UHERO

THE ECONOMIC RESEARCH ORGANIZATION
AT THE UNIVERSITY OF HAWAIʻI

Potential opportunities to diversify the economy of Hawaiʻi

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Executive Summary

The economy of Hawai‘i is extraordinarily concentrated in the tourism industry. As a result of tourism’s dominance, Hawai‘i’s economy faces short-term risks from shocks that impact visitor numbers and long-term stagnation from flat and volatile tourism spending over the last three decades. In response to these issues—which became especially salient during the COVID-19 pandemic—policymakers in Hawai‘i increasingly emphasize the need to diversify. Still, it is not clear which industries Hawai‘i could diversify into.

To consider this question, we analyzed the locations of industries across the US and the industries in Hawai‘i’s counties to identify potential opportunities to diversify. The information in this report will be useful for policymakers seeking advice for economic development policy and for businesses and entrepreneurs seeking new opportunities. It also presents Hawai‘i as a case study of an approach that will be useful for other places looking to diversify. There are three main questions addressed in this report:

What is the case for diversifying the Hawai‘i economy?

Specializing is natural for a small open economy. Small and isolated economies are less able to access the productivity benefits of *external increasing returns to scale*. External increasing returns describe how the productivity of firms can increase with the size of something external to the firm such as a market, city, or industry. Small, open, and isolated places tend to become more specialized because it creates a *local* external scale—the scale of their industry specialization—that offers similar productivity advantages. Specialization initially generates growth due to external scale economies. But if various developmental barriers have prevented some industries from emerging, then Hawai‘i could be *over*-specialized. Specialization generates both short and long-term risks due to greater exposure to a single industry.

With this theoretical basis, we show how Hawai‘i initially benefited from specializing in the tourism industry and how this specialization now exposes Hawai‘i to short and long-term risks. These risks are especially apparent when we examine how total visitor spending has been relatively flat for decades and punctured by periodic crises. In this way, diversification is not an end in itself but aims to build a more resilient economy that is less exposed to the short- and long-term risks that to some extent can be expected in a small and open economy like Hawai‘i.

What are the opportunities for diversifying Hawai‘i’s economy?

To find diversification opportunities, we apply the *Principle of Relatedness* (Hidalgo et. al., 2018), which predicts regional diversification patterns and informs prioritization of economic development initiatives. We studied the industrial composition of all counties in the US to measure *relatedness* between industries. Two industries are described as related because they probably require similar conditions if they appear together frequently. With this understanding of the relationships between industries in US counties, we examine the industrial composition of Hawai‘i’s counties to identify underperforming industries with a higher probability of being stronger because they are related to existing strengths.

Several opportunities are related to the ocean. These ocean-based industries include *Finfish Fishing*, *Shellfish Fishing*, *Boat Building*, *Port and Harbor Operations*, *Finfish Farming and Hatcheries*, and *Seafood Preparation and Packaging*. These all seem logical diversification options given Hawai‘i’s location in the Pacific Ocean providing the necessary natural resource. Industries are also more likely to remain in the long term if they rely on local resources.

The results also offer the opportunity to prioritize the clusters that are related to Hawai‘i’s industries, which would support diversification both within clusters and beyond. Perhaps most notable of all, the *Fishing and Aquaculture* cluster stands out with a higher relatedness density also across all four counties. As expected, the two hospitality clusters of *Local Hospitality Establishments* and *Hospitality and Tourism* feature in all four counties, both serving tourists. A *Water Transportation* cluster features strongly in Honolulu, and moderately on Maui. And a

Video Production and Distribution cluster features moderately in Honolulu but is also an option for Maui and could be relevant on the Big Island and Kaua'i. Interestingly, this modern analysis of industrial location reflects in part what is already known to Kanaka Maoli, given Hawai'i's history of Polynesian ocean-faring and fishponds.

What is the appropriate policy response?

The results highlight the difficulty of diversifying. Many of the related industries on O'ahu are already thriving. And the Neighbor islands are more specialized in tourism, so have fewer branching opportunities. While related industries are expected to be more feasible, the weakness of the identified related industries indicates that they face developmental bottlenecks. Indeed, it is not surprising that the industries identified have a history of various start-up attempts and failures. It seems that these are industries that have potential but consistently fail because various developmental barriers exist such as infrastructure requirements, market failures, or government failures. Policies that address those bottlenecks would allow market discovery processes to support a more diversified economy.

Rather than an economic development policy that focuses on sectors that are already growing, policy efforts to diversify will be more productive if they target industries facing challenges that have not yet been adequately addressed. This is a new and ambitious approach because it targets the barriers to diversification, rather than targeting industries that are already showing signs of growth. Industries can be disregarded if those barriers are too difficult to address. But for many industries, there may be a role for cost-effective policies to address the developmental bottlenecks that are constraining those industries, enabling the market discovery process to diversify the economy.

Economists are cautious of policies that "pick winners" because the market combines private information, so any selection by policy-makers is unlikely to contain as much information as the market. But, our study is not intended to "pick winners". Rather, the principle of relatedness reveals additional information about Hawai'i's economy from market outcomes across the US—information that the market could not incorporate on its own. So, it can be used to prioritize initiatives where there may be developmental bottlenecks constraining these industries. Nonetheless, policymakers do not usually have the deep industry knowledge required to identify and address industry-specific bottlenecks. Instead, policies can be designed to reveal industry bottlenecks from private information and evaluated, in part, by the results of our study. Policies that address general or common bottlenecks are also likely to improve efficiency and support diversification. Ongoing monitoring and governance are required for policies to be effective.

The information in this report will be useful for Hawai'i policymakers seeking advice for economic development policy and businesses and entrepreneurs seeking new opportunities. It also presents Hawai'i as a case study of an approach that will be useful for other places looking for strategies to diversify.

1. Introduction

The economy of Hawai‘i is extraordinarily concentrated in the tourism industry (Bond-Smith and Fuleky, 2023). This generates two major risks for the economic well-being of Hawai‘i residents:

i. short-term volatility due to a vulnerability to any shocks that affect tourist numbers; and

ii. low growth in recent decades due to Hawai‘i being locked into the tourism industry, combined with stagnant long-term productivity growth in the local tourism industry.

Short-term volatility means that Hawai‘i residents risk periods of unemployment or income shocks. In the long-term, concentration in a single sector has resulted in low income and productivity growth in Hawai‘i since the Great Recession and arguably since the lost decade in Japan, triggered by their real estate and stock-market bubble that burst in 1991.

The dominance of tourism means that its economic performance is the main determinant of Hawai‘i’s economic outcomes. Visitor numbers and visitor spending are key parameters in UHERO’s quarterly forecast for the economy of Hawai‘i (Bonham et. al., 2024). Similarly, Hawai‘i’s economy is exposed to short-term fluctuations in the US and global economies and local shocks that affect visitor numbers (Bond-Smith and Fuleky, 2023). Hawai‘i’s economic outcomes are therefore much more volatile than more diversified regions of the US, but there are also long-term risks. While tourism generated significant growth in the three decades after statehood, tourism has experienced very low spending growth in the most recent three decades (Bond-Smith, 2024). Per-capita GDP has now fallen about 5% below the US from peaks at around 25% above the US in the 1970s and 80s. In response, many kama‘āina may feel that they have little option but to leave Hawai‘i to pursue opportunities on the continent, often citing Hawai‘i’s high cost of living. Continuing on this trajectory risks Hawai‘i falling further behind other places in the United States. This would further push residents to leave the state or to face a growing gap between the economic outcomes they achieve in Hawai‘i and potential opportunities on the mainland.

In response to these issues over decades, policy discussions in Hawai‘i have long focussed on how to diversify its economy. But diversification itself is not the ultimate goal. It is an intuitive reaction to the view that the economy is over-specialized. The real purpose of diversifying is to address the risks associated with a more specialized economy. It is therefore important to first reframe the goals of a diversification strategy. Ultimately, policymakers are aiming to build a more resilient economy that is less exposed to these short- and long-term risks. This does not mean simply adding many unproductive sectors. And it does not necessarily mean reducing tourism or replacing it with a new industry. Neither of these strategies would address the actual issues. A successful diversification strategy recognizes the goal of reducing risk as well as recognizing the ultimate causes of Hawai‘i’s specialized economy.

Diversification is not an argument against the tourism industry. There are substantial benefits generated by the gains from trade due to specializing in Hawai‘i’s comparative advantage and where it can take advantage of increasing returns to scale. Therefore, arbitrary restrictions on the tourism sector will hinder current productivity and incomes. Furthermore, Hawai‘i’s diversification opportunities build on its existing strengths, so efforts to restrict tourism may also undermine opportunities to diversify. There are still many valid arguments to shift Hawai‘i tourism towards more sustainable practices, but the focus of this study is to figure out what *additional industries* can grow in Hawai‘i. Any initiatives that would be developed based on the results of this report would be implemented alongside any initiatives that would aim to improve the sustainability of Hawai‘i’s tourism industry. New industries would inevitably lessen the role of tourism and improve Hawai‘i’s economic resilience by expanding the economy and incentivizing a shift in factors of production toward potentially more productive uses.

The challenge is to identify suitable new industries. The *Principle of Relatedness* (Hidalgo et. al., 2018) explains how economies grow by diversifying into related and higher-value industries that

branch out from the skills, infrastructure, institutions, and capabilities used by existing industries (Hidalgo et. al., 2007, Neffke et. al., 2011). This is because *related* industries require similar inputs and conditions to thrive (Hausmann and Hidalgo, 2011). It means that adding a related industry only requires a little new "know-how" for the region to have all of the necessary factors required for sustaining that industry (Hausmann, 2016), whereas adding an unrelated industry requires all of the new know-how and capabilities for that industry. On this basis, relatedness can be used as a useful indicator of the feasibility of an industry. Based on Bond-Smith et. al. (2019), we use this principle to identify new opportunities for diversification that build upon Hawai'i's existing strengths.

But many of the most related industries are already thriving—these industries will be difficult to expand as they are probably already operating at an efficient scale. Rather, *diversification will be supported by adding industries that are currently too small*. So, we also focus on industries that are currently weak, despite being more related to Hawai'i's existing industries. While these more related industries might be expected to thrive, they likely face challenges in Hawai'i. In short, if Hawai'i's economy is *over*-specialized—because market and government failures or inadequate infrastructure has prevented alternative industries from thriving at their efficient scale—the *Principle of Relatedness* offers a way of prioritizing industries that are likely to require policy and regulatory changes or investments to address the bottlenecks that have limited their development. *Clusters* can also support a more diversified economy both within clusters and beyond. Clusters are formed when firms and industries benefit from locating close to one another. Using the cluster definitions from Delgado et. al. (2016) we also evaluate how well each cluster is related to the existing industry structures in Hawai'i's counties. This can be used to prioritize clusters for economic development that also support diversification.

The report continues as follows. Section 2 makes the case for diversifying Hawai'i's economy. Specialization in tourism is a natural response to Hawai'i's small scale, open economy, and natural endowments. However, that specialization has resulted in low per capita real GDP growth in recent decades and volatility in response to shocks. Section 3 explains the approach to identify opportunities. Specifically, we are looking for (i) more feasible industries, indicated by relatedness, and (ii) industries that probably face developmental challenges, indicated by a location quotient of less than one. Section 4 explores the results of this analysis and discusses the main diversification opportunities. Section 5 explains how these findings can inform new initiatives to support a diversified economy. Lastly, Section 6 provides some concluding remarks.

2. The economic case for diversifying the economy of Hawai‘i

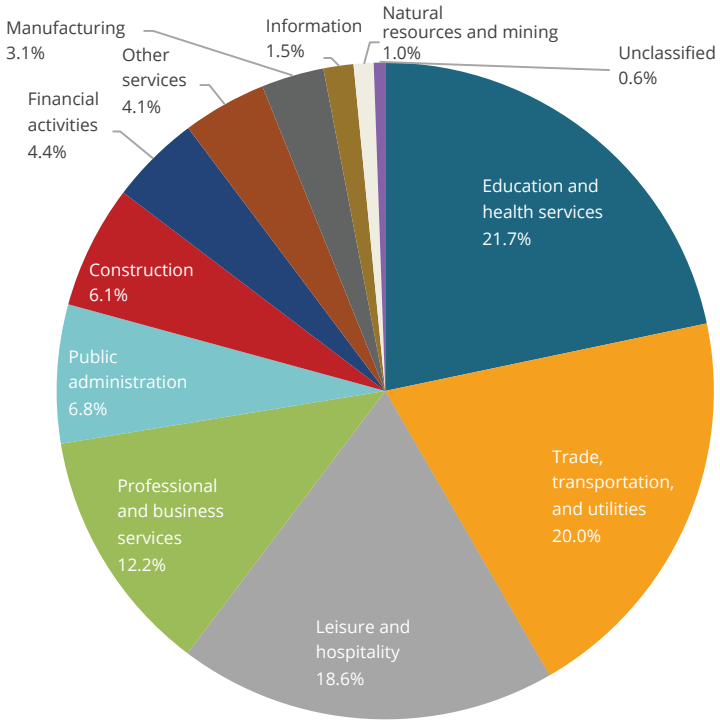
As a result of specializing in tourism, Hawai‘i experienced significant economic growth in the past. But growth has lagged since the Great Recession, and arguably since the lost decade in Japan, such that Hawai‘i’s per capita GDP has now fallen behind the continental states and the gap is widening. Hawai‘i is also exposed to short-term fluctuations in the US and global economies that affect visitor numbers as well as local shocks. Both of these risks became especially clear during the COVID-19 pandemic and the recent Maui wildfires, but previous recessions also punctured tourist spending and GDP. The below case highlights the need to diversify the economy to build resilience to both short and long-term risks.

2.1 Specialization

Figure 1 shows 2022 employment shares in Hawai‘i by *Supersector*. Supersectors aggregate detailed industries. Industries can also be classified as local if they primarily serve local customers or export to other places. Several non-tradable industries appear strongly in all states, such as most of the industries in the *Education and Health Services* supersector, as these services must be provided locally. But regions specialize in the traded industries where they sacrifice the least in terms of other goods or services they could produce, allowing them to gain from trade for products produced elsewhere.

Leisure and Hospitality is almost twice as large a share of jobs in Hawai‘i compared to the US overall. Although locals also consume leisure and hospitality, most of this activity is serving tourists. Tourism also includes a large share of retail and transportation, both part of the *Trade, Transportation, and Utilities* supersector. Specialization is also related to weakness in other traded sectors. Hawai‘i is not known for *Manufacturing*, representing only 3.1% of employment compared to 8.5% nationally. While Hawai‘i residents often view agriculture as important due to Hawai‘i’s history, the *Natural Resources and Mining* supersector, which includes agriculture, accounts for only a tiny share of employment, a third the size of Hawai‘i’s small manufacturing sector and less than the national share.

Figure 1: Statewide Hawai‘i employment shares by supersector 2022



Data source: Bureau of Labor Statistics (2023) Quarterly Census of Employment and Wages, County Employment and Wages Full Data Update, June 7, 2024.

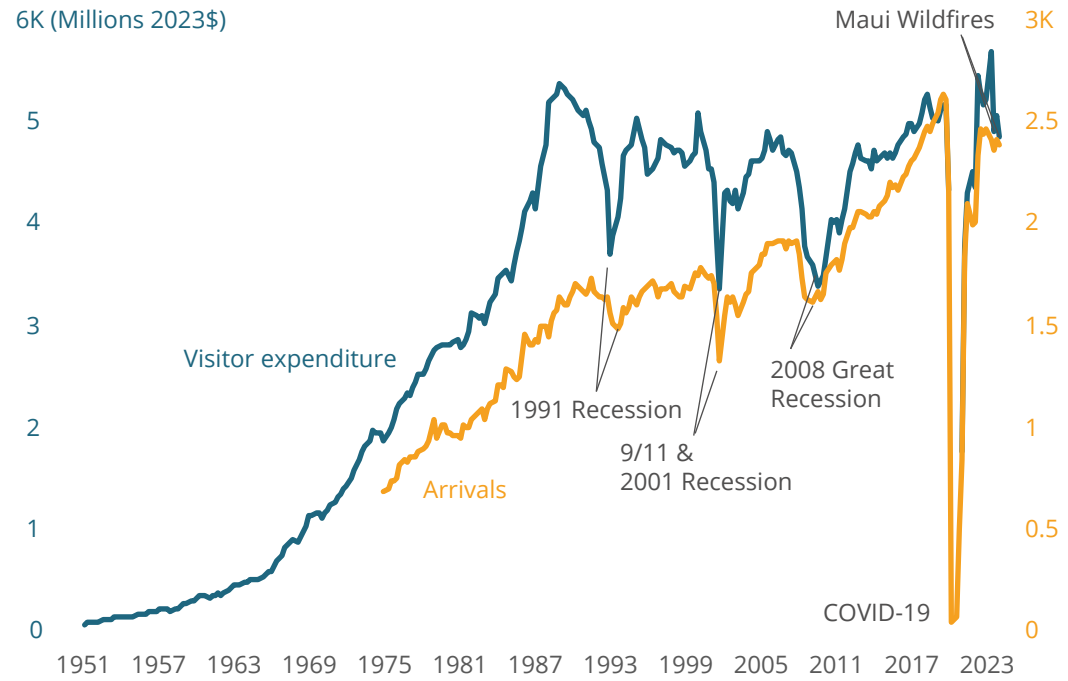
The limited share of traded industries present in Hawai‘i is characteristic of its economic geography—many traded products are difficult to produce in Hawai‘i because these businesses face both expensive real estate and high spatial transaction or transportation costs to export their products and source their inputs. Many traded products benefit from economies of scale, and external increasing returns to scale, which means that their productivity depends on the scale of production, the size of an industry, or the size of the local market. The combination of Hawai‘i’s small size and distance from the continent means that many of these products are provided from locations on the mainland where they are produced in closer proximity to larger markets.

But in addition to Hawai‘i’s natural tendency to specialize, it may also be the case that some industries are prevented from emerging in Hawai‘i because of various market and government failures, a lack of necessary infrastructure, a lack of specific skills, or some other missing capability. While it is expected that the small open economy of Hawai‘i would be more specialized in its comparative advantage in tourism than other places, the extent that such failures limit alternatives to tourism is the extent that Hawai‘i is *over*-specialized. Therefore, supporting all of the necessary capabilities for highly-related industries to thrive would enable a market discovery process to diversify the economy into its highest value allocations. Of course if the only barriers to these industries are Hawai‘i’s small size and isolation—and no market or government failures or investment in infrastructure and skills could cost-effectively change industry sizes—then Hawai‘i is simply as specialized as it needs to be as a small, open, and isolated economy. In this case, diversifying would require an even more ambitious approach that may not meet any cost-benefit criteria or other policies may be necessary to address the risks and costs of hosting its specialized economy.

2.2 Risks

Specialization in tourism exposes Hawai‘i’s economy to risks from economic shocks that affect tourist numbers (Bond-Smith and Fuleky, 2023). But specialization in tourism has also generated long-term risks with per tourist spending declining for at least three decades. Since 1990, tourist numbers have been periodically punctured by economic shocks including the 1991 recession, 9/11 and the 2001 recession, the Great Recession, and COVID-19 (See Figure 2). Recently, the Maui wildfires that destroyed Lahaina led to a sudden sharp drop in the number of tourists visiting

Figure 2: Quarterly real visitor spending (2023 $) Q1 1951 to Q1 2024 and quarterly tourist arrivals Q1 1975 to Q1 2024



Data source: UHERO. Notes: Visitor spending deflated to 2023 dollars using the Honolulu CPI. Both series are seasonally adjusted by UHERO.

Maui. While the shock is mostly confined to Maui, it also highlights that shocks can be either local or external. Hawai'i's dependence on tourism generates a vulnerability to these short-term shocks that affect tourist numbers which is most acute on the Neighbor Islands because their economies are even more specialized in tourism than the state overall.

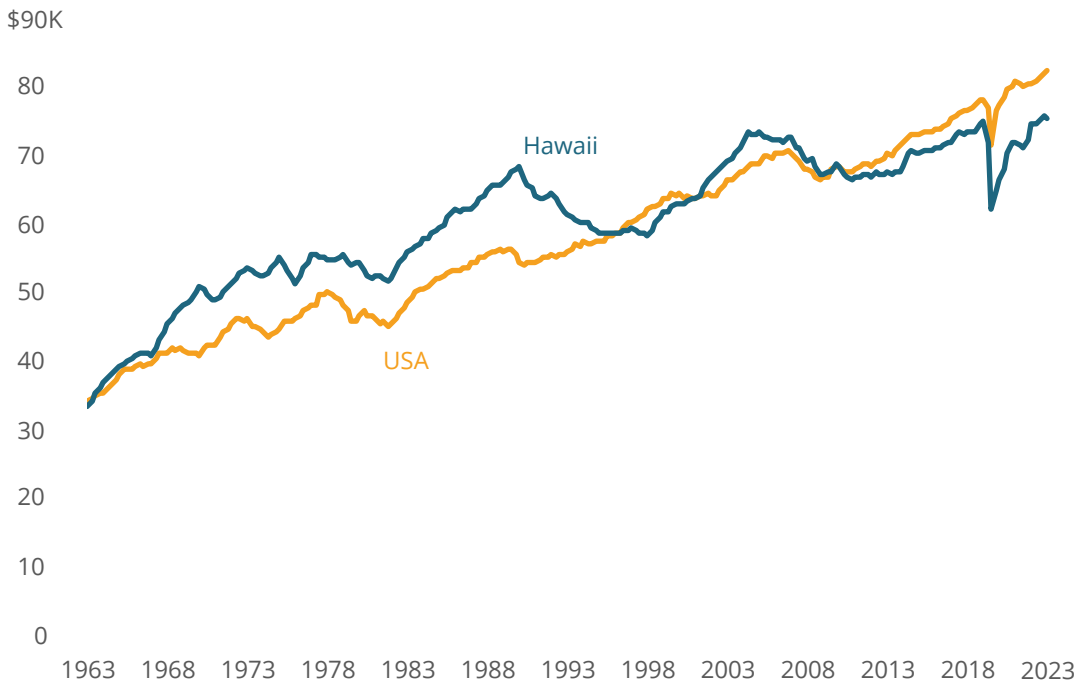
While tourist numbers from Japan declined during and since the lost decade, tourist numbers from the US grew even more. But this increase did not generate an increase in real revenue for Hawai'i's tourism industry. Notably, total visitor spending grew continuously in every year between statehood and 1988 with significant growth again since 2001. But visitor spending has fluctuated around a relatively constant peak since 1990. Put simply, tourism has lacked revenue growth for decades and spending per tourist is declining.

2.3 Growth

Economic growth has improved living standards for most people for over 150 years. For several decades after statehood in 1959, Hawai'i's per capita GDP grew at a rapid pace by taking advantage of technological change in air travel, access to a growing American middle-class tourist market, and access to a wealthy international tourist market, particularly from Japan. Between 1964 and 1990 Hawai'i had a real (inflation-adjusted) per capita GDP annual trend growth rate of 2.0%, while the US overall had a real per capita growth rate of 1.6% (See Figure 3 below). But real per capita growth in Hawai'i has stalled since 2005, even before the Great Recession, and arguably since Japan's 'lost decade' in the 1990s. In the period since 1990, Hawai'i's trend growth rate has fallen to only 0.5% compared with 1.1% for the US overall. Stalling economic growth in Hawai'i is the realization of a long-term risk from specialization in the tourism industry (Bond-Smith, 2024).

The unique combination of forces that generated growth in Hawai'i in the four decades following statehood has not been so advantageous in the three and a half decades since. The lost decade in Japan in the 1990s led to declines in the number and spending of Japanese tourists visiting Hawai'i. As a result, Hawai'i went from having a GDP per capita that was around 25% higher than the US in the third quarter of 1990 at more than $68,000 (in 2023 dollars) to about equal with the US at the end of 1996 at around $58,000. Growth returned to Hawai'i towards the end of the lost decade, reaching a new peak in the first quarter of 2005 at just over $73,000 (in 2023 dollars), but

Figure 3: Quarterly real per capita GDP, USA and Hawai'i, 1964-2023



Source: Authors' calculations with UHERO data. Notes: USA per capita GDP is deflated using the US GDP deflator. Hawai'i per capita GDP is deflated using the Honolulu CPI. Honolulu CPI is seasonally adjusted by UHERO, the other series' are seasonally adjusted by the Bureau of Economic Analysis.

stalled and declined again, not reaching this peak again until mid-2018. The COVID-19 pandemic was another disaster for Hawai'i's visitor-dependent economy (Bond-Smith and Fuleky, 2023). While visitor numbers have since recovered, Hawai'i's economy took a long time to recover and couldn't keep up with the return to growth in the rest of the US, only returning to its pre-pandemic per-capita levels in 2023.

GDP per capita is now around 8% lower than the US overall and forecast to continue growing slower than the US. If these statistics also accounted for Hawai'i's higher cost of living, then Hawai'i already fell behind the US more than two decades ago and its GDP per capita is now about 17% lower than the US.[1] This roller coaster of volatility and the long-term stagnation in Hawai'i's per capita GDP appears to be largely due to Hawai'i's specialization in tourism.

This income level and growth trajectory is similar to the regions commonly referred to as "left-behind places" (Hendrikson et. al., 2018). If Hawai'i's economic growth continues to lag behind the rest of the US, it will be more difficult for Hawai'i residents to remain living in Hawai'i as better opportunities appear elsewhere. Even before the COVID-19 pandemic, Hawai'i's population had started to decline, but this accelerated following the pandemic as the rest of the US recovered faster than Hawai'i. Between mid-2018 and mid-2023, Hawai'i's population declined by 1.7%, after increasing almost continuously since statehood in 1959. The only other population declines appeared in 1963 and in 1998 when US and Hawai'i GDP per capita was also about equal. This does not mean that people are not moving to Hawai'i, but that the net population flow is outward. As a result, data from the 2020 US Census shows that there are now more Native Hawaiians living in the mainland US than in Hawai'i (Rico et. al., 2023). A return to economic growth could offer Hawai'i residents a chance to thrive and remain in Hawai'i.

2.4 A spatial-economic perspective

The forces that generated Hawai'i's specialization in tourism—particularly US tourists—and lagging per capita growth are explained by a spatial perspective of Hawai'i's economy, outlined in more detail in Bond-Smith (2024). Specialization is a natural response to Hawai'i's economic geography in an open global trade environment. Its specialization in tourism aligns with Hawai'i's natural advantages and benefits from clustering to increase productivity across the many different kinds of businesses that serve tourists.

Small and isolated economies are less able to access *external increasing returns to scale*. External increasing returns describes how the productivity of a firm increases with the size of something external to the firm such as a market, city, cluster, or industry. Regions hosting several interconnected cities can attract the economic activities that benefit from their scale advantage. Large and connected cities attract activities that benefit from being located in large cities. Small, open, and isolated places tend to become more specialized because it creates a *local* external scale—the scale of their industry specialization—to access similar productivity advantages. Specialization establishes a comparative advantage in an industry with external increasing returns to scale boosting productivity that allows a smaller economy to trade for products that are not its comparative advantages, benefiting from gains of trade.

Hawai'i's relatively small scale implies that its productivity would be lower due to a lack of economies of scale and increasing returns to scale. For non-traded goods and services, this translates into higher prices. For many traded goods and services it translates into difficulties for businesses to compete with the productivity of mainland firms. The industries that thrive in Hawai'i do so because Hawai'i is geographically close to critical factors of production for those industries creating Hawai'i's comparative advantages (Hawai'i's climate, environment, etc.). Businesses in the tourism industry benefit further from the scale of all tourism-related economic activity due to complementarities between products and vertical linkages within the industry. The combination of small scale, isolation, and openness creates forces that encourage specialization in a single industry or cluster —as this creates scale in that industry or cluster that initially provides for productivity advantages—but generates a barrier to entry for firms in other industries because these industries are never able to establish sufficient scale to access similar advantages.

External scale economies are a problem for economic development because it implies a low-growth trap due to a coordination or hold-up problem (Matsuyama, 1990; Rodrik, 1996) such that a firm is only competitive once its industry (or related industries) reaches a sufficient scale. A *coordination problem* is where the interests of two or more people or businesses coincide, but only if they both take the required actions, which may be costly if the other does not. A *hold-up problem* is similar, except that each waits for the other to move first. The coordination or hold-up problem can prevent economic development because establishing a firm is difficult until its industry and related activities are also established. Once a region's specialization starts to decline, it can be difficult for other industries to emerge to offer growth opportunities since those industries are not yet established, implying a regional development trap (Diemer et. al., 2022). This means that small and isolated economies become locked in to their local specialization and can face periodic stagnation as they struggle with transitions between old and new industries.

As a result, Hawai'i's economy is locked in to its specialization in tourism even when the relative performance of the tourism industry has declined because other industries face challenges to grow. Unfortunately, these dynamics leave Hawai'i's economy exposed to short-term volatility and generate a regional development trap that is now leading to long-term relative decline.

2.5 Policy implications

Coordination and hold-up problems can be solved by undertaking complementary investments that commit to expanding the scale of particular external economies. This suggests that governments implement industry policies (Rodrik, 2004, 2007) that stimulate private (Morck and Nakamura, 2007) and public investment (Rosenstein-Rodan, 1943; Murphy et. al., 1989) to establish sufficient scale in new activities. Such a commitment overcomes the coordination or hold-up problem by signaling to investors and entrepreneurs that the market will reach a sufficient size to provide the necessary productivity advantages that businesses in those new industries need to thrive.

Hawai'i's government has made such commitments in the past. Investment in infrastructure to support the tourism industry in the '60s was itself an economic development initiative intended to diversify Hawai'i's economy away from plantation agriculture. But such investments do not have to achieve the scale of the tourism industry, as it is the relative scale that is important. Each niche industry will have its own optimal scale in which Hawai'i could establish itself as a major host for that industry. For example, a collaboration between the Oceanic Institute, the Hawai'i Department of Agriculture, and the University of Arizona in the late '80s ultimately started Hawai'i's shrimp broodstock industry (Wyban, 2014). Another example is state and federal investments in Astronomy. While not all initiatives will be successful,[2] if the gains from successful initiatives outweigh the costs of failed initiatives then Hawai'i residents are made better off. However, this requires deep knowledge of the activities being developed, robust cost-benefit analysis, monitoring of performance, and governance that allows failing initiatives to be abandoned.

With stagnant growth in per capita real GDP, a potential coordination problem preventing the entry of other industries, and the possibility that other missing capabilities or market failures limit otherwise viable alternatives, there is an argument for further such commitments to establish new industries. Such a commitment overcomes the coordination problem and ideally also addresses potential market and government failures or invests in shared infrastructure in order to facilitate the market discovery process. Such initiatives will be more cost-effective if they can target industries that are related to Hawai'i's existing strengths. Even if many initiatives fail, if there are enough successful initiatives, it will support productivity growth and improve Hawai'i's economic outcomes.

The remainder of this report is dedicated to analysis that indicates potentially more promising industries and industry clusters for diversifying Hawai'i's economy.

3. Identifying related industries and priority clusters

The methods used in this project are evidence-based and widely published in the academic literature. Based on decades of research (see Boschma (2017) for a summary), economists and regional development practitioners are now promoting several analytical tools for designing place-based industry policies (e.g. Balland et. al. (2019) based on the *Principle of Relatedness* (Hidalgo et. al., 2018). Variations of this approach have been used to support diversification and economic development in Western Australia (Bond-Smith et. al., 2019; Hausmann et. al., 2021), South Africa (Hausmann et. al., 2023), Sri Lanka (Malalgoda, C., 2018), Albania (Obrien et. al., 2019), Jordan (Hausmann et. al., 2019) and others with current projects in Wyoming and the United Arab Emirates.[3] The underlying insight for this research is that economies tend to grow by developing industries, technologies, and professions that branch out from the skills, infrastructure, institutions, and capabilities used by existing industries (Hidalgo et. al., 2007, Neffke et. al., 2011). These activities are described as *related* to a region's existing strengths because they require similar inputs and conditions to thrive (Hausmann and Hidalgo, 2011). On this basis, estimates of relatedness are a useful indicator for a region to potentially add or expand an activity.

We adapt these tools to focus on the goal of diversifying the economy. A separate technical paper explains the methods used in this report in detail (Bond-Smith and Ilamkar, 2024).[4] The data-driven approach in this project focuses on *related* industries that are currently *underperforming*, as a preliminary short-list for the industries that would diversify the economy, if only the developmental bottlenecks facing these industries can be addressed. The underlying principle for these two criteria is that diversifying the economy will be more economically efficient if we add related industries, rather than supporting something that is already thriving (which would simply create transfers to existing industries and offer limited benefit for diversifying) or aiming for something unrelated to existing strengths (which is likely to be costly and unable to be sustained).

This is an ambitious approach because it targets the barriers to diversification, rather than targeting industries that are already showing signs of growth. It may be impossible to address some of these barriers, and those related industries can be disregarded. But for many industries, there may be a role for cost-effective policies to already address these barriers. A successful diversification strategy addresses difficult problems in areas of potential that have not yet offered significant growth. Similarly, the size of employment is not the important factor as some industries are very small, but could play an important role in diversifying the economy. By targeting industries that are highly related to existing industries, regardless of their size, Hawai'i can develop several niche industries that achieve relatively large scale in Hawai'i compared to other locations, even if they are relatively small shares of the economy.

Data

The analysis in this report uses *County Business Patterns* (CBP) employee count data from 2021 for all counties in the 50 US states. This annual series of subnational economic data includes employment by *North American Industry Classification System* (NAICS) six-digit industries during the week of March 12 and their annual payroll. Although Hawai'i was still feeling the effects of COVID on employment at that time, the distortion is unlikely to affect the calculation of location quotients and relatedness densities, which we use to identify diversification opportunities.[5]

Since the scope of CBP excludes agriculture and aquaculture, we supplement the CBP data with the *Quarterly Census of Employment and Wages* (QCEW)[6] in Quarter 1 Month 3 of 2021 (the same month as CBP data is surveyed). Unfortunately, many of the industries in the QCEW are recorded as zeros to protect confidentiality. This should have a limited effect, as low employment usually means a location quotient of less than one (so, they are not included in the calculation of relatedness density anyway), but it may mean that results are underestimated for the industries imported from the QCEW data.

Government employment is not included in the CBP and is not detailed in the QCEW so is excluded from our analysis. But government employment is also not subject to market forces in

the same way as private enterprises, so it is unclear how our results would be interpreted for government.

Location quotients of industries and clusters

Diversification opportunities build upon existing strengths, so our analysis starts with understanding the industrial structure and local strengths of Hawai'i's counties. First, we calculate *location quotients* (LQ) for NAICS six-digit industries for every county in the US. LQ measures the local relative size of an industry. An LQ of one implies that a county has the same share of employment in that industry as the country overall. LQs greater than one, imply greater specialization in that industry whereas LQs below one imply the industry is a smaller share of the regional economy than nationally. The QCEW already provides LQs, so for the relevant agriculture industries where the data is sourced from QCEW we use the LQ as given.

Secondly, we calculate LQs for clusters of industries. Clusters are firms and industries that benefit from locating close to one another through factors like labor market pooling, knowledge spillovers and supply-chain linkages. By understanding which clusters are thriving it helps to describe a region's strengths where the combinations of industries are important. We use cluster definitions in Delgado et. al. (2016) as this is also based on the CBP data and similar measures of relatedness. In order to incorporate agriculture and aquaculture from the QCEW data, we supplement the cluster definitions with a single agriculture cluster and we add aquaculture to the *Fishing and Fish Products* cluster, renaming it *Fishing and Aquaculture*.

Summarizing this information helps to understand the foundation on which new opportunities will be built. It is also important to understand the strengths of neighboring counties since collaboration between counties could also help to establish a new industry.

Relatedness densities of industries and clusters

The *Principle of Relatedness* (Hidalgo et. al., 2018) shows how economies tend to diversify into *related* industries that build upon the capabilities used by their existing industries. Relatedness describes how two industries require similar capabilities and conditions to thrive. As a result, related industries are expected to frequently appear together in places that host the necessary capabilities. This principle also means that the co-location patterns of businesses reveal their relationships with one another in terms of requiring similar capabilities and conditions. Neffke et. al. (2011) and others use the principle to show that regions tend to grow by adding related industries. On this basis, the co-location patterns of existing industries indicate which industries are likely to be related to each other and if those co-location patterns do not appear locally, it is predictive of the emergence of a new industry. Balland et. al. (2019) applies this approach to technology classes to identify the related technologies that a regional development strategy could feasibly target. As noted above, several others use this principle to highlight industries that could support the economic growth of a region or country. In this report, we extend this approach to focus on industries that would diversify the economy.

Relatedness is measured by examining the frequency that pairs of industries locate together in counties across the US with LQs of at least one and calculating the conditional probability of an industry appearing in a randomly drawn county, given that another industry is present in that county. If two industries frequently locate together and are rarely separate, it implies that they require very similar conditions and capabilities to thrive, and are therefore related. We then measure the intensity of relationships between each industry and the existing portfolios of industries with location quotients greater than one in each of Hawai'i's four counties. This measure of *relatedness density* is widely shown to be predictive of an industry increasing its location quotient above one and is the key indicator of potential diversification opportunities in our study.

An industry with a higher relatedness density suggests that the county is likely to host more of the conditions and capabilities that the industry requires to thrive, and is, therefore, a more feasible industry. As a result, many of the highly related industries will already be thriving and

will be unable to expand further to diversify the economy. But, if an industry is currently small (with an LQ of less than one), its growth would assist with diversifying the economy. On this basis, industries with a relatively higher relatedness density and an LQ of less than one are highlighted in our results as potential diversification opportunities.

Yet these diversification opportunities are also likely to face significant challenges to their development, which is why they are currently small. Still, these are useful targets for diversifying the economy because the county is more likely to host the necessary capabilities. Other industries that are already thriving will be operating closer to an unconstrained equilibrium scale and therefore will be more difficult to expand. And the county is unlikely to host the necessary capabilities for industries that are unrelated to its existing strengths.

We also calculate the density of industry relatedness within clusters to identify clusters that contain multiple feasible industries including both current strengths and potential diversification options. Clusters are a useful framework for designing economic development policies. We use cluster definitions from Delgado et. al. (2016) which uses the principle of relatedness to group NAICS industries such that industries are more related to other industries within the cluster than outside the cluster. By using relatedness density to prioritize clusters, rather than targeting clusters based on current performance and growth, a regional economic development strategy can focus on the clusters that are likely to have greater potential to both support diversification and current economic strengths, even if those industries and clusters are not currently growing or are relatively small in terms of employment.

The clusters in Delgado et. al. (2016) are classified as local or traded. Local clusters contain industries typically serving local residents and are common to most counties across the US because these businesses need to be local to provide those products and services. Traded clusters provide goods and services to customers outside the county, so a county doesn't need to host all traded industries to access traded products. On this basis, regional development and diversification policy can narrow its focus to understand which traded clusters can be expanded. Since many of the so-called local clusters in Hawai'i are probably also serving tourists and some of the traded clusters are not traded in Hawai'i's island geography, the local and traded classification is occasionally treated differently in this report.[7] So, our conclusions focus on the traded industries, accounting for the Hawai'i context.

4. Results

This section presents an overview of the results, with specific county tables in the appendix for readers interested in the detailed results. We first discuss industry strengths across the counties showing how tourism industries appear as both large employers and with higher location quotients. Then we examine relatedness densities of industries for each county—as our proxy or indicator for feasibility—highlighting the diversification opportunities where these highly-related industries (i.e. more feasible) are also currently small or not present. In scatter plots for each county, with relatedness densities on the x-axis and location quotients on the y-axis, these diversification opportunities are visible in the lower right quadrant (industries with higher relatedness densities and location quotients less than one). Similarly, we examine the relatedness densities of clusters in each county because it highlights the clusters that contain more feasible industries including both current strengths and diversification opportunities. The substantial similarities in diversification opportunities suggests that Hawai'i's islands all have similar capabilities and could collaborate in a state-wide diversification strategy, with some nuances for O'ahu. So, our discussion in section 4.3 focuses on the industries and clusters that appear strongly in the results, often in multiple counties.

4.1 Overview of industry structure

Employment by industry

In all four counties, industries serving tourists dominate employment. For example, on each of the Neighbor Islands, *Hotels and Motels* are the largest employing industry followed by *Full-Service Restaurants*, while on O'ahu, Full-Service Restaurants are the largest employing industry and Hotels are fourth. Table 1 shows some of the highest employing industries in the two hospitality clusters (*Tourism and Hospitality*, and *Local Hospitality Establishments*).

The overall list of industries by employment is also dominated by local services such as healthcare, education, supermarkets, and warehouse clubs, but these employers are significant in most counties across the US. The CBP data includes only private enterprises, so government employment is excluded, which is also a large share of work in Hawai'i. Our focus is primarily on the traded industries including local industries serving tourists.

Table 1: Industries with greater employment in the *Hospitality and Tourism* cluster and the *Local Hospitality Establishments* cluster—Employment and local rank of employment based on 2021 County Business Patterns data

	O'ahu		Maui		Kaua'i		Hawai'i Island	
	Employment	*Local rank of employment*	*Employment*	*Local rank of employment*	*Employment*	*Local rank of employment*	*Employment*	*Local rank of employment*
Hotels (except Casino Hotels) and Motels	10,556	4	8,909	1	2737	1	4,757	1
Full-Service Restaurants	15,244	1	4,348	2	1286	2	2,543	2
Limited-Service Restaurants	13,917	3	1,887	4	992	3	1,907	5
Snack and Nonalcoholic Beverage Bars	3,834	17	780	12	274	16	624	14
Golf Courses and Country Clubs	1,003	65	590	15	363	13	643	13
Gift, Novelty, and Souvenir Stores	1,043	63	389	28	151	32	212	46

Notably, O‘ahu’s industrial structure differs slightly from the Neighbor Islands because Honolulu is a large metropolitan area. As a result, O‘ahu benefits from agglomeration economies that allow it to host industries such as corporate offices, commercial banking, engineering services, and management consulting services that are not usually hosted on the Neighbor Islands. This greater diversification on O‘ahu also results in more branching opportunities for the economic development of new industries discussed in Sections 4.2 and 4.3 below.

Employment totals do not truly reflect the industries that Hawai‘i is best at because many large industries are also large industries in most other counties across the US. Location quotients reveal the industries where Hawai‘i’s counties have a greater share of employment than other counties. A location quotient measures the size of an industry relative to its size nationally. That is, an LQ of 1 implies that an industry has the same share of local employment as its share of national employment and a location quotient of 2 implies that it has twice the share of local employment compared to its share of national employment. For example, *Full-Service Restaurants* tend to be a large employment industry in most counties in the US. While it is larger than average in all Hawai‘i counties (its size ranges between 24% larger on O‘ahu compared to the national average and 100% larger on Maui), other industries are much greater relative strengths.

Table 2 summarizes some of the industries in the two hospitality clusters with higher location quotients. Three of the most prominent strengths in all four counties are *Scenic Sightseeing Transportation, Land*; *Scenic Sightseeing Transportation, Water*; and *Scenic Sightseeing Transportation, Other* which have between 1,500% and 10,000% larger shares in Hawai‘i’s counties compared to the national average. Industries within the two hospitality clusters also lead in location quotient metrics reflecting the tourism sector’s dominance of Hawai‘i’s economy. A notable characteristic in the table is that many of the individual industries in the two hospitality clusters are actually very small—the major exceptions are Hotels and Restaurants.

Beyond the two hospitality clusters, LQs also reveal a few non-hospitality industries where Hawai‘i’s counties have significantly larger employment shares than counties on the mainland. Some of these are well known such as *Fossil Fuel Electric Power Generation* which features clearly in all four of Hawai‘i’s counties and *Coffee and Tea Manufacturing* on the Big Island with an employment share almost 13 times its national level. But others are perhaps less obvious. While still small, Maui also hosts a Coffee and Tea Manufacturing industry with about six times the employment level of other places in the US. And Honolulu, Maui, and Hawai‘i Island all host *Fish and Seafood Merchant Wholesalers*. Yet most of the niche industries, even outside of the two hospitality clusters, are also clearly connected to tourism, such as *Bus and Other Motor Vehicle Transit Systems* and *Luggage and Leather Goods Stores*.

Table 2: Industries with higher location quotients in the *Hospitality and Tourism* cluster and the *Local Hospitality Establishments* cluster—location quotient and local rank of location quotient

	O‘ahu		Maui		Kaua‘i		Hawai‘i Island	
Industry	*Location Quotient*	*Local rank of LQ*	*Location Quotient*	*Local rank of LQ*	*Location Quotient*	*Local rank of LQ*	*Location Quotient*	*Local rank of LQ*
Scenic and Sightseeing Transportation, Other	16.3	4	47.3	5	196.4	1	118.0	2
Scenic and Sightseeing Transportation, Land	50.5	1	108.6	3	63.4	4	72.2	3
Scenic and Sightseeing Transportation, Water	16.8	3	131.1	2	84.0	3	67.8	4
Hotels (except Casino Hotels) and Motels	3.3	45	16.5	10	13.3	8	10.0	12

Employment by Cluster

Clusters are formed when firms and industries benefit from locating close to one another through factors like labor market pooling, knowledge spillovers, and supply-chain linkages. Delgado et al. (2016) define 70 different clusters and classify six-digit NAICS industries into those clusters based on co-location patterns, input-output links, and labor occupations in which industries are more related to other industries within the cluster than outside the cluster. We examine the location quotients of both traded (see Table 3) and local (see Table 4) clusters in each county.

Neighbor island employment is strongly dominated by the two hospitality clusters, with three of the top five largest employing industries on Maui, Kaua'i, and the Big Island, falling into the *Hospitality and Tourism* cluster or the *Local Hospitality Establishments* cluster. On Maui and Kaua'i *Hospitality and Tourism* features as the largest cluster, while on Hawai'i Island it is third. However, on O'ahu, *Hospitality and Tourism* is actually the eighth largest cluster of employment, but two supposedly local clusters that rank higher will also be serving tourists—*Local Hospitality* is second and *Local Retailing of Clothing and General Merchandise* is third. On this basis, several local clusters are included in the traded table below to reflect their connection to tourism in the Hawai'i context.

For local clusters, the size of the industry is usually proportional to the size of the population, so a location quotient of one can be expected (See Table 4). This is especially true in Hawai'i where it is not usually practical to travel to another county to access local services. In all four counties, *Local Health Services* feature as one of the three largest clusters of employment, but mostly because this is a large employment cluster in most counties in the US and it is classified as *local* rather than *traded*. Notably, *Local Health Services* has a location quotient of less than one in all three of the Neighbor Island counties in Hawai'i, meaning that there are fewer employees in this sector than elsewhere in the US relative to the size of the workforce. This could be indicative of a healthcare worker shortage on the Neighbor Islands. A location quotient of one in Honolulu reflects its role serving the entire state, rather than only residents on island, so it may also reflect a shortage. Other large employment clusters on O'ahu also relate to its role as a large metropolitan area, such as *Business Services* and *Local Commercial Services*.

Table 3: Traded* clusters with location quotients above one, ranked by location quotient

Industry	Location Quotient	Employment level	Local rank of employment
O'AHU			
Water Transportation	3.3	1,797	24
Jewelry and Precious Metals	2.8	114	38
Hospitality and Tourism	2.4	14,354	8
Transportation and Logistics	1.8	8,621	12
Insurance Services	1.5	5,577	18
Local Retailing of Clothing and General Merchandise	1.4	15,606	6
Food Processing and Manufacturing	1.4	1,932	23
Local Hospitality Establishments	1.2	38,728	2
Performing Arts	1.1	694	30
MAUI			
Hospitality and Tourism	10.5	10,430	1
Performing Arts	2.9	303	21
Jewelry and Precious Metals	2.3	16	36
Local Hospitality Establishments	1.5	8,520	2
Local Retailing of Clothing and General Merchandise	1.5	2,708	6
Transportation and Logistics	1.3	1,035	13
Leather and Related Products	1.2	9	38
KAUA'I			
Hospitality and Tourism	9.1	3474	1
Local Hospitality Establishments	1.5	3,247	2
Local Retailing of Clothing and General Merchandise	1.4	992	7
Transportation and Logistics	1.2	387	13
HAWAI'I ISLAND			
Hospitality and Tourism	6.3	5629	3
Forestry	3.8	85	24
Food Processing and Manufacturing	1.7	365	18
Local Retailing of Clothing and General Merchandise	1.7	2805	6
Local Hospitality Establishments	1.3	6371	2
Transportation and Logistics	1.2	832	15

*Note: *Local Hospitality Establishments and Local Retailing of Clothing and General Merchandise are treated as Traded in the Hawai'i context for Tables 3 and 4, as these are likely to serve tourists. Electric Power Generation and Transmission and Environmental Services are treated as Local in the Hawai'i context due to the island geography.*

Table 4: Local* clusters with location quotients above one, ranked by location quotient

Industry	Location Quotient	Employment level	Local rank of employment
O'AHU			
Electric Power Generation and Transmission	6.1	1,147	26
Local Education and Training	2.1	7,862	15
Environmental Services	2.0	313	32
Local Real Estate, Construction, and Development	1.3	18,341	5
Local Community and Civic Organizations	1.2	14,895	7
Local Utilities	1.2	3,676	19
Local Food and Beverage Processing and Distribution	1.1	13,501	9
Local Logistical Services	1.1	8,190	13
Local Financial Services	1.1	9,376	11
Local Entertainment and Media	1.0	2,507	22
Local Health Services	1.0	45,391	1
MAUI			
Electric Power Generation and Transmission	11.4	367	18
Local Household Goods and Services	1.6	1,261	12
Local Education and Training	1.3	844	15
Local Real Estate, Construction, and Development	1.2	2,908	4
Local Community and Civic Organizations	1.2	2,381	7
Local Food and Beverage Processing and Distribution	1.4	2,743	5
Local Logistical Services	1.1	1,390	11
KAUA'I			
Local Household Goods and Services	1.7	524	11
Local Real Estate, Construction, and Development	1.4	1,271	4
Local Food and Beverage Processing and Distribution	1.4	1,093	5
Local Community and Civic Organizations	1.2	930	8
Local Utilities	1.2	235	17
Local Logistical Services	1.0	504	12
Local Education and Training	1.0	247	16
HAWAI'I ISLAND			
Local Education and Training	1.8	999	12
Local Food and Beverage Processing and Distribution	1.8	3208	5
Local Real Estate, Construction, and Development	1.5	3300	4
Local Household Goods and Services	1.4	997	13
Local Logistical Services	1.1	1220	11
Local Motor Vehicle Products and Services	1.1	1889	10
Local Community and Civic Organizations	1.1	1948	8

*Note: *Local Hospitality Establishments and Local Retailing of Clothing and General Merchandise are treated as Traded in the Hawai'i context for Tables 3 and 4, as these are likely to serve tourists. Electric Power Generation and Transmission and Environmental Services are treated as Local in the Hawai'i context due to the island geography.*

4.2 Summary of diversification opportunities

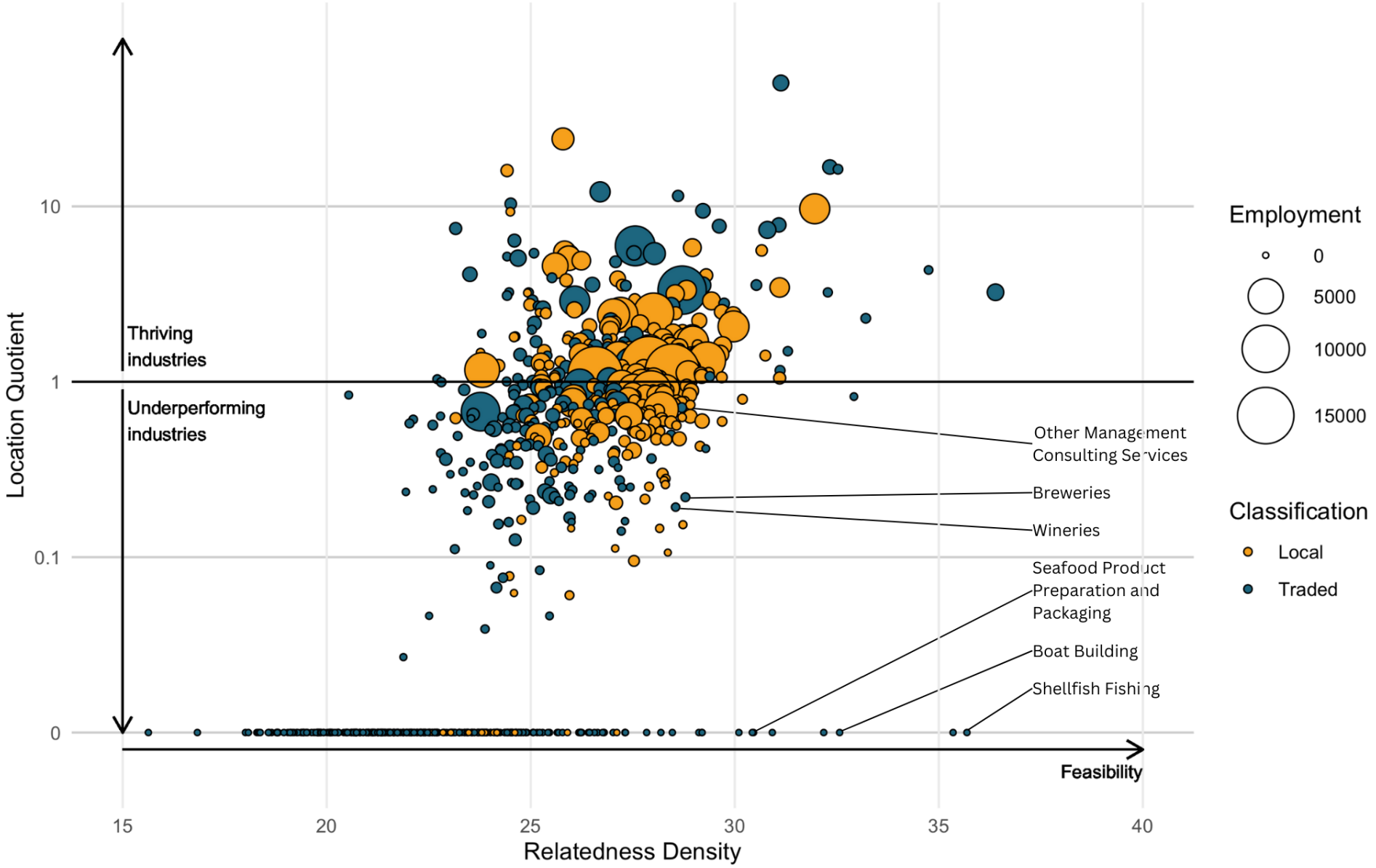
In this section we summarize our results by county and we discuss these industries in more depth in the following section.[8] When considering these results, it is important to recognize that properly understanding the potential for a new industry still requires deeper examination of the necessary capabilities required for these industries to thrive than what can be revealed by this aggregated economy-wide analysis. So, the analysis should be thought of as the starting point for identifying potential industries for diversifying the economy based on statistical probabilities and each county's existing industries. Subsequent discussions, policy designs, and regional development initiatives can build on this starting point to support a diversified economy.

In all four counties, several industries that use the surrounding oceans stand out with higher relatedness densities and location quotients less than one, suggesting their potential as diversification opportunities. These ocean-based industries include *Finfish Fishing*, *Shellfish Fishing*, *Boat Building*, *Port and Harbor Operations*, and *Seafood Preparation and Packaging*. These all seem logical diversification options given Hawai'i's location in the Pacific Ocean providing the necessary natural resource, though their current small scale indates these industries are likely to face challenges to expand. Such industries are perhaps also likely to remain in the long term because they rely on local resources, so long as the developmental barriers currently limiting their expansion can be addressed.

On O'ahu, the top industries by relatedness density with location quotients less than one are *Shellfish Fishing*, *Boat Building* and *Seafood Product Preparation and Packaging* (See Figure 4). This means that the co-location patterns of these industries in the rest of the US indicates that they are likely to appear in Honolulu alongside its existing industries. *Shellfish Fishing* and *Seafood Product Preparation and Packaging* are likely to build on Honolulu's existing strength in *Finfish Fishing* and *Fish and Seafood Merchant Wholesalers*. Boat Building is likely to build on existing strengths in the *Water Transportation* cluster such as *Coastal and Great Lakes Freight Transportation*, *Marine Cargo Operations*, *Other Support Activities for Water Transportation*, and *Navigational Services to Shipping*. It will also build on industries outside its own cluster, such as *Marinas* and *Scenic and Sightseeing Transportation, Water*, both in the *Hospitality and Tourism* cluster.

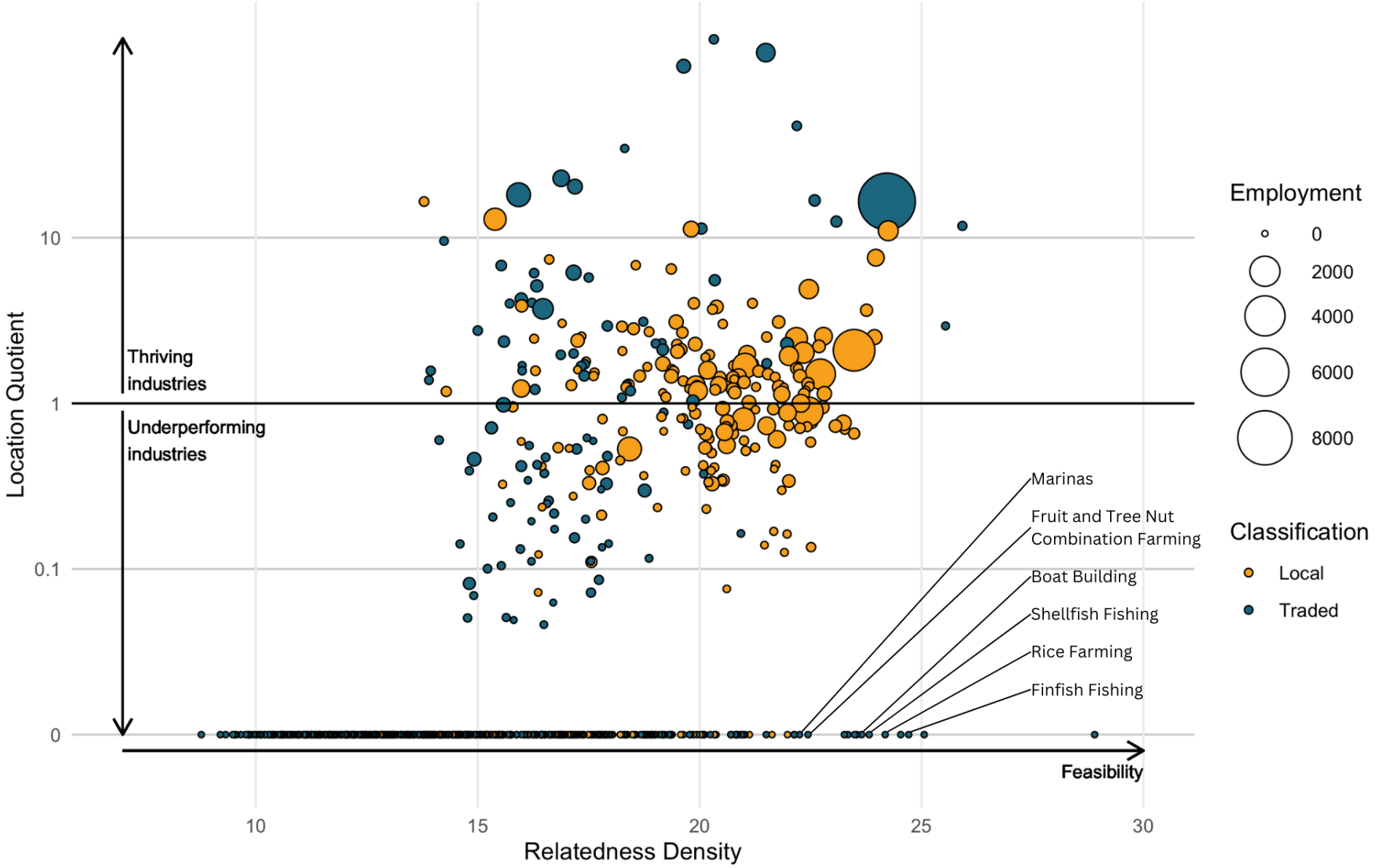
In Maui Nui, the top industries by relatedness density with location quotients less than one are *Finfish Fishing*, *Rice Farming*, *Shellfish Fishing*, *Boat Building*, and *Fruit and Tree Nut Combination Farming* (See Figure 5). The co-location patterns of these industries in the rest of the US indicates that they are likely to appear in Maui County alongside its existing industries. *Finfish Fishing* and *Shellfish Fishing* are likely to build on an existing strength in *Fish and Seafood Merchant Wholesalers*. Boat Building is likely to build on existing strengths in the *Water Transportation* cluster such as *Marine Cargo Operations*. *Marinas* are likely to build on the existing specialization in tourism such as *Scenic and Sightseeing Transportation, Water*, and are perhaps also a stepping stone to Boat Building. *Fruit and Tree Nut Combination Farming* will build on Maui's existing strength in growing Macadamia Nuts. Although it is very small, it suggests that opportunities for agriculture in Hawai'i appear to be unique niches, such as tropical crops. Yet a more detailed study of specific crops is required to fully understand the possibilities.

Figure 4: Identifying diversification opportunities in Honolulu



Note: Diversification opportunities are those with a higher relatedness density that are currently small. Some agriculture and fishing industries have an LQ of zero to protect confidentiality in the source data. If these are actually already greater than one, then these may not be suitable to expand further. Some local and traded classifications can be reversed in the Hawai'i context due to its island geography and specialization.

Figure 5: Identifying diversification opportunities in Maui County



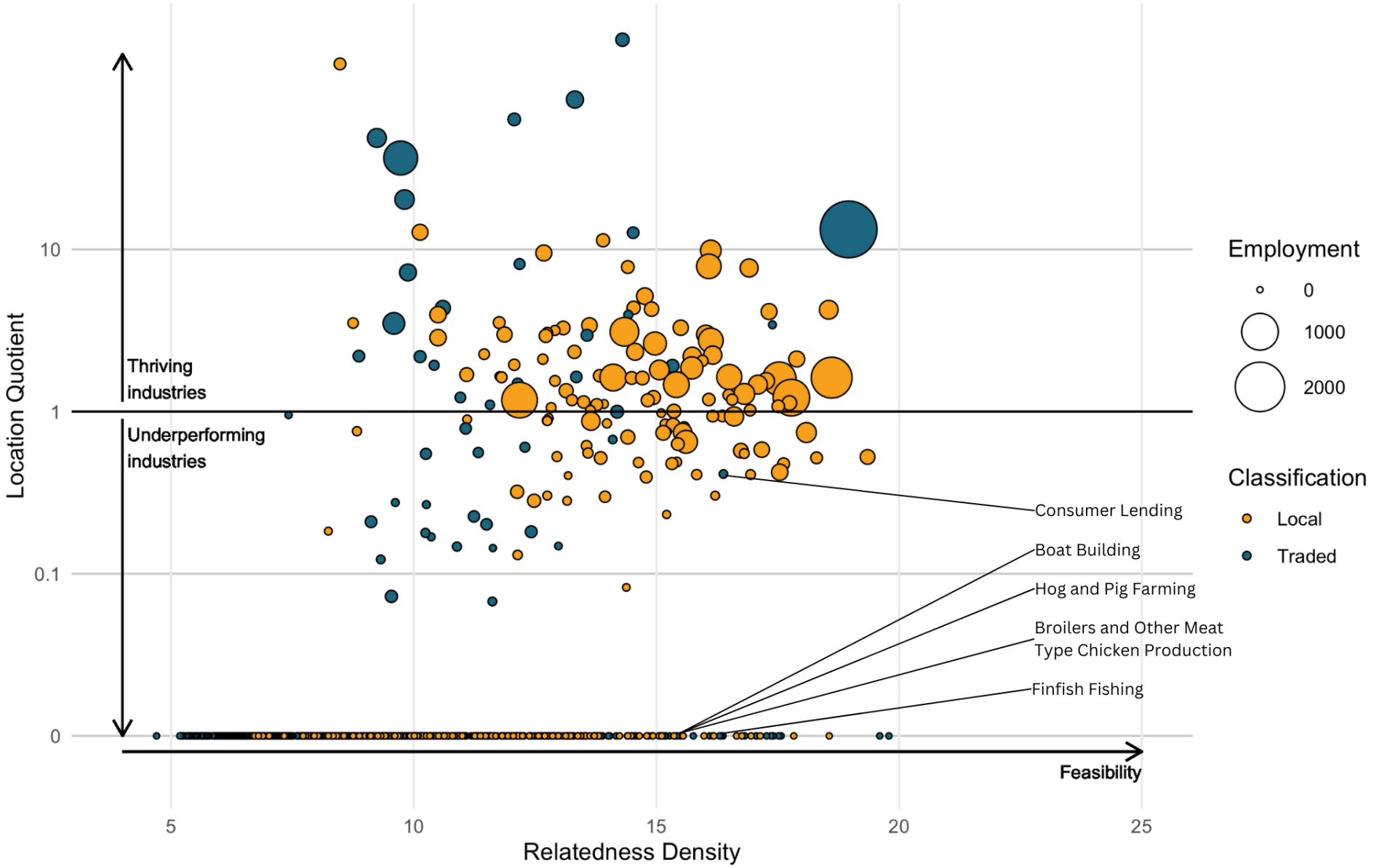
Note: Diversification opportunities are underperforming industries with higher relatedness density. Some agriculture and fishing industries have an LQ of zero to protect confidentiality in the source data. If these are actually already greater than one, then these may not be suitable to expand further. Some local and traded classifications can be reversed in the Hawai'i context due to its island geography and specialization.

Kaua‘i is the most limited county in Hawai‘i for diversification options in our results (See Figure 6). All industries on Kaua‘i have lower relationship densities than the other counties, which means there are limited branching opportunities to new industries. Furthermore, many of the industries with higher relatedness densities are unsuitable for Kaua‘i so are disregarded as diversification opportunities on Kaua‘i. Of the industries that are logically feasible, *Finfish Fishing* again appears to be the only strongly feasible option. We've also highlighted *Hog and Pig Farming* and *Broilers and other Meat Type Chicken Production* in the chart, but these industries are probably just as feasible in the other counties in Hawai‘i, it's just that Kaua‘i seems to have fewer options. *Boat Building* also has a similar level of relatedness density as these agriculture industries, and perhaps it is possible to also establish some activities in this industry on Kaua‘i. Given these very limited opportunities, Kaua‘i may want to also consider other strategies that take advantage of its proximity to Honolulu. If connectivity is sufficient to commute regularly, though not every day, it may be possible to take hybrid-remote work in Honolulu and otherwise work from home, offering Kaua‘i residents a more diversified job market.

Hawai‘i Island has many more options to diversify its economy than any of the other three counties. Its existing industrial diversity creates more branching opportunities, meaning there are a variety of local capabilities that can be used to establish new industries. And unlike O‘ahu, many of its highly related industries are still small. Again, many of the top diversification opportunities on the Big Island are part of the *Fishing and Aquaculture* cluster including *Finfish Fishing*, *Shellfish Fishing*, and *Finfish Farming and Hatcheries*. These industries will build on the existing aquaculture industry. But since all aquaculture industries were recorded with zero employment in the QCEW data for Hawai‘i, it is likely that the relatedness of aquaculture industries with other industries are even underestimated for Hawai‘i Island. While *Logging* also appeared strongly in the other two Neighbor Island Counties we had not included it in our discussion because logging is not possible without suitable forests. But it is perhaps most feasible on the Island of Hawai‘i. As with other islands, *Boat Building*, *Rice Farming*, *Wineries*, and *Marinas* also appear reasonable options. *RV Parks and Campgrounds* and *Recreation and Vacation Camps* both appear high in the list, but are currently weak because an island geography is not conducive to driving long distances with an RV. But perhaps these are more feasible on the Big Island. Nonetheless, this is probably not helpful for diversifying the economy of Hawai‘i, since it offers diversification within tourism and is unlikely to increase value-added in the tourism industry.

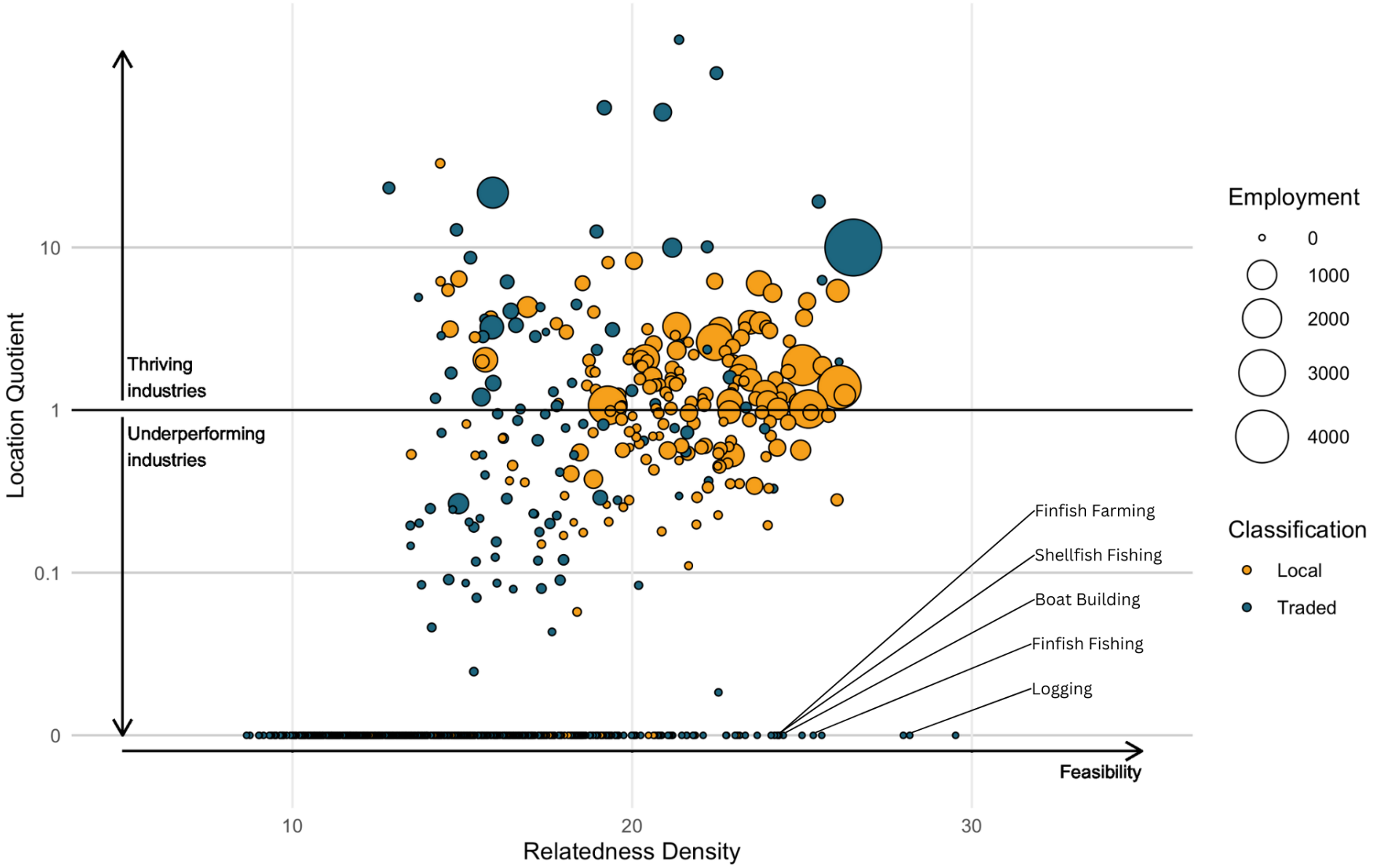
Some industries in the results should be disregarded. Relatedness density is an imperfect proxy for feasibility. And since we seek diversification by expanding underperforming industries, these industries likely face substantial barriers. Often the barrier is a natural resource. For example, *Inland Water Freight Transportation* is clearly infeasible in Hawai‘i. Similarly, *Logging* and *Timber Tract Operations* require large forests, and *Bituminous Coal and Lignite Surface Mining* requires coal deposits. Inland water transportation appears because Hawai‘i has seaports, while mainland ports often have inland water transportation. Logging appears because places with forestry have common industries found in most counties. Coal mining likely appears due to Hawai‘i's *Fossil Fuel Electric Power Generation* and mainland coal power plants often being located near coal mines. Rice farming may also fall in the unfeasible category as scarce water resources, particularly in Maui, could be prohibitive. But to the extent that rice farming competes for water with traditional crops such as Kalo (taro), it makes more sense to think of Kalo production as a diversification opportunity that is hidden in this relatedness analysis because it is included in the broader category of *Other Vegetable (except Potato) and Melon Farming*.

Figure 6: Identifying diversification opportunities on Kaua'i



Note: Diversification opportunities are underperforming industries with higher relatedness density. Some agriculture and fishing industries have an LQ of zero to protect confidentiality in the source data. If these are actually already greater than one, then these may not be suitable to expand further. Some local and traded classifications can be reversed in the Hawai'i context due to its island geography and specialization.

Figure 7: Identifying diversification opportunities on Hawai'i Island



Note: Diversification opportunities are underperforming industries with higher relatedness density. Some agriculture and fishing industries have an LQ of zero to protect confidentiality in the source data. If these are actually already greater than one, then these may not be suitable to expand further. Some local and traded classifications can be reversed in the Hawai'i context due to its island geography and specialization.

4.3 Discussion of specific industries for diversification

Since this project searches for diversification opportunities based on a statistical analysis, it is the starting point for much deeper discussions of policy designs and initiatives that would support diversification. We start this discussion by briefly exploring some of the specific industries that our results indicate could be potential opportunities for diversifying the economy of Hawai'i. Ultimately, establishing these industries requires deep knowledge from people in these industries to reveal the developmental bottlenecks and explore suitable policy responses and solutions.

Shellfish Fishing

Shellfish Fishing appeared as the strongest diversification opportunity on O'ahu and one of the top possibilities for both Maui and the Big Island. It is not clear why shellfish fishing isn't yet a thriving industry in Hawai'i, but there must be some significant barrier to its development. While species of shellfish taken from the sea in mainland counties differ from the species that can be found in Hawai'i, there are still suitable commercial species such as shrimp, lobster, and clams. Environmental regulations may be challenging for *Shellfish Fishing* in Hawai'i's unique tropical environment. Many species have necessary restrictions on taking at particular times of the year. Many shellfish often have to be sold alive and perhaps regulations make this difficult. It may be that shellfish fisheries are already depleted beyond a commercially viable scale and would require restoration before a commercial fishery could be sustained. In any case, to establish a Shellfish Fishing industry requires a regulatory system that offers commercial options and a fisheries management system that ensures its long term viability.

Given the sustainability concerns that might come with a commercial Shellfish Fishing industry, its presence in the list could also point to alternatives such as *Shellfish Farming*. Since Shellfish Farming generally had lower relatedness density than Shellfish Fishing and it wasn't one of the top diversification options, it may require additional investments to establish missing capabilities. But it may also be underestimated in our analysis due to the zeros that appear in the QCEW data to protect confidentiality. After all, there are shrimp broodstock operations on the Big Island, Kaua'i, and even Moloka'i. Expanding these operations or establishing them on other islands would support a diversified economy. In particular, this may be an important option for Maui and Kaua'i counties where branching opportunities are more limited.

Finfish Fishing

Finfish Fishing appears as the strongest diversification opportunity on Maui, and one of the strongest on the Big Island. It also has a higher relatedness density on O'ahu where it is already a strength along with *Fish and Seafood Merchant Wholesalers*. With limited branching opportunities, Finfish Fishing was one of the few industries with a relatively higher relatedness density for Kaua'i, although it would probably be more difficult to establish on Kaua'i compared to other islands.

It is not clear why Finfish Fishing is only thriving on O'ahu and not the Neighbor Islands. While Finfish Fishing requires a regulatory and fisheries management system to ensure a sustainable industry and to protect Hawai'i's ecosystem, this is probably not the major issue since the industry is established on O'ahu. Given the common result across the islands, it may be that residents on the Neighbor Islands could be already working on boats docked in Honolulu.

It's also possible that the scale of commercial fishing would be just too small on the Neighbor Islands. Perhaps the downstream wholesale industry in Honolulu is an essential capability that other islands simply don't have the scale to host. And facilities such as wharves might also require that the industry operate at a sufficiently large scale. Logistics would also be more difficult from the Neighbor Islands, but if air transport connections to Japan from Kona were restored, this might help with supplying fresh fish to Asia from the Big Island.

Finfish Farming and Fish Hatcheries

Finfish Farming and Fish Hatcheries appears as a strong diversification opportunity on the Big Island. There is already an existing Aquaculture cluster at NELHA and Hawai'i is already known

for producing shrimp broodstock. But again, given the limitations in the QCEW data, the results for this industry may be underestimated. Yet our analysis captures other activities that appear on Hawai'i Island which imply that *Finfish Farming and Fish Hatcheries* could be viable. Therefore, it may also be an option for other islands if it is indeed underestimated. Based on this result, it may be worth reexamining the initiatives that established shrimp broodstock on the Big Island and whether similar initiatives could be replicated for finfish species (and on other islands).

Again current environmental and fisheries management regulations may be a challenge for Fish Farming and Fish Hatcheries in Hawai'i. Native Hawaiians had subsistence fish farming in fishponds across the islands, reflecting that they have understood the suitability of Fish Farming as an industry in Hawai'i for centuries. Indigenous knowledge will be important for establishing Fish Farming while sustaining Hawai'i's fragile ecosystem.

The difference in the modern context is establishing it at a commercial scale for trade, while still also managing its environmental impacts and its long-term sustainability. Yet with some species and locations, perhaps this could be less of an issue in Hawai'i since it is surrounded by such deep oceans. This would be a unique characteristic of Hawai'i that most other places with finfish farming would not be able to host—offshore Fish Farming at relatively short distances from shore, where wastes can be quickly swept away and diluted by the open ocean. There are already some examples of near-shore fish farming in Hawai'i. In any case, establishing either or both near-shore and offshore finfish aquaculture requires a regulatory system that can enable commercial scale farms and manage its environmental impacts to protect Hawai'i's ecosystem.

Seafood Product Preparation and Packaging

Seafood Product Preparation and Packaging is identified as one of the strongest diversification opportunities on O'ahu, but did not appear high on the lists for the other islands. As Honolulu already has a strength in *Finfish Fishing* and *Fish and Seafood Merchant Wholesalers*, the addition of *Seafood Product Preparation and Packaging* would increase the value-added of the existing fishing industry and offer opportunities for new exports.

Yet it probably requires significant scale, in order to supply sufficient product for a packaging plant. It is not clear whether it is a lack of local scale or some other limitation that is preventing a significant Seafood Product Preparation and Packaging industry. In any case, this type of food processing and manufacturing typically occurs close to where seafood is brought to shore. So, it would be one of the more suitable manufacturing industries for Hawai'i, despite its isolation from other markets.

Establishing this industry on O'ahu could potentially support fishers and fish farmers on Neighbor Islands too, provided fish can be transported to Honolulu quickly. Similarly, connectivity to export markets is important for seafood products, since they are best delivered fresh and Honolulu's connections to Japan would offer a valuable market.

Boat Building

Boat Building was identified as a diversification opportunity in all four counties, though it was strongest on O'ahu. This industry likely builds on O'ahu's existing strengths in *Ship Building and Repairing*, *Coastal Freight Transportation*, *Marine Cargo Operations*, *Other Support Activities for Water Transportation*, and *Navigational Services to Shipping*. It may also build on industries outside its own cluster, such as *Marinas* and *Scenic and Sightseeing Transportation, Water*, both in the *Hospitality and Tourism* cluster.

Yet a major barrier to a boat building industry would be the cost of importing materials. Given the high cost of shipping materials, the niche for Hawai'i may be in boat repair and maintenance (included in the NAICS Boat Building category) in which superyachts could visit Hawai'i for maintenance during the northern winters. On the Neighbor Islands, Boat Building may require coordination with the development of *Marinas* and other facilities to host visiting boats for maintenance.

Deep Sea Freight Transportation

On Oʻahu, *Deep Sea Freight Transportation* appears as a diversification opportunity. As is well-known, many ships bound for the US do not stop in Hawaiʻi because of the Jones Act, which requires that ships moving between US ports only use US built and crewed ships. Therefore, ships usually go to Long Beach before freight is rerouted on smaller ships to Hawaiʻi. As a result, this industry is hosted by larger west coast ports.

Conceptually, it may be technically possible that Pearl Harbor could act as a hub for rerouting shipments to other ports on the west coast, in absence of the Jones Act. However, with substantial economies of scale in shipping and external increasing returns to scale from local transport costs, the scale of Long Beach and the large California market would still be the main attraction for a Deep Sea Freight Transportation industry. This leaves Oʻahu as a spoke in the sea freight network, rather than a hub. In any case, the possibility of hosting Deep Sea Freight Transportation cannot even be considered without the removal of the Jones Act.

Breweries and Wineries

Both *Breweries* and *Wineries* appear as diversification opportunities on Oʻahu. *Wineries* also appear as options for Maui and Kauaʻi and are a possibility on the Big Island, which already hosts Breweries as a strength. On this basis, perhaps Breweries are also an option for the other Neighbor Islands too even though they did not feature strongly in our results. It's not that wineries appear as strongly feasible on the Neighbor Islands either, it's just that the Neighbor Island counties have fewer diversification options, so wineries are relatively more feasible than other industries.

Since both Breweries and Wineries already operate in Honolulu, even if they are small compared to other places in the US, and Breweries are a strength on the Big Island, then these industries may not face any significant barrier to development at all. Instead, their small scale could be because it is a manufacturing industry and transportation costs are significant from Hawaiʻi. This would mean that Hawaiʻi-based brewers and wine-makers are primarily serving a local and tourist market. Breweries can be relatively larger on the Neighbor Islands if they can supply products to the entire state, which would explain the higher location quotient on the Big Island. On this basis, perhaps these have already reached their maximum viable scale.

Logging and Timber Tract Operations

Logging and *Timber Tract Operations* featured in our results as diversification options for all of the counties, but this is obviously not feasible without forests. So, this might not be an option in most counties, but is perhaps possible on the Big Island. A sustainable logging industry requires planting suitable forests, rather than harvesting old-growth forests, but if this is possible it would provide timber for Hawaiʻi's construction industry without importing or could provide unique timbers for other purposes and export opportunities beyond a local market.

Of course, understanding the possibilities for forestry requires deep knowledge of Hawaiʻi's ecosystems and forestry industry. Again, this idea is not entirely new. In 2004, the Department of Land and Natural Resources published a study on the feasibility of locally-grown hardwoods (Dudley and Quinn, 2004) which would offer higher value uses in furniture, flooring, cabinetry, and other fixtures. The study was optimistic about the opportunity for locally-grown hardwood. Eucalyptus has been planted on former sugar cane land on the Big Island for research into commercial opportunities. And Koa wood might offer a unique native timber for higher-value uses. There may be particular issues for planting forests in Hawaiʻi, such as various pests, that would require further research before an environmentally and commercially sustainable forest can be planted. And even then, trees take a long time to grow.

Agriculture industries

While many Hawaiʻi residents support a return of agriculture, very few agricultural industries appear with a high relatedness density in our analysis. However, as noted elsewhere in this report, these may be underestimated due to data classifications and data limitations in the

CBP and QCEW which mean agriculture is under-represented. In any case, the results still imply that an import substitution strategy for common agricultural commodities is probably not a suitable strategy in Hawai'i because many of these more common crops are less likely to be underestimated in our results. The lower relatedness densities in our results mean that even if those industries are hosted here, they are likely to decline as they probably have lower productivity (and higher prices) than the other locations in the US where these industries are thriving. Instead, a revival of agriculture could be supported by more niche crops.

For example, *Rice Farming* appears as an opportunity on Maui and moderately for Hawai'i Island, though it would probably only be possible in particular parts of the island where there is a lot of rainfall to provide sufficient water without tapping into underground or surface water resources that might not be available. But the result may also point to the potential for Kalo (taro) farming. Yet access to water resources may mean expansion of either rice or Kalo farming is infeasible.

With the exception of rice farming on Maui and Hawai'i Island, it is surprising that other agricultural industries do not appear strongly. *Other Non-Citrus Fruit Farming*, which includes both pineapple and coffee, has relatively low relatedness densities. Similarly, *Other Vegetable (except Potato) and Melon Farming*, which includes farming Kalo, and *Tree Nut Farming*, which includes macadamia nuts, have a slightly higher relatedness density, but they do not stand out. The low relatedness density of agricultural industries is predictive of their decline in the islands and reflects their relative performance in recent years. However, since pineapples, coffee, kalo, and macadamia nuts are too small a share of US agriculture to warrant their own classifications, it may be that they are too diluted by the various other crops in their NAICS categories. On this basis, understanding the opportunities in agriculture perhaps requires an agriculture-specific analysis with more unique crop definitions to reveal the niche crops that are more feasible in the islands.

4.4 Clusters of strengths and opportunities

A cluster-based economic development strategy could support diversification if clusters are prioritized according to indicators of potential, such as relatedness density, rather than performance. On this basis, we examine the density of industry relatedness by cluster. This approach identifies clusters of industries that include both existing strengths and diversification opportunities as well as offering the potential to establish entirely new clusters. In this section, we summarize the main clusters that appear in our results across the counties that would support diversifying the economy. Our discussion focuses on traded clusters, but we make allowances for Hawai'i's unique context where the island geography prevents trading between counties.

For each county we again show scatter plots of relatedness densities on the x-axis and location quotients on the y-axis (See Figures 8 to 11) with more detailed tables in the appendix, but relatedness density is the only criteria required for prioritizing clusters. Again, some clusters are disregarded if they are clearly not feasible because they are missing a crucial natural resource.[9]

Tourism

As expected, the clusters serving tourists feature strongly in all four counties. Primarily, we highlighted the two hospitality clusters of *Local Hospitality Establishments* and *Hospitality and Tourism*, but *Local Retailing of Clothing and General Merchandise*; *Jewelry and Precious Metals*, and *Performing Arts* also serve tourists.

The strength of these clusters in terms of relatedness density implies that tourism will remain strong in the islands, but there could be opportunities for diversification within the tourism industry. Diversification is not about penalizing tourism or reducing it. A successful diversification strategy will build upon and branch out from Hawai'i's existing strength in tourism, so initiatives that undermine tourism will also undermine efforts to diversify.

Fishing and Aquaculture

Perhaps most notable of all, *Fishing and Aquaculture* stands out with a higher relatedness density across all four counties. Of course this isn't really new at all. Kanaka Maoli used fishponds for centuries before Europeans arrived in the islands. There are shrimp broodstock operations on the Big Island, Kaua'i, and even Moloka'i, and Fishing is a strong industry on O'ahu. The high relatedness density suggests that industries in the cluster could thrive across all of the counties, and there are a number of industries within the cluster that could expand. But as noted above, regulatory and fisheries management systems need to balance ecological concerns and commercial viability for this cluster to thrive.

Data limitations also mean that our conclusion may be conservative. Several aquaculture industries appear in the QCEW data as zero employment to protect confidentiality when the numbers are small, even if there is already some employment in these industries. It is possible that the calculated relatedness densities are therefore underestimates, meaning that fishing and aquaculture could be even more feasible as a diversification option than our results suggest. Notably, aquaculture is a fast growing industry globally. Since 2022, there are now more fish taken from farms than fished in the wild (Food and Agriculture Organization of the United Nations, 2024).

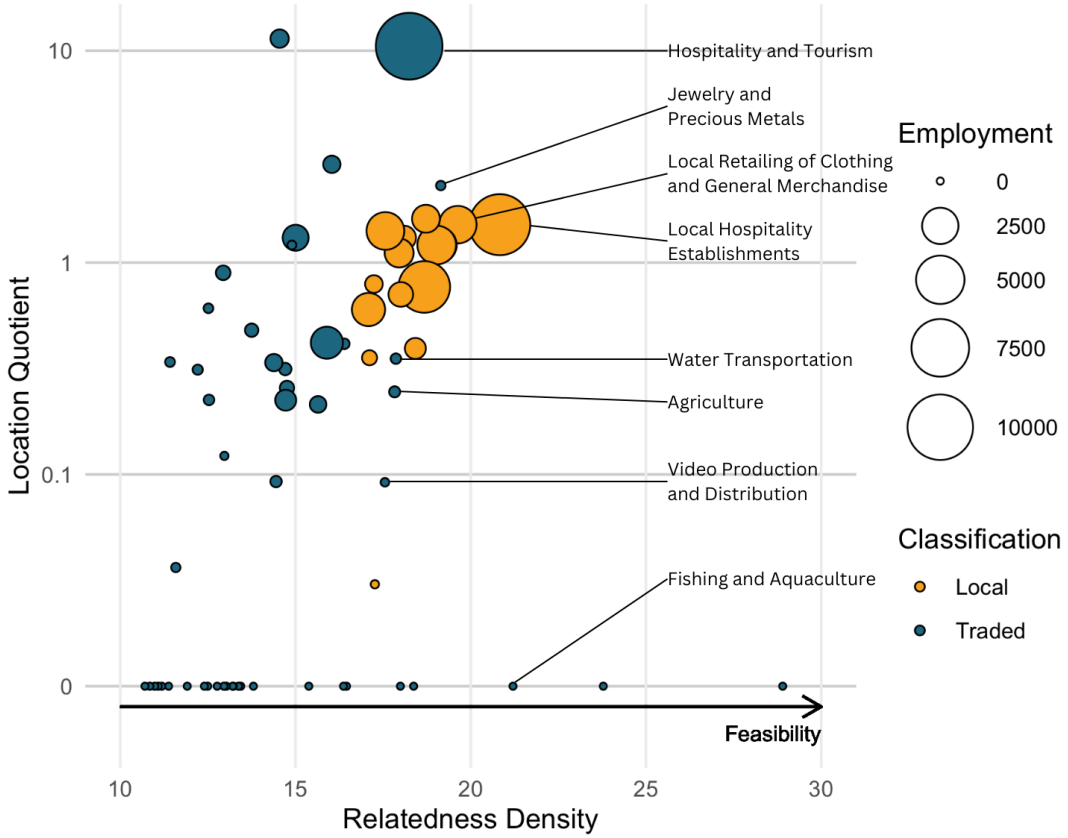
Education and Knowledge Creation

O'ahu hosts an *Education and Knowledge Creation* cluster. The strength of this cluster is likely underestimated since the County Business Patterns data only included private employment (i.e. employees of the University of Hawai'i are not included in our data). Therefore, if public colleges were included in the data it would perhaps also feature more strongly in the Neighbor Island results too.

College education is a major export in several other open economies such as Australia, New Zealand, and the United Kingdom but US student visa requirements may make this more difficult. Nonetheless, DBEDT has previously noted the economic impact of both international students (DBEDT, 2021) and out-of-state students (DBEDT, 2023).

Figure 8: Relatedness Density and Location Quotients of Clusters in Honolulu

Figure 9: Relatedness Density and Location Quotients of Clusters in Maui County



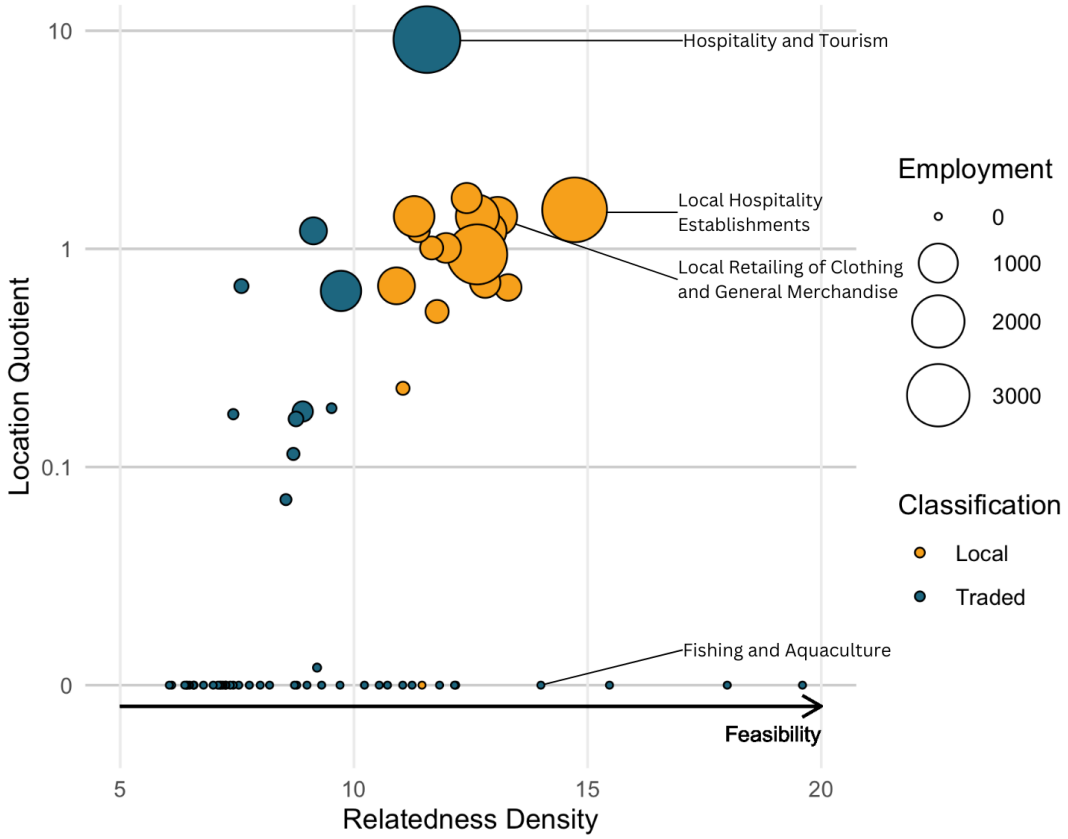
There are other important elements of this cluster too such as *Language Schools* and *Flight Training* where Hawai'i has unique characteristics that support these. The major diversification opportunity in this cluster is in *Research and Development in the Physical, Engineering, and Life Sciences*. However, this already features a location quotient around 1 on Maui and 1.2 on the Big Island. So, from a diversification perspective, maybe this is a good industry for the Neighbor Islands given their limited diversification opportunities.

Video Production and Distribution

Unsurprisingly, *Video Production and Distribution*, features moderately in Honolulu but more surprisingly, it is also a moderate option for Maui and has potential on the Big Island and Kaua'i. Hawai'i has hosted a number of significant film and television productions but its employment level is still relatively low. Film and television may be more difficult to host on the Neighbor Islands with a limited labor market pool for a relatively specialized set of skills, but there may be options to collaborate in productions in order to jointly host this industry with O'ahu. The scenery on all of Hawai'i's islands is attractive for filmmakers.

The starting point for expanding Video Production and Distribution is to determine the missing capabilities that may be limiting the industry from becoming larger. Is this skills, studio facilities, scale, or something else? Notably, tax breaks should not be thought of as one of the necessary capabilities and tax competition for film-making should be avoided. Yet the existing incentives could also be poorly structured to expand this industry. Previously, UHERO research has noted that the annual tax credit cap to all productions may be too low, disincentivizing an expanded industry (La Croix and Mak, 2021).

Figure 10: Relatedness Density and Location Quotients of Clusters on Kaua'i

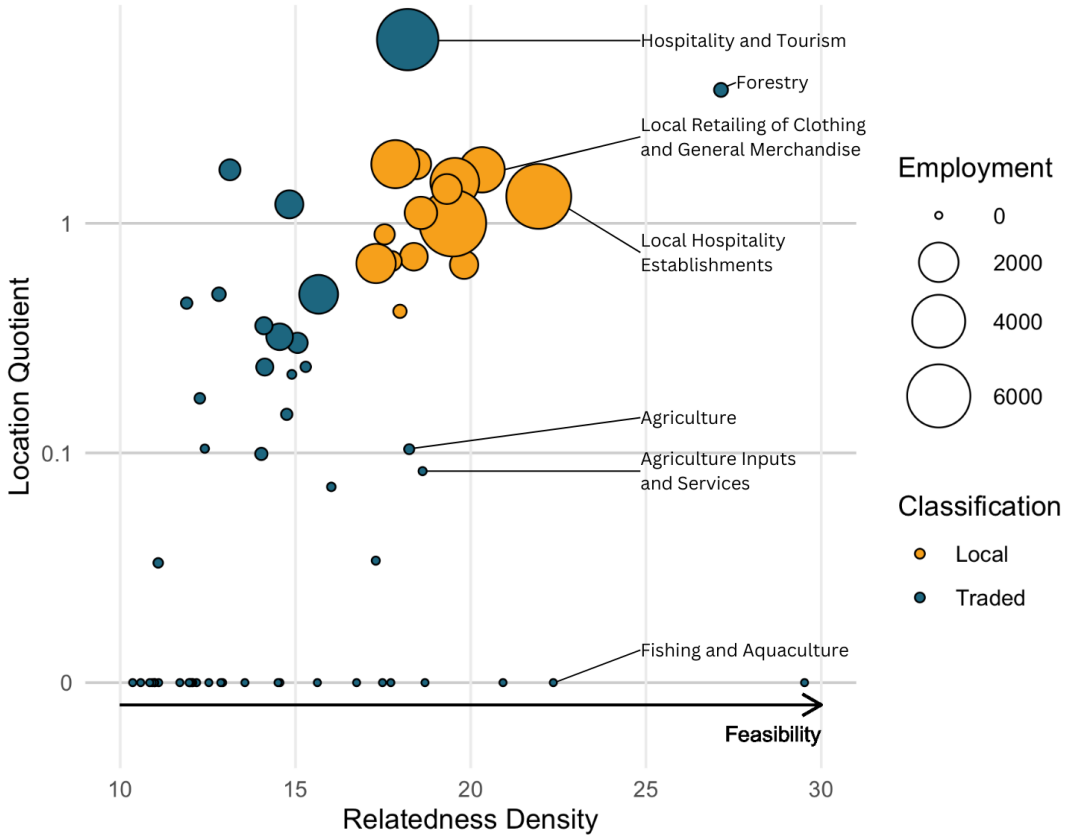


Water Transportation

A *Water Transportation* cluster already features strongly in Honolulu with several industries appearing with location quotients above one. It had one of the highest relatedness densities of any feasible cluster on O'ahu, but also features moderately amongst clusters for Maui, in part because of its existing strength in *Marine Cargo Handling*. The water transportation cluster did not include *Coastal and Great Lakes Passenger Transportation* (i.e. inter-island passenger ferries) in our analysis because it was located in so few counties across the US that it was below the minimum threshold we set for estimating relatedness. Instead, this cluster is predominantly about freight, including Honolulu's existing *Marine Cargo Handling* and *Coastal Freight Transportation* industries. But it also includes diversification options such as *Boat Building* (and maintenance) and *Deep Sea Freight Transportation*. However, hosting a *Deep Sea Freight Transportation* industry would only be plausible on O'ahu and only with removal of the Jones Act, which seems unlikely.

While *Coastal Passenger Transportation* was excluded from this analysis, inter-island passenger ferries may still be a possibility given the strength of other industries in the water transportation cluster. But it has a rocky history in Hawai'i. Ridership on the Hawai'i super-ferry never reached its break-even level in its 11 months of operation. A study in 2017 noted that ferry services were technically feasible, but the Neighbor Islands (and West O'ahu for intra-island ferry services) lacked the necessary infrastructure and environmental review requirements created significant delays and costs (Department of Transportation, 2017). Even if it is not a viable industry on its own, passenger ferries could be considered on the same basis as other public transportation, with public subsidies for commuting residents. The direct contribution of a subsidized industry wouldn't offer an economically efficient approach to diversify the economy, but it may indirectly support diversification by enabling commuting to Honolulu. Commuting every day would probably be infeasible for most workers, but greater transit options would offer residents on the Neighbor Islands more opportunities to take remote-hybrid employment on O'ahu. In the post-COVID economy, where many more jobs are feasibly remote or hybrid, maybe ferry transportation could become viable.

Figure 11: Relatedness Density and Location Quotients of Clusters on Hawai'i Island



Agriculture

While *Agriculture* didn't feature in the location quotient results and many individual agricultural industries were also weak in the industry relatedness results, it is still a potential cluster based on the results for relatedness density by cluster. This cluster makes sense since Hawai'i has hosted a strong agricultural sector in the past, so of course it still has all the requisite capabilities to host it again. Similarly, a *Livestock Processing* cluster has some potential on all four islands, probably through links to Agriculture and *Local Food and Beverage Processing and Distribution*.

This result reflects that Hawai'i probably hosts all of the necessary capabilities for a thriving agriculture cluster. Yet the results were very poor for most mainstream agricultural products, suggesting their continued decline. So, if an import substitution strategy is not viable, the key to a thriving agriculture industry will be finding niche crops that are highly valuable or finding other processes that can add significant value to overcome Hawai'i's limited scale, distance from other markets, and high price for land. There are examples of this already such as Kona coffee or macadamia nuts. Expanding these types of products and finding more high-value niche crops would help to diversify the economy. Some of the best opportunities could be in crops that can not be grown in any other state.

Forestry

In multiple counties, *Forestry* appears as a potential cluster with higher relatedness densities, but it is probably unsuitable in most places. The exception may be Hawai'i Island. While relatively small, the *Support Activities For Forestry* industry is already significant on the Big Island. These activities probably relate to the management of native forests or current research projects, so whether this can be extended to commercial forests is not clear without deeper knowledge of the industry.

As with the industries that were disregarded, relatedness density implies that each county probably has all of the necessary capabilities required for many of the industries in the Forestry cluster, if only forests were present locally. Ultimately, this is a policy choice for Hawai'i to establish sustainable commercial forests, perhaps on unused farmland, but it may also be considered too much of an environmental impact on Hawai'i's ecosystems or disregarded for other reasons.

5. Policy recommendations

The industries we identify to diversify the economy based on the *Principle of Relatedness*, are likely to face challenges to grow, almost by definition. Policy design can make use of our analysis to prioritize addressing barriers to growth in these industries. Yet economists are always cautious of policies that "pick winners". The market reveals winners by combining private information, so any selection by policy-makers is unlikely to contain as much information as the market. But, the analysis here is not intended to "pick winners". Rather, the *Principle of Relatedness* reveals additional information about Hawai'i's economy from market outcomes across the US, showing where the market in Hawai'i has been unable to develop particular industries that might be expected to thrive. This is additional information that the market could not incorporate on its own. So, it can be used to prioritize initiatives where market outcomes have revealed in our analysis that there are likely to be developmental bottlenecks. The policy response requires figuring out the reasons why the market has been unable to already develop those industries that might be expected to thrive. If those reasons can be addressed in a cost-effective way, it would then enable those industries to emerge through the usual market discovery process.

Our results do not guarantee that any particular industry will be a success and these results do not imply that policy-makers or investors should pick these as winners in any particular initiative. It is likely that the diversification opportunities we identify are industries that face considerable problems, which is why they have been unable to emerge through the usual market discovery process, in spite of being related to a county's existing strengths. In this way, this objective proxy measure for feasibility, combined with finding weaknesses using location quotients, prioritizes industries that are more likely to face binding developmental bottlenecks that are preventing growth in otherwise promising areas of opportunity.

Of course, policymakers may also consider other factors, but any additional criteria should be considered carefully. Regional economic development policy will not solve every economic issue in Hawai'i so policy-makers should be cautious of using development policy for additional purposes that are poorly targeted. Additional criteria that target externalities can promote economic efficiency. For example, policies that push for more sustainable tourism, promote energy efficiency, or reduce carbon emissions all aim to reduce negative externalities, though regional economic development may not be the most suitable policy area for addressing these issues. Other criteria, unrelated to externalities, imply trade-offs that limit the potential for diversification and growth. Therefore, we suggest that the analysis here should be used for a strictly-defined purpose: to design place-based economic development policies that aim to diversify and grow the economy of Hawai'i by targeting developmental barriers in more feasible but underperforming industries. Other well-defined policies would be required to address other economic issues.

Below we explain the two main policy areas where our results are most useful.

5.1 Barriers to individual industries

Almost by definition, the industries identified as diversification opportunities in this report are industries that have problems in Hawai'i—where firms currently face a significant barrier to further development. If these industries didn't face such developmental barriers, then their relatively higher relatedness density suggests that they could be expected to already thrive. Even though each county is likely to have many of the necessary capabilities needed for those industries, based on the presence of existing industries, the diversification opportunities must be industries where some necessary capability is missing or some bottleneck is preventing further growth.

The appropriate policy response is to address such bottlenecks and the underlying causes of those bottlenecks, rather than picking winning industries or firms. While addressing industry-specific bottlenecks is to some extent "picking winners", since it would be impossible to address every bottleneck and enable every possible industry, it is not picking winning firms, so it sustains a market discovery process. Addressing bottlenecks involves tackling market and government failures that then allow the market to function. In this way, the results of this study help to prioritize initiatives that potentially target the most binding developmental bottlenecks, in industries that are more likely to thrive, because the market has been unable to address these bottlenecks on its own.

Identifying the barriers to expansion of any specific industry in Hawai'i requires deep knowledge from the people involved in those industries and such detail is not revealed by an aggregate analysis such as this. Instead, the analysis here can be thought of as a shortlist of the industries with the greatest potential for policies, initiatives, and investments to address developmental bottlenecks. But this shortlisting supports economic development and diversification policy by reducing the range of industries that would be considered for support. Rather than spreading economic development efforts thinly across all possible industries, it allows for a targeted economic development strategy that focuses on more likely opportunities rather than the most fashionable industries or those with political influence. In this way, this report and any policy proposals that build on this work, are a conversation starter to reveal further private information about the factors constraining diversification that are not currently revealed by the market.

An effective diversification policy aims to address these constraints which then allows the market to combine private information as an industry develops. Such constraints or bottlenecks could be market failures or government failures that prevent a particular activity from emerging. Other constraints may be infrastructure requirements or sector specific skills. In some cases the developmental bottleneck may be relatively clear. After all, Hoteliers cannot invest in hotels in Hawai'i without suitable infrastructure to transport their customers. But for other industries the market failures and barriers may be less obvious, requiring inside knowledge of an industry to fully understand the barriers and market failures that they are facing. For example, research-based investments are difficult for the market to undertake since the knowledge developed from research is shared by more than the firm undertaking the investment. To address this, initiatives could fund research targeting specific priority areas for Hawaii in ways that the benefits can be shared by multiple market actors. There are likely to be other market failures that limit the development of the diversification opportunities identified in this report that require much deeper knowledge of those industries. Such failures might require public infrastructure that can be shared by multiple providers to overcome the market failure. If these market failures can be identified and clearly articulated, then there may be a suitable policy solution that would directly address such market failures.

For industries where the barrier to entry is not so clear, a successful diversification and growth policy aims to *reveal* barriers from private information, in order to design tailored initiatives, monitor their performance, and implement strong policy governance procedures. This type of policy would solicit proposals from those with deep knowledge of the developmental bottlenecks facing related industries that are preventing those industries from emerging and award funding to proponents who meet all the criteria. Ideally, proponents would provide evidence of a clear market or government failure. For example, it may be that their industry requires workers with

particular skills and specific infrastructure that is not provided by the market, or that regulatory and legal barriers limit their industry and are not fit-for purpose. They would have to explain why the market is unable to resolve that failure on its own, such as various coordination problems, externalities, or other information failures. Proponents would provide evidence to show that the failure is the issue rather than some other explanation. And they would need to propose a cost-effective solution that would resolve the issue without favoring any particular firm. Lastly, proponents would explain the measures of success for their proposed initiative, how those measures would be monitored, and the appropriate responses to failures and successes in those measures. When initiatives are underperforming, there must be mechanisms that correct for performance issues and ultimately abandon or end an initiative. While many such initiatives might fail and be abandoned, just as private investors abandon failing investments, the overall policy achieves its purpose if the successes outweigh the failures. Many other existing regional economic development policies would also benefit from implementing similar governance and monitoring mechanisms.

Given the strong performance of multiple ocean-based industries in our results, the logical policy response would be to start with examining industries in the *Fishing and Aquaculture* and *Water Transportation* clusters. With multiple industries utilizing the same natural resource, it implies a blanket regulatory issue is possible. Furthermore, there may be specific skills that would be needed to support these industries, both at trade level and professional roles. If this skill provision is insufficient in Hawai'i, these industries may benefit from investment that expands the relevant training opportunities at both four-year and community colleges. Other policies could support research and development to support higher value from these industries. The success of NELHA on the Big Island may serve as a template for similar initiatives, though this too required a significant federal investment. The strong result for Fishing and Aquaculture also supports investments such as the NSF Growth Engine *CliRAIM*, which provided funding towards this project prior to its decision to refocus on Aquaculture.

5.2 Support for clusters of strength and opportunity

In addition to addressing industry-specific developmental bottlenecks, the results imply supporting a number of local industry clusters of strength and opportunity. Clusters are a useful framework for economic development policy because industries within a cluster benefit from the co-location and success of other industries in their cluster.

The results suggest prioritizing particular clusters. Across the islands *Local Hospitality Establishments*, *Hospitality and Tourism*, and *Local Retailing of Clothing and General Merchandise* could be prioritized together as Tourism. And all of the islands can also prioritize a *Fishing and Aquaculture* cluster. Honolulu could prioritize an *Education and Knowledge Creation* cluster, a *Video Production and Distribution* cluster and a *Water Transportation* cluster with some possibilities to collaborate with the Neighbor Islands on these three clusters. An *Agriculture* cluster seems possible in all four counties, though it requires a strategic approach to lift its value. *Forestry* appears in our results across all of the counties, but could probably only be considered as a priority cluster on the Big Island with perhaps a few limited options on other islands. And while it wasn't considered in our analysis because it wasn't in the CBP or QCEW data, a defense industries cluster fits the same conceptual foundations of the principle of relatedness, so could perhaps be prioritized on O'ahu.

This clustering approach is not entirely new. Many CEDS prioritize industry clusters. For example, Hawai'i's 2023 Statewide CEDS prioritizes eight, much broader clusters: Agriculture, Aquaculture, and Food Systems; Creative Industries; Education and Knowledge Creation; Energy and Sustainable Renewables; Health and Wellbeing; Hospitality and Tourism; Defense and National Security; and Science and Technology. But our results show how the principle of relatedness can support a diversification-focussed CEDS using objective measures.

6. Concluding remarks

The analysis here uses the *Principle of Relatedness* to reveal the industries that would help to diversify the economy of Hawai'i, but there is nothing particularly surprising about our results. All of the opportunities identified have already been discussed widely and for quite some time. The greatest value from this analysis is that the feasible opportunities to diversify the economy are revealed through an *objective* measure rather than subjective and emotive lobbying of various interest groups. Therefore, the types of policies that could be developed from the principle of relatedness are far less susceptible to subjective political incentives. It is not the loudest voices that are elevated by this report. The often vocal support for reviving agriculture in the islands is not strongly supported by our results. It appears as an option, but other options in more niche industries are likely to be more feasible such as aquaculture, water transportation, and film production which uniquely fit into Hawai'i's industry portfolio.

Of course some of the opportunities highlighted here have been known for centuries. The potential for reviving and modernizing aquaculture and water transportation in Hawai'i is reminiscent of Native Hawaiian knowledge that has been overlooked by modern epistemology. On this basis, developing modern versions of the activities that thrived in the Kingdom of Hawai'i would also seem to be a relevant path forward for diversification opportunities. That said, the economic structure of Hawai'i changed dramatically with its exposure to the outside world and the opportunity to trade. So, this also requires adapting traditional knowledge to a modern, globalized context.

The proposed approach in this report—to address developmental bottlenecks in underperforming industries with potential—has not been commonly used in Hawai'i. It is tempting to pick industries with faster growth. This is the approach taken by the State's Department of Business, Economic Development and Tourism in monitoring "Emerging Activities" (DBEDT, 2023). Yet these are industries that have already overcome developmental bottlenecks through market-led initiatives. These are industries that perhaps require support to grow from infancy, but this is a "steady as she goes" approach that is probably sufficient to get the policy settings right for those industries. Our ambitious approach to diversification targets the more difficult problems in areas of potential that have not yet offered significant growth. These are areas with potential that are facing problems that need to be addressed.

Similarly, the size of employment is not the important factor as some industries are very small, but could play an important role in diversifying the economy. By targeting industries that are highly related to existing industries, regardless of their size, Hawai'i can develop several niche industries that achieve relatively large scale in Hawai'i compared to other locations, even if they are relatively small shares of the economy, because such core strengths could be sustained in Hawai'i for the long term.

A successful diversification strategy will build on the analysis here. But perhaps even more critical to its success is policy design and governance. Diversification initiatives will be more successful if they can uncover private information about new opportunities and the barriers to accessing them, maintain an entrepreneurial discovery process, monitor progress, and respond effectively to failures. Governance may even be more important than the particular sectors of opportunity.

Overall, the report leads us to two overarching conclusions. Firstly, it particularly highlights the difficulty to find industries to diversify Hawai'i's economy, especially on the Neighbor Islands. In Honolulu, many industries with a high relatedness density already have a location quotient greater than one, so further expansion might be difficult if these are already operating at an equilibrium scale and there are few or no barriers to industry expansion. For the Neighbor Islands, a high relatedness density requires connections to existing strengths. But all of the Neighbor Islands are more specialized in tourism, and so they tend to have fewer branching opportunities, resulting in lower relatedness densities.

Secondly, the industries that we found for diversifying the economy will be incredibly difficult to establish. The options are littered with attempts and failures in Hawai'i. There are significant barriers to many of these options that have not been overcome in the past. If these are too great to overcome in a cost-effective way, then perhaps it implies that Hawai'i's economy is, in fact, not *over*-specialized—it is possible that Hawai'i is simply as specialized as necessary as a small and very open economy—it's just that it is more specialized than other places. On this basis, perhaps the goal of diversifying is a distraction from more pertinent policy initiatives that would help to reduce the risks and impacts of Hawai'i's specialization. In any case, it would still be worthwhile investigating the potential to address developmental bottlenecks in other industries, alongside considerations of other ways to address concerns about Hawai'i's specialized economy.

Despite these conclusions, the study leaves us with optimism for turning around a long-term slump in the Hawai'i economy. While Hawai'i's economic growth has been lagging for far too long—recently leading to a declining population as many Hawai'i residents leave for opportunities and a lower cost-of-living on the mainland—the approach we prpose to diversify Hawai'i's economy opens the door to potentially changing this trajectory and supporting a thriving and growing economy.

Appendix - Diversification opportunities and clusters by county

Table A1: Highest relatedness densities for traded industries with location quotients less than one in Honolulu

Industry	Location Quotient	Relatedness Density
Shellfish Fishing	0.00	35.69
Gold Ore Mining	0.00	35.35
All Other Traveler Accommodation	0.81	32.92
Boat Building	0.00	32.57
Bed-and-Breakfast Inns	0.00	32.18
Timber Tract Operations	0.00	30.92
Seafood Product Preparation and Packaging	0.00	30.46
Port and Harbor Operations	0.00	30.43
Inland Water Freight Transportation	0.00	30.10
Recreational and Vacation Camps (except Campgrounds)	0.41	29.29
RV (Recreational Vehicle) Parks and Campgrounds	0.00	29.20
Support Activities for Forestry	0.00	29.19
Dimension Stone Mining and Quarrying	0.00	29.12
Breweries	0.21	28.79
Other Management Consulting Services	0.70	28.70
Wineries	0.18	28.55
Broilers and Other Meat Type Chicken Production	0.00	28.47
Independent Artists, Writers, and Performers	0.49	28.44
Promoters of Performing Arts, Sports, and Similar Events with Facilities	0.00	28.19
Construction, Mining, and Forestry Machinery and Equipment Rental and Leasing	0.35	27.96
Libraries and Archives	0.00	27.84
Promoters of Performing Arts, Sports, and Similar Events without Facilities	0.24	27.44
Inland Water Passenger Transportation	0.00	27.32
Support Activities for Animal Production	0.15	27.31
Deep Sea Freight Transportation	0.00	27.31
Water Supply and Irrigation Systems	0.24	27.24
All Other Nondepository Credit Intermediation	0.13	27.22
Professional Organizations	0.26	27.18
Distilleries	0.31	27.14
Computer Systems Design Services	0.75	27.12
Construction and Mining (except Oil Well) Machinery and Equipment Merchant Wholesalers	0.39	27.06
Wireless Telecommunications Carriers (except Satellite)	0.87	27.04
Motion Picture and Video Production	0.34	27.04
Other Support Activities for Air Transportation	0.80	27.03
Computer Facilities Management Services	0.64	27.03
Logging	0.00	27.02
Interior Design Services	0.51	26.99
Limousine Service	0.90	26.90
Other Gambling Industries	0.00	26.80
Fabricated Structural Metal Manufacturing	0.00	26.79
Skiing Facilities	0.00	26.76
Other Scientific and Technical Consulting Services	0.74	26.73
Other Commercial and Industrial Machinery and Equipment Rental and Leasing	0.90	26.70
Outdoor Advertising	0.31	26.67
Drafting Services	0.84	26.66
Nuclear Electric Power Generation	0.00	26.64

Note: Diversification opportunities are traded industries with location quotients less than one and relatively higher relatedness densities. The table should be interpreted with caution based on the text in the main report.

Table A2: Highest relatedness densities for clusters in Honolulu

Cluster	Location Quotient	Relatedness Density
Metal Mining	0.00	35.35
Water Transportation	3.26	30.76
Fishing and Aquaculture	0.46	30.19
Jewelry and Precious Metals	2.81	29.74
Forestry	0.00	29.09
Local Retailing of Clothing and General Merchandise	1.43	28.39
Local Hospitality Establishments	1.19	28.23
Local Community and Civic Organizations	1.22	28.10
Hospitality and Tourism	2.45	27.41
Local Real Estate, Construction, and Development	1.28	27.31
Local Health Services	1.00	27.25
Local Education and Training	2.10	27.25
Local Food and Beverage Processing and Distribution	1.15	27.16
Video Production and Distribution	0.28	27.04
Local Household Goods and Services	0.72	26.98
Local Logistical Services	1.10	26.93
Local Personal Services (Non-Medical)	0.88	26.92
Local Motor Vehicle Products and Services	0.81	26.79
Local Entertainment and Media	1.02	26.71
Local Commercial Services	0.98	26.32
Local Utilities	1.18	26.09
Performing Arts	1.14	25.98
Education and Knowledge Creation	0.76	25.93
Local Financial Services	1.08	25.90
Local Industrial Products and Services	0.61	25.82
Business Services	0.73	25.60
Agricultural Inputs and Services	0.04	25.38
Livestock Processing	0.47	25.24
Nonmetal Mining	0.00	25.23
Transportation and Logistics	1.81	24.70
Leather and Related Products	0.61	24.58
Marketing, Design, and Publishing	0.33	24.56
Distribution and Electronic Commerce	0.53	24.45
Apparel	0.93	24.32

Table A3: Highest relatedness densities for traded industries with location quotients less than one in Maui County

Industry	Location Quotient	Relatedness Density
Gold Ore Mining	0.00	28.90
Dimension Stone Mining and Quarrying	0.00	25.06
Finfish Fishing	0.00	24.71
Logging	0.00	24.53
Rice Farming	0.00	24.18
Shellfish Fishing	0.00	23.82
Boat Building	0.00	23.65
Support Activities for Forestry	0.00	23.54
RV (Recreational Vehicle) Parks and Campgrounds	0.00	23.49
Timber Tract Operations	0.00	23.34
Recreational and Vacation Camps (except Campgrounds)	0.00	23.26
Fruit and Tree Nut Combination Farming	0.00	22.44
Marinas	0.00	22.25
Broilers and Other Meat Type Chicken Production	0.00	22.13
Wineries	0.00	22.13
Skiing Facilities	0.00	21.50
Ship Building and Repairing	0.00	20.99
Finfish Farming and Fish Hatcheries	0.00	20.94
Breweries	0.00	20.94
Consumer Lending	0.15	20.93
Sawmills	0.00	20.86
Farm and Garden Machinery and Equipment Merchant Wholesalers	0.00	20.84
Farm Supplies Merchant Wholesalers	0.00	20.80
Support Activities for Animal Production	0.00	20.70
All Other Nondepository Credit Intermediation	0.00	20.37
Tobacco Farming	0.00	20.24
Museums	0.36	20.09
Other Heavy and Civil Engineering Construction	0.00	20.09
Soil Preparation, Planting, and Cultivating	0.00	20.08

Note: Diversification opportunities are traded industries with location quotients less than one and relatively higher relatedness densities. The table should be interpreted with caution based on the text in the main report.

Table A4: Highest relatedness densities for clusters in Maui County

Cluster	Location Quotient	Relatedness Density
Metal Mining	0.00	28.90
Forestry	0.00	23.78
Fishing and Aquaculture	0.00	21.21
Local Hospitality Establishments	1.55	20.83
Local Retailing of Clothing and General Merchandise	1.46	19.63
Jewelry and Precious Metals	2.33	19.15
Local Community and Civic Organizations	1.15	19.09
Local Real Estate, Construction, and Development	1.20	19.03
Local Household Goods and Services	1.60	18.72
Local Motor Vehicle Products and Services	0.70	18.69
Local Health Services	0.76	18.67
Local Financial Services	0.38	18.42
Nonmetal Mining	0.00	18.37
Hospitality and Tourism	10.47	18.24
Local Education and Training	1.33	18.09
Local Personal Services (Non-Medical)	0.70	18.00
Agricultural Inputs and Services	0.00	17.99
Local Logistical Services	1.10	17.96
Water Transportation	0.34	17.86
Agriculture	0.24	17.83
Local Food and Beverage Processing and Distribution	1.37	17.57
Video Production and Distribution	0.08	17.55
Local Industrial Products and Services	0.02	17.26
Local Entertainment and Media	0.78	17.24
Local Utilities	0.35	17.11
Local Commercial Services	0.59	17.08

Table A5: Highest relatedness densities for traded industries with location quotients less than one on Kaua'i

Industry	Location Quotient	Relatedness Density
Logging	0.00	19.79
Gold Ore Mining	0.00	19.60
Timber Tract Operations	0.00	17.57
Grain and Field Bean Merchant Wholesalers	0.00	17.52
Dimension Stone Mining and Quarrying	0.00	17.41
Bed-and-Breakfast Inns	0.00	17.36
Farm Supplies Merchant Wholesalers	0.00	17.27
Farm and Garden Machinery and Equipment Merchant Wholesalers	0.00	17.06
RV (Recreational Vehicle) Parks and Campgrounds	0.00	17.06
Support Activities for Forestry	0.00	16.82
Consumer Lending	0.40	16.38
Recreational and Vacation Camps (except Campgrounds)	0.00	16.37
Finfish Fishing	0.00	16.33
Sawmills	0.00	16.30
General Freight Trucking, Long-Distance, Truckload	0.00	16.10
Bituminous Coal and Lignite Surface Mining	0.00	15.76
Broilers and Other Meat Type Chicken Production	0.00	15.49
Hog and Pig Farming	0.00	15.42
Boat Building	0.00	15.42
Wineries	0.00	15.27
Bituminous Coal Underground Mining	0.00	15.19
Marinas	0.00	15.18
Soybean Farming	0.00	15.13
Shellfish Fishing	0.00	15.11
Oilseed and Grain Combination Farming	0.00	15.07
Specialized Freight (except Used Goods) Trucking, Long-Distance	0.00	14.92
Support Activities for Oil and Gas Operations	0.00	14.84
Finfish Farming and Fish Hatcheries	0.00	14.59

Note: Diversification opportunities are traded industries with location quotients less than one and relatively higher relatedness densities. The table should be interpreted with caution based on the text in the main report.

Table A6: Highest relatedness densities for clusters on Kaua‘i

Cluster	Location Quotient	Relatedness Density
Metal Mining	0.00	19.60
Forestry	0.00	17.99
Coal Mining	0.00	15.47
Local Hospitality Establishments	1.54	14.72
Fishing and Aquaculture	0.00	14.00
Local Financial Services	0.66	13.30
Local Retailing of Clothing and General Merchandise	1.40	13.08
Local Community and Civic Organizations	1.17	12.86
Local Motor Vehicle Products and Services	0.69	12.81
Local Real Estate, Construction, and Development	1.36	12.64
Local Health Services	0.93	12.64
Local Household Goods and Services	1.74	12.41
Agriculture	0.00	12.18
Nonmetal Mining	0.00	12.15
Local Logistical Services	1.04	11.97
Agricultural Inputs and Services	0.00	11.83
Local Personal Services (Non-Medical)	0.51	11.78
Local Education and Training	1.01	11.66
Hospitality and Tourism	9.10	11.56
Local Industrial Products and Services	0.00	11.46
Local Utilities	1.16	11.38
Local Food and Beverage Processing and Distribution	1.43	11.29
Oil and Gas Production and Transportation	0.00	11.24
Local Entertainment and Media	0.22	11.05
Jewelry and Precious Metals	0.00	11.04
Local Commercial Services	0.67	10.91
Livestock Processing	0.00	10.72
Water Transportation	0.00	10.54
Video Production and Distribution	0.00	10.23

Table A7: Highest relatedness densities for traded industries with location quotients less than one on Hawai'i Island

Industry	Location Quotient	Relatedness Density
Gold Ore Mining	0.00	29.52
Logging	0.00	28.17
Timber Tract Operations	0.00	27.98
Dimension Stone Mining and Quarrying	0.00	25.58
Finfish Fishing	0.00	25.33
RV (Recreational Vehicle) Parks and Campgrounds	0.00	25.00
Boat Building	0.00	24.45
Recreational and Vacation Camps (except Campgrounds)	0.00	24.31
Shellfish Fishing	0.00	24.27
Finfish Farming and Fish Hatcheries	0.00	24.19
Consumer Lending	0.32	24.16
Broilers and Other Meat Type Chicken Production	0.00	24.09
Farm and Garden Machinery and Equipment Merchant Wholesalers	0.76	23.90
Sawmills	0.00	23.68
Rice Farming	0.00	23.33
Wineries	0.00	23.16
Marinas	0.00	23.03
Grain and Field Bean Merchant Wholesalers	0.00	22.76
General Freight Trucking, Long-Distance, Truckload	0.01	22.54
All Other Nondepository Credit Intermediation	0.36	22.25
Tobacco Farming	0.00	22.09
Support Activities for Oil and Gas Operations	0.00	21.81
Soybean Farming	0.00	21.79
Wireless Telecommunications Carriers (except Satellite)	0.72	21.62
Poultry Processing	0.00	21.61
Postharvest Crop Activities (except Cotton Ginning)	0.00	21.60
Specialized Freight (except Used Goods) Trucking, Long-Distance	0.54	21.58
Soil Preparation, Planting, and Cultivating	0.00	21.46
Support Activities for Animal Production	0.29	21.38
Independent Artists, Writers, and Performers	0.76	21.25
Skiing Facilities	0.00	21.19
Bituminous Coal and Lignite Surface Mining	0.00	21.17
Drilling Oil and Gas Wells	0.00	21.05
Shellfish Farming	0.00	20.85
Hog and Pig Farming	0.00	20.79
Other Heavy and Civil Engineering Construction	0.00	20.75
Bituminous Coal Underground Mining	0.00	20.67
Museums	0.64	20.34
Libraries and Archives	0.00	20.25
Facilities Support Services	0.07	20.19
Crude Petroleum and Natural Gas Extraction	0.00	20.11
Crop Harvesting, Primarily by Machine	0.00	20.06
Potato Farming	0.00	20.04

Note: Diversification opportunities are traded industries with location quotients less than one and relatively higher relatedness densities. The table should be interpreted with caution based on the text in the main report.

Table A8: Highest relatedness densities for clusters on Hawai'i Island

Cluster	Location Quotient	Relatedness Density
Metal Mining	0.00	29.52
Forestry	3.81	27.14
Fishing and Aquaculture	0.00	22.36
Local Hospitality Establishments	1.30	21.94
Coal Mining	0.00	20.92
Local Retailing of Clothing and General Merchandise	1.70	20.32
Local Financial Services	0.65	19.81
Local Motor Vehicle Products and Services	1.06	19.75
Local Community and Civic Organizations	1.06	19.64
Local Real Estate, Construction, and Development	1.52	19.55
Local Health Services	0.99	19.49
Local Household Goods and Services	1.42	19.32
Nonmetal Mining	0.00	18.69
Agricultural Inputs and Services	0.07	18.63
Local Logistical Services	1.08	18.58
Local Education and Training	1.76	18.44
Local Personal Services (Non-Medical)	0.71	18.38
Agriculture	0.09	18.24
Hospitality and Tourism	6.34	18.20
Local Industrial Products and Services	0.40	17.98
Local Food and Beverage Processing and Distribution	1.80	17.85
Local Utilities	0.67	17.75
Oil and Gas Production and Transportation	0.00	17.72
Local Entertainment and Media	0.89	17.54
Jewelry and Precious Metals	0.00	17.48
Local Commercial Services	0.66	17.30
Water Transportation	0.02	17.29
Livestock Processing	0.00	16.74
Video Production and Distribution	0.06	16.02
Business Services	0.48	15.66
Wood Products	0.00	15.62
Performing Arts	0.23	15.29
Education and Knowledge Creation	0.29	15.06

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Endnotes

1 This estimate is based on regional price differences according to the Bureau of Economic Analysis, Regional Price Parities by State and Metro Area, Dec 14 2023.

2 It remains controversial whether there has been enough use to have made the Convention Center a good investment. But this is also an implementation, management and governance issue that could be addressed with policy or initiative design. It is not an argument against the logic of making specific investments to initiate economic development by addressing market failures.

3 For example, see https://growthlab.hks.harvard.edu/policy-research for more information on projects underway by the Growth Lab at Harvard's Center for International Development.

4 At publication of this UHERO report, this technical paper is still a work in progress.

5 The slow recovery of international visitors to Oʻahu may reduce the estimates of location quotients for tourism industries in Honolulu. But if the recovery of US visitors in Hawaiʻi is similar to other tourist destinations in the US then location quotients would be mostly unaffected on the Neighbor Islands. In any case, the hospitality industries in Hawaiʻi generally have a location quotient well above the threshold of one, so it does not affect the calculation of relatedness at all.

6 CBP is our preferred data source, as QCEW shows zeros for employment in many six-digit industries to protect confidentiality. It is possible that a very small six-digit agriculture industry could have positive employment, and it is shown as zero. The overall impact of this limitation is ambiguous, and we do not expect that it significantly affected our results. To protect confidentiality, CBP contains noise for very small observations, but this is unlikely to affect the results in this report because our analysis relies on the threshold that a location quotient is above or below one. It would be rare for noise to tip LQ above or below the threshold, but none of our conclusions are so close to this threshold for this to be a consideration.

7 For example, *Full-Service Restaurants* are classified as local, but one of the reasons this industry is larger in all Hawaiʻi counties is because of the tourism industry. Alternatively, *Environmental Services*, which includes industries like *Waste Collection* and *Materials Recovery Facilities*, should not be considered traded in Hawaiʻi since these activities occur on island.

8 Note that our conclusions disregard industries with higher relatedness densities that are clearly not possible or are unlikely in each county.

9 For example, Coal mining also appears in the results as a potential cluster for all islands but this is clearly not feasible without coal deposits. It likely appears to be related to existing industries in each county because Hawaiʻi has so much Fossil Fuel Electric Power and coal power plants are often located next to coal mines on the mainland. So, this result is disregarded.

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AT THE UNIVERSITY OF HAWAIʻI

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Queen's Health Systems

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Central Pacific Bank
D.R. Horton
First Insurance Company of Hawaii, Ltd.
Hawaii Pacific Health
Hawaiian Airlines
Hawaiian Electric Industries
Matson
Tradewind Group

KUAHIWI - A HIGH HILL, MOUNTAIN

Alexander & Baldwin
Better Homes and Gardens Real Estate Advantage Realty
Castle & Cooke Hawaii
Chamber of Commerce
Halekulani Corporation
Hawaii Gas
Hawaii Hotel Alliance
Hawaii State AFL-CIO
Hawaiian Dredging Construction Company
HGEA
Honolulu Board of Realtors
Honolulu Board of Water Supply
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