hawaii's employment became more diversified between 2001 and 2019. From 2001 to 2019, Hawaii's employment Entropy index increased 1.2 percent from 2.587 to 2.619, primarily due to increased job shares in real estate and rental and leasing, construction, transportation and warehousing, health care and social assistance, and management of companies and enterprises. This was offset by decreased shares in wholesale trade, agriculture, forestry, fishing and hunting, retail trade, manufacturing, government, and information.

An alternative measure of diversification is the Herfindahl index or HHI. Unlike the Entropy index, a lower value of HHI means more diversification of the economy. Based on employment HHI, Hawaii was more diversified from 2001 to 2007, less diversified from 2007 to 2011, and more diversified from 2011 to 2019. This pattern is the same as the pattern based on the Entropy index of total job. From 2001 to 2019, Hawaii's employment HHI decreased 8.1 percent from 1,019.5 to 936.6, indicating more diversification from 2001 to 2019.

The diversifications of real GDP from 2001 to 2019 based on the Entropy index and HHI have different results. Based on the Entropy index, Hawaii's real GDP was slightly less diversified between 2001 and 2019. Based on the HHI, Hawaii's real GDP was slightly more diversified. From 2001 to 2019, Hawaii's real GDP Entropy index decreased 0.1 percent from 2.555 to 2.552 (slightly less diversification). From 2001 to 2019, Hawaii's real GDP HHI decreased 1.1 percent from 1,085.7 to 1,073.9 (slightly more diversification).

The Hachman index shows how similar or dissimilar a given region's economic structure is relative to that of the U.S. Hachman index values closer to one would mean that the region's economic structure is very similar to that of the nation. Values closer to zero would mean that the region has a very different industrial structure as compared to the nation. For total jobs, the estimated Hachman values were closer to one than to zero, meaning that Hawaii's total job structure is relatively similar to that of the U.S. as a whole. For real GDP, the estimated Hachman values were lower than the corresponding Hachman indexes for total jobs, meaning that Hawaii's real GDP structure is relatively less similar to the U.S. compared with the total job structure.

The trends of total job Hachman index and real GDP Hachman index have evolved differently. From 2001 to 2019, the Hachman total job indexes increased while the Hachman real GDP index decreased. This means that Hawaii's job structure grew more similar to the U.S. over time, but the real GDP structure became less similar to the U.S. over time.

Location quotients provide more information about the structure of the economy by identifying areas of specialty and concentration. As expected, most of the tourism-related sectors, including accommodation and food service; arts, entertainment, and recreation; retail trade; and real estate were found to be basic (export) sectors in Hawaii. Because of large federal government activity, the government sector also had a LQ of greater than one. From 2001 to 2019, utility changed from a non-basic to a basic sector. All other sectors in Hawaii were mostly non-basic in 2019.

The top five sectors that increased the job shares the most from 2001 to 2019 in Hawaii are health care and social assistance (1.3 percentage point), construction (1.0 percentage point), real estate and rental and leasing (0.9 of a percentage point), transportation and warehousing (0.9 of a percentage point), and accommodation and food services (0.7 of a percentage point). The top sectors that decreased their jobs shares the most are government (-2.9 percentage points), retail trade (-1.2 percentage point), information (-0.6 of a percentage point), manufacturing (-0.6 of a percentage point), and agriculture, forestry, fishing and hunting (-0.5 of a percentage point).

The top five sectors that increased the real GDP shares the most from 2001 to 2019 are real estate and rental and leasing (3.8 percentage points), transportation and warehousing (1.7 percentage point), information (1.0 percentage point), health care and social assistance (0.9 of a percentage point), and administrative and support and waste management (0.8 of a percentage point). The top sectors that decreased their real GDP shares the most are government (-3.2 percentage points), accommodation and food services (-1.4 percentage point), other services (-1.2 percentage point), construction (-0.9 of a percentage point), and wholesale trade (-0.6 of a percentage point).

As Hawaii moves forward in the global economy, it is important to keep the eye on the ball of economic growth and utilize economic diversification as a tool for stable growth, rather than the end goal.

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