



A Growth Perspective on Wyoming

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This report informs the Pathways to Prosperity Project between the Growth Lab at Harvard University and the State of Wyoming. It has been updated based on stakeholder feedback and continued research across the State Wyoming following a first draft circulated in November 2022.

Acknowledgments

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This report is intended as a situation analysis of Wyoming's economic position in the context of an evolving national and global economy, particularly after the emergence of the COVID-19 pandemic. It focuses on drivers of economic output and jobs. In doing so, it does not begin to discuss the significant advantages that Wyoming has in the strength of its various communities and continuous public contributions of private individuals across the state. This report could not have been conducted in the same detail without these strengths. The Pathways to Prosperity Project that is informed by this report will seek to continue to leverage these capabilities of the Wyoming community to strengthen growth and resilience moving forward.

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Executive Summary

This report sets out to understand if the economy of the State of Wyoming is positioned to grow into the future. To do this, the report begins by investigating the past. To know where the state economy could be headed, and how that direction may be improved, it is critical to understand how the state developed the economic structure and drivers that it has today. Thus, Wyoming's economic trajectory is explored over the long, medium, and short term. From this investigation, we find that Wyoming faces an overall growth problem, but we also find a high degree of variation in economic engines and growth prospects across the state. The problem that this report identifies is that the composition of economic activities is not positioned to sustain a high quality of life *across all parts of the state*.

“Across all parts of the state” is an essential part of the problem statement for Wyoming. While some local and regional economies in the state are growing and bumping up against identifiable constraints, other local and regional economies are experiencing sustained contractions and will require new sources of growth in order to retain (or expand) population and high quality of life. Since economic dynamics vary significantly across the state, analysis is conducted in as much geographic detail as possible. By combining historical and geographic dimensions of growth, this report aims to inform pathways for sustained and inclusive prosperity across the of Wyoming.

Growth over the long term...

Wyoming's long-term economic trajectory — based on data going back to 1870 — is intimately tied to its limited population agglomeration and specialization in natural resource industries. Wyoming's population has lagged behind neighboring states over virtually its entire history, which largely results from the comparatively limited agricultural potential and broader livability of its land. An index of land quality in terms of its ability to support human population — by Henderson et al. (2022) — indicates that Wyoming's counties have some of the lowest potential for dense human population in the United States. Despite its early advantage in transcontinental rail, Wyoming also missed an early influx of population growth that affected other parts of the West due to the nature of its resource base. Over time, Wyoming's mining resources gained value, but population growth was always very limited. At points in time where resources gained value due to high national or global prices, the state's fiscal system gained increasing reliance on taxing resource extraction rather than other sources of income or wealth.

Wyoming's small population agglomerations predispose the state to not just remain small in population terms, but to engage in a limited set of economic activities. Evidence from the contemporary economic geography of the U.S. indicates that the vast majority of tradable economic activities tend to be larger in central locations close to lots of human population, whereas only a small minority of industries — concentrated strongly in natural resources, agriculture, and tourism — tend to be larger in remote places. These remote places tend to have lesser access to the wide variety of skills and knowhow needed to support economic diversification while also being further away from markets. Wyoming faces a striking disadvantage in the modern economy, where a diverse set of high-income jobs cluster in large labor markets, due to its small and dispersed population centers. This report outlines the co-evolution of Wyoming's low population with its low economic diversification. This co-evolution has not undermined Wyoming's ability to support a high quality of life but does make this standard of living vulnerable under changing national and global economic conditions.

Growth over the last 20-30 years...

Wyoming's economy over the last generation follows directly from its longer history. A recent boom-bust cycle looms large over Wyoming's medium term economic trajectory. Although the boom leading up to the time of the Global Financial Crisis fueled growth of jobs and income — led by mining and associated construction — the bust thereafter (and especially after the end of a global commodity supercycle in 2014) had several deleterious consequences. Whereas Wyoming surpassed all its neighbors in the growth rate of middle-class jobs (measured as those paying \$40,000 to \$80,000 in 2000 USD) from 2000-2013, by the late 2010s this had collapsed to among the very lowest in the region. The number of jobs in the state fell while other states recovered from the Global Financial Crisis and some neighboring states grew rapidly. Job lost was most intensive for people not born in the state, while job growth for the Wyoming-born population flatlined. From 2014-2017 businesses in Wyoming also cited slow business and the unpredictability of business conditions as major sources of lost profits at higher rates than surrounding states.

Many effects and consequences of the bust were specific to local areas of Wyoming. Counties such as Sublette, Campbell, Big Horn, Sweetwater, and others were highly exposed to the shock in prices due to their high concentration of wages accounted for by the mining sector. Albany, Teton, Laramie, and Goshen counties, in comparison, were relatively insulated. There were also important differences in which counties produced which resources. Campbell and Converse counties were highly exposed to coal, whereas natural gas and oil figured more heavily into a variety of other counties, with these different resources being differentially affected by national and global market dynamics and technology change. Smaller towns were the hardest-hit communities as these labor market effects played out. Larger towns in a variety of counties tended to maintain more growth in population and labor force participation, whereas small towns more often shrunk. Importantly, several areas of the state — often those concentrated in mineral resources — lost social mobility, reflecting a decline in equal opportunity.

The population of Wyoming today is highly geographically dispersed, with no large cities and half the population living in towns of fewer than 10,000 people. Median household income compares favorable versus neighboring states, reflecting an often-high quality of life. Nevertheless, migration patterns suggest that economic prosperity is not shared by all. A majority of people born in Wyoming no longer live in the state, and rates of out-migration among young adults are the highest in the US. This is offset by large amounts of in-migration — most people who live in Wyoming were born in another state — but there is an overall brain drain of college-educated people out of the state.

Post-pandemic growth and prospects...

The short-term trajectory of Wyoming's economy since 2020 has been shaped by the pandemic but in many respects is also a continuation of the medium term bust. Wyoming's aggregate employment and wages have recovered at slower rates than in surrounding states, but these effects are overwhelmingly driven by sluggish activity in the mining sector. Many counties experienced growth in manufacturing, professional services, finance, and accommodation & food services. The best- and worst-faring counties mostly parallel medium-term trends as well. Teton, Albany, Lincoln, and Sheridan counties grew jobs and wages from 2020 Q1 to 2022 Q1. Some of

the hardest-hit counties on these measures were Converse, Sweetwater, Campbell, and Natrona counties.

A silver lining from the pandemic was the large-scale adoption of remote work, which opened the possibility of new service employment in geographically remote communities. While rates of remote work generally increased in Wyoming from 2019 to 2021, these increments were small compared to those in areas of surrounding states. The commuting zones in Wyoming with the highest rates of remote work adoption now hover around 10%, for instance, whereas parts of every neighboring state have rates closer to 15% or in some instances 25%. In most parts of Wyoming this can be explained by the pre-existing occupation structure not being especially amenable to remote work, but in Laramie and Cheyenne rates of remote work are below expectations given the occupation structure.

Declining national consumption of fossil fuels, especially coal, has been a key driver of Wyoming's economic challenges. Yet, going forward another near-term opportunity for Wyoming lies in new energy and changes in national and global economic systems through decarbonization. Wyoming had an impressive rate of growth in occupations needed for the 'green' economy from 2010-2020 versus neighboring states, and its rate of patenting environmentally-friendly technologies also compares favorably. It also has natural resources and established capabilities that may position it to benefit from new demand for low-carbon energy, rare earth minerals, and carbon sinks — in addition to other opportunities likely not yet evident.

Understanding pathways to prosperity

Overall, Wyoming's economic structure has provided a high quality of life for many residents and an enviable level of equity and social mobility. But its reliance on fossil fuels is threatened by global trends in decarbonization. If these continue to accelerate, Wyoming's economic future could look a lot like an extension of the recent bust. Losses of jobs, income, equality of opportunity, and funding for vital public goods and services like K-12 education could threaten Wyoming's ability to maintain a high quality of life — especially in smaller communities, which have borne the brunt of shrinking population. If left unaddressed, this could kickstart cycles of economic decline and negative impacts on health and community wellbeing that could become difficult to reverse.

Additional growth engines will be needed to support high quality of life across Wyoming and insulate against shocks. The routes to those new, additional industries will likely vary considerably by location, however. Some cities and larger towns in Wyoming maintained growth through the bust in a variety of industries, and these growth engines could scale. However, these cities appear to be hitting observable constraints, including limited growth in housing supply to support a larger workforce. Other towns and regions that have lost jobs, especially in mining and construction, without offsetting sources of growth will need to develop new drivers of tradable income that are consistent with their comparative advantages and disadvantages. These economies may have pathways forward that come through linkages with larger and more diverse economies inside and outside the state. They may, in many cases, benefit innovative approaches from the state to support local resilience and transformation.

With a grounding in this report, the Pathways to Prosperity Project between the Growth Lab at Harvard University and the State of Wyoming will work to enable stronger pathways to prosperity in practice at both the state and local levels.

1. Is Wyoming Positioned to Grow?

This report aims to provide a comprehensive perspective on Wyoming's process of economic growth over time. Understanding Wyoming's growth process, and how it has evolved within an ever-changing national and global economy, is an important step for understanding potential weaknesses in the state economy today and possible challenges ahead. Growth matters because an economy that is not growing fast enough will struggle to produce enough good jobs for residents of the state and undermine the wellbeing of Wyomingites. Ultimately, this report set out to answer the question, "Is Wyoming positioned to grow?" However, in the process of exploring this question, it became evident that Wyoming does not have a single economy but rather operates as a set of largely disconnected regional and local economies. Growth at the state level is a precondition for resilient local economies and communities, though growth at the state level does not ensure strong economies and living standards at the local level. Thus, this report discusses the growth of Wyoming as a whole and growth patterns across different parts of the state, insofar as data allows.

An initial look at aggregate statistics points to a problem. The State of Wyoming has experienced slow economic growth and an overall reduction in jobs over the last decade. Growth and employment patterns within the state have been disconnected from the growth trajectory of the United States overall and from faster growing neighboring states including Utah, Colorado, and Idaho. Since 2020, the economic shock of COVID-19 has been acute, and employment has recovered only partially — again much more slowly than the rest of the Mountain West region. The state's economy is highly concentrated in and dependent on energy and mineral wealth, and the private sector has struggled to grow and diversify despite a focus on small government, low taxation, and business-friendly regulations. Amidst slow growth, Wyoming has experienced a persistent pattern of outmigration of its labor force at the state level, especially among young adults, and sharp declines in population for many rural parts of the state. Poor economic opportunity may be creating new challenges for individual wellbeing and pressures on communities across the state. Wyoming has historically enjoyed high median incomes and social mobility. Slow growth, job losses, and outmigration over the last decade may signal that the state economy and local economies will struggle to support high levels of wellbeing moving forward if current trends continue.

To build a comprehensive perspective on growth in Wyoming — and across different parts of Wyoming — this report has three main sections that explore growth drivers and patterns along three different time horizons. First, we describe Wyoming's growth over the long-term — from 1870 until the modern era. This grounding in the past is essential to understand determinants of growth and potential path dependencies that have led Wyoming to have the economy that it does today. Second, we explore growth performance over the medium-term of the last 20 years in detail. This period includes a boom-and-bust cycle, very large differences in economic performance across the state, and striking patterns of migration. Third, we discuss growth in the short-term since the start of the pandemic. Here we see a continuation of medium-term trends in how the economy responds to the shock of COVID-19 but also potentially important differences from the past that introduce new challenges and opportunities. Finally, we reflect on Wyoming's growth process in total and propose a defining growth problem for the state. Based on this problem, we introduce several industry and regional perspectives that are indicative of potential constraints and opportunities that that will likely matter for future growth and economic resilience.

2. Long-Term Growth

Wyoming today is a rural, remote, mineral-based economy that is surrounded by states with larger population agglomerations and more diverse industrial activities. As will be explained in this section, this outcome is not merely the result of modern economic policy choices. It is rooted in deep, long-term forces, including both its factor endowments and historical path dependencies, which cannot be overlooked when considering economic growth strategies today. The historical analysis finds that innate geography has predisposed the population of Wyoming to be small and dispersed and that the state has missed several waves of economic diversification that swept its neighborhood and concentrated in larger agglomerations. Achieving future growth will require breaking this cycle of low population growth, at least to some degree and in some places. Given changes in technology that have made harsh environments more livable, this is possible, but policies to facilitate population growth may need to overcome historic barriers to this growth.

This section will first establish the basic facts of Wyoming's population growth in comparison with other states, and then examine why the trajectory of Wyoming's population matters for its overall economy. It will then delve into foundational reasons for Wyoming's persistently low population, and ultimately explore how that low population base has limited the state's participation in new economic activities over the course of the last 150-odd years. The section will explore how the economic compositions of other states in the region have evolved over the long-term as technologies and national and global demand have changed; and summarize how a few U.S. cities with significant geographic disadvantages became larger population and economic centers than towns in Wyoming today.

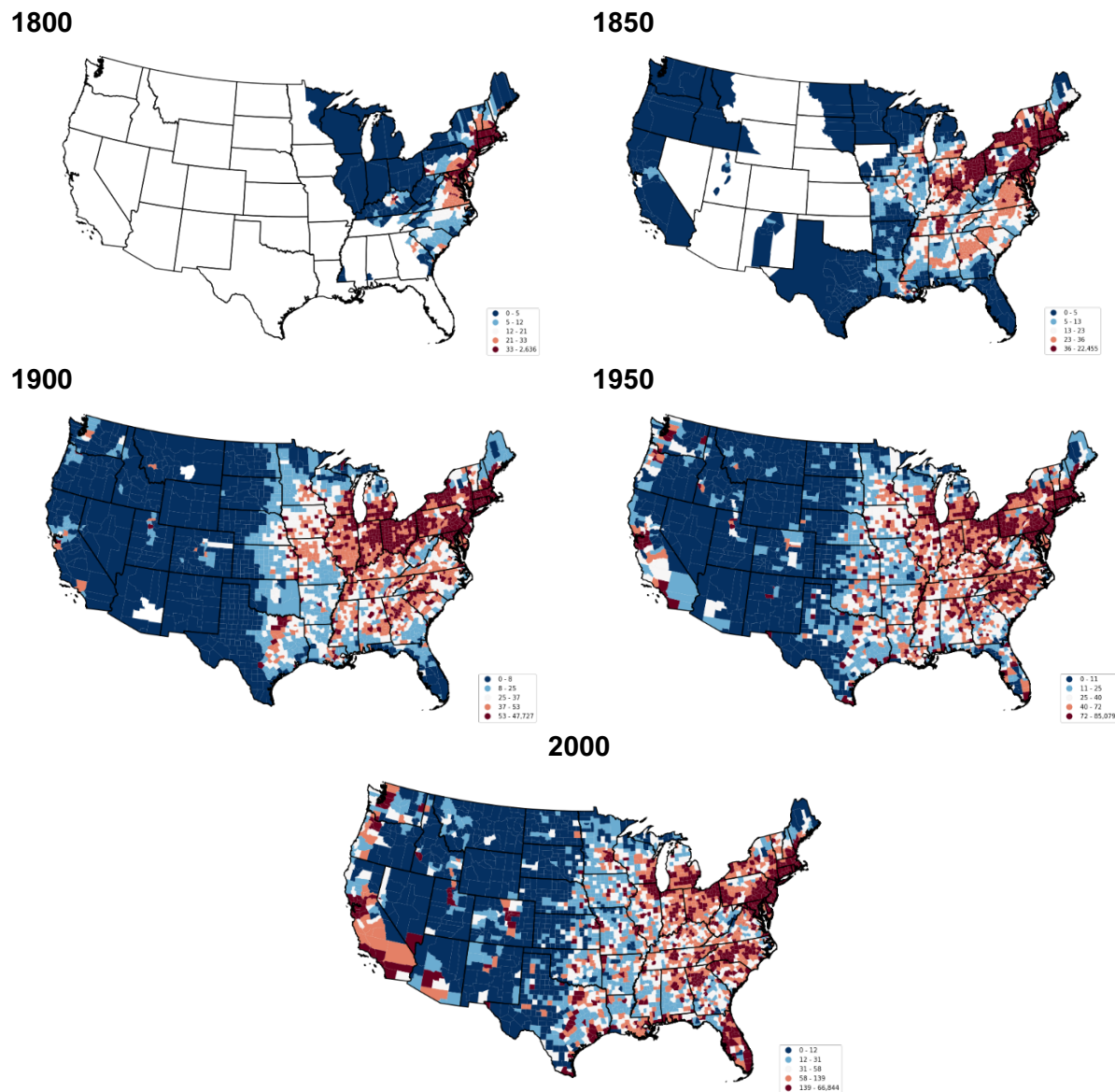
An overview of 200 years of population growth

We can establish some basic features of population growth in Wyoming by observing the pattern of population expansion across the United States over two centuries. Though people lived in Wyoming long before it was known as Wyoming, tracking the westward expansion of the U.S. population provides an overall picture of how Wyoming's population developed in relation to other states. Figure 1 shows this westward expansion of the U.S. population. By 1900, there was a clear frontier line to the west of the Mississippi River. To the west of that frontier, population had emerged along several parts of the West Coast as well in several population centers of the Mountain West, particularly around Denver and Salt Lake City. Wyoming's population by 1900 was focused within the southeast corner of the state. By 1950, that frontier softened slightly as populations along the West Coast grew, but population centers in the Mountain West remained isolated. As of 2000, this trend had largely continued, with noteworthy population growth in the southwestern U.S. in new areas, but growth in the Mountain West largely built on historic population bases.

The lack of population growth in Wyoming over the long-term is more striking if one looks at total state population over time (Figure 2). Wyoming followed a nearly linear path of population growth from 1880 to today, without periods of sustained acceleration in population growth that many neighboring states experienced. By 1960, Wyoming had half the population of Idaho, Montana, North and South Dakota, and less than a third of Nebraska and Colorado. Today the Mountain West region overall is experiencing rapid population growth and in-migration, led by Colorado, Utah, and Idaho. Population growth in Wyoming, meanwhile, has not accelerated. Within

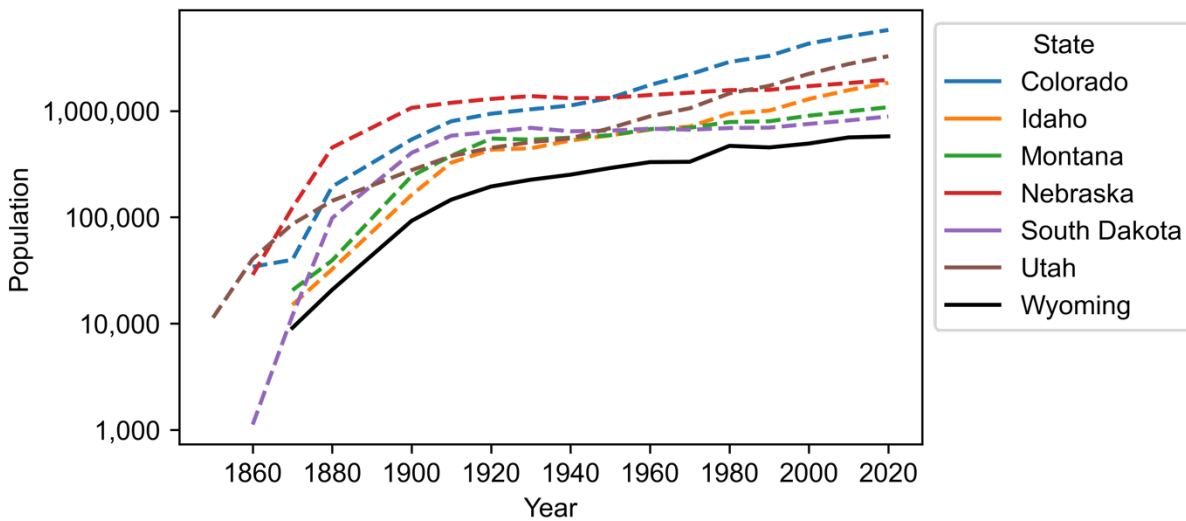
Wyoming, nearly half of the state's contemporary population is concentrated in its five largest counties. As shown in Figure 3, much of its long-term population growth has occurred in the eastern half of the state (Laramie, Natrona, Campbell, and Albany counties) and especially in the southeast corner (Laramie, Natrona, and Albany counties). Nevertheless, a large share of the state's overall population is dispersed throughout its territory. Wyoming's urbanization rate in 2010 was just 65%, as compared to the overall U.S. rate of 81%.

Figure 1: Population Density Across the U.S. Over Time (1800 – 2000)



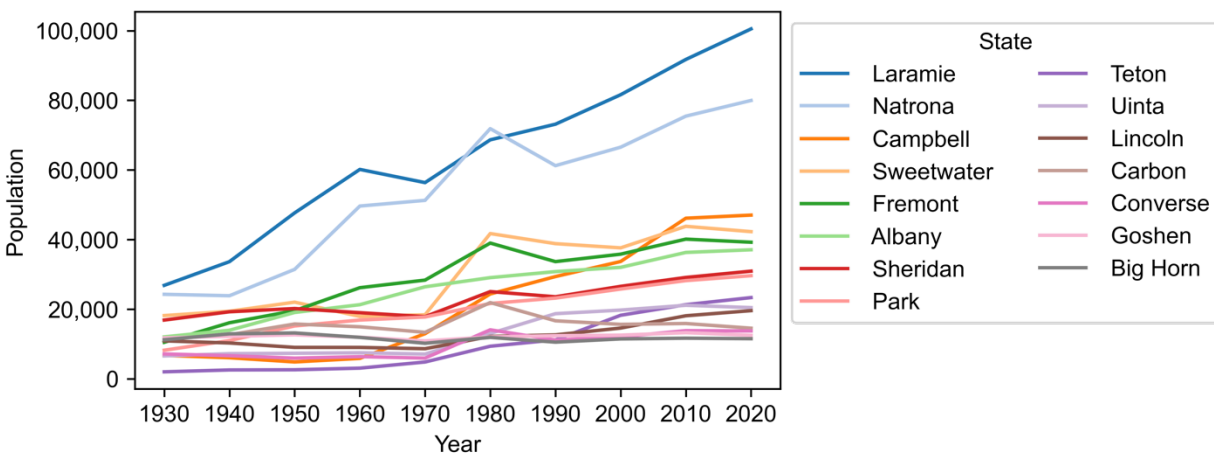
Sources: IPUMS NHGIS, University of Minnesota, www.nhgis.org

Figure 2: Population of Wyoming and Neighboring States (1860 – 2000)



Source: IPUMS – US Census Bureau (2022)

Figure 3: Population Over Time in 15 Most Populous Counties Today (1930 – 2020)



Source: U.S. Census Bureau

Does it matter that Wyoming's population is persistently small and rural?

Wyoming's constrained population trajectory does not simply matter for the overall size of its economy. It has crucial consequences for the long-term development of its economic composition because numerous industries depend strongly on access to urban agglomerations that bring together many kinds of productive knowhow. This contention is theoretically underpinned by work such as Hausmann and Hidalgo (2011), which fits a model of economic development based in 'capabilities' to real-world trade data. In this model, every kind of economic activity requires some set of capabilities. These capabilities may consist of types of infrastructure (like water or electricity), institutional frameworks (such as the protection of property rights), access to supply

chains (like suppliers of intermediate production goods), or — vitally — the practical productive knowhow that resides in people’s brains. Some economic activities require few capabilities, while others require many. For example, manufacturing jet turbines requires considerably more varied types of knowhow than manufacturing shoes, which is reflected in the number of specialized workers and firm relationships that are required for production.

In practice, some places can supply few capabilities and thus participate in few economic activities, whereas other places can supply many capabilities and thus participate in many economic activities. Germany has a far more diversified industrial portfolio than, say, Nigeria because Germany can supply many more different kinds of capabilities. Importantly for Wyoming, this kind of comparison also applies when considering remote versus central places within a particular country. Central locations with access to cities and ports can more easily access diverse capabilities, whereas remote locations disconnected from economic activity tend to have fewer at hand. It can be shown directly, in fact, that many valuable industries in the U.S. are predisposed to locate in central rather than remote locations.

We investigate this relationship by quantifying how remote different modern-day U.S. Commuting Zones are and comparing those values to the locations of different industries. Specifically, we first compute an index of remoteness versus centrality of U.S. Commuting Zones that incorporates: (1) the driving time to the nearest Commuting Zone of at least 500,000 people; (2) the driving time to all other Commuting Zones, weighed by how long it takes to get to each destination and how many people live in each destination; and (3) the driving time to the nearest port. This index is computed such that places with lower scores are more remote, and places with higher scores are more central (i.e., more connected to other places). Figure 4 shows a heatmap of how remote versus central different Commuting Zones are. Note the relatively high remoteness of Wyoming. We next compute each Commuting Zone’s relative concentration of employment in 676 tradable non-farm NAICS 6-digit industries from 2000–2016, using cleaned County Business Patterns data from Eckert et al. (2020). We take Revealed Comparative Advantage (RCA) as our measure of concentration, as described in Box 1.

Box 1: Revealed Comparative Advantage

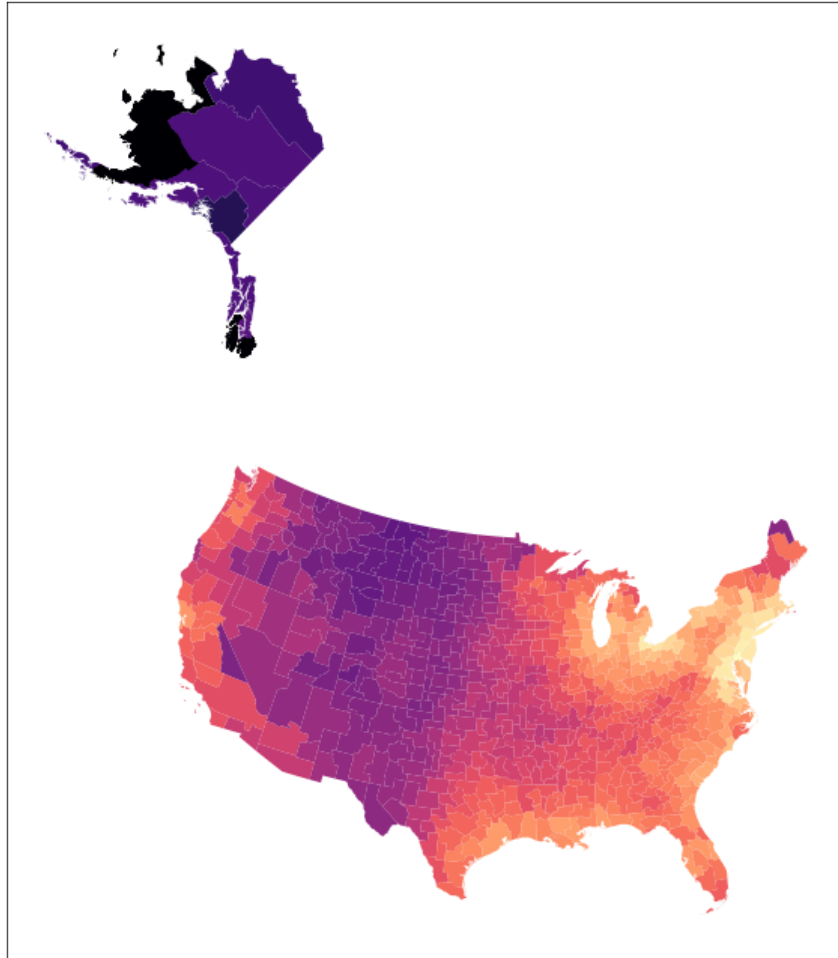
Revealed Comparative Advantage (RCA) is a measure of a location’s specialization in a particular industry. In the context of US Commuting Zones specializing in different industries, it is calculated as follows:

$$RCA_{cz,industry,year} = \frac{\% \text{ of CZ jobs in industry } i \text{ in year } y}{\% \text{ of US jobs in industry } i \text{ in year } y}$$

For the purposes of relating industry presence to the remoteness of different Commuting Zones, we convert RCA to the range -1 (if there is no presence of an industry at all) to 1 (if there is an overwhelming presence of an industry) using the following transformation:

$$RCA' = \frac{RCA - 1}{RCA + 1}$$

Figure 4: Heatmap of Remoteness (Darker) vs. Centrality (Brighter) of Commuting Zones



Source: Own calculations

We perform a series of regressions, one per industry, of the presence of an industry in a commuting zone on the remoteness of commuting zones. Based on the analysis, only 35 out of 676 industries have a tendency toward greater concentration in remote places. These industries are listed in Table 1 in the Appendix. Nearly all these industries are associated with resource extraction, agriculture, and tourism — all activities that one might intuitively link to remoteness, because they strongly leverage the natural environment of a place. The associated implication is that the other 641 industries are likelier to appear, to different extents, in central rather than remote locations. This includes a wide variety of service and manufacturing industries. Table 2 in the Appendix shows ten examples of such industries.

Wyoming's lack of population agglomerations has thus contributed to its status as a remote location, which in turn has limited its diversification by making it less likely to participate in a wide variety of industries. This represents a significant disadvantage for the state economy. This begs the question of why Wyoming's population is low. We explore this question in the next subsection and then trace in some detail the industry evolution of the state in comparison to other states over time. Understanding this path is important for understanding future growth pathways.

Why is Wyoming's population persistently small and rural?

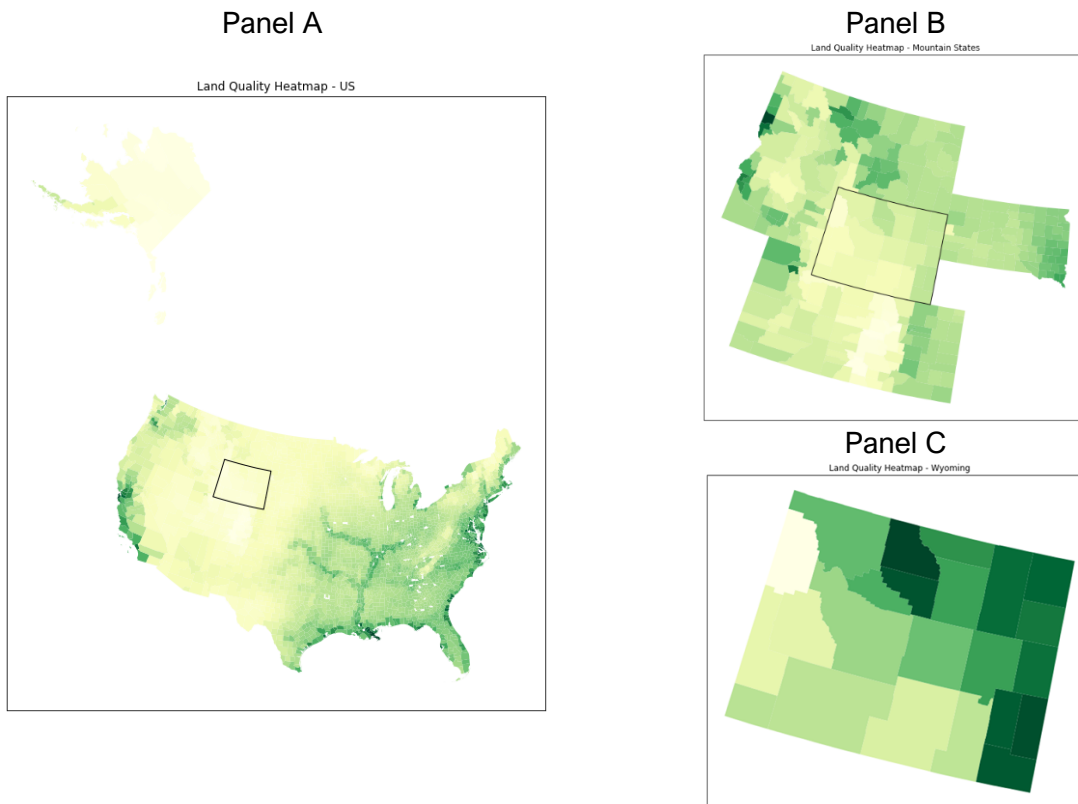
Settlement patterns all over the planet result from a combination of geographic influences and the legacy of human choice in history. While each of these channels play a role in Wyoming, the evidence suggests that the natural environment has been an especially important constraint on the state's population growth going back to its foundations. The following subsections contend that Wyoming's population growth has been limited by the innate habitability of its land, as well as the lack of mineral deposits suitable for large-scale exploitation early in its history. The administrative unavailability of parts of Wyoming for human settlement may have played a less-decisive role.

A useful variable with which to investigate the relationship between Wyoming's natural environment and its long-term population distribution is an index of land quality constructed by Henderson, Storeygard & Weil (2022). This index is especially pertinent because it transforms a wide variety of global geographic data (including distance to coasts, elevation, ruggedness, disease presence, agricultural potential, agricultural growing periods, presence of navigable rivers and lakes, temperature, and precipitation) into an overall metric of how suited a specific area is to support human population. This index is constructed by determining how each geographic variable contributes to population levels across many grid cells covering the surface of the earth (controlling for country-level effects), and then using those relationships together to assess how each individual grid cell is suited for human population overall. By its construction, the variable is useful for understanding how well a particular place's actual population aligns with its empirical potential to support human population, as informed by land quality. Wyoming has relatively low land quality compared to both the U.S. broadly and the Mountain West region specifically (Figure 5, Panels A & B), albeit with notable variation within the state (Panel C).

Nationally, Wyoming ranks at the bottom of the distribution of land quality by this index, while the Mississippi Valley and the Atlantic, Pacific, and Gulf coastlines have the highest land quality. Compared to neighboring states, land quality is generally lower across most of Wyoming's land area. However, eastern Wyoming's land quality is in some instances comparable to eastern Montana and western South Dakota. Wyoming's low level of overall land quality likely results from a confluence of factors. Figure 6 showcases five example factors that may be relevant for Wyoming: its temperature, terrain ruggedness, elevation, wind speed, and precipitation. While there are notable localized variations, on the whole Wyoming is relatively mountainous, dry, cold, and windy, making it a challenging environment for human settlement, especially prior to modern household technologies.

These factors arguably combine to deliver a limited population carrying capacity for Wyoming. Indeed, Commuting Zones with levels of land quality comparable to Wyoming have generally maintained low levels of population density. Figure 7.A shows that in 1900 the great majority of Commuting Zones (up to the 99th percentile) with land quality near that of Wyoming had population densities of at most 75 people per square mile. Figure 7.B demonstrates that by modern times this number had somewhat increased to a 100 people per square mile, but it remains low overall; the equivalent number in the middle of the distribution is closer to 1,000 per square mile. By 2010, one commuting zone (including Cheyenne) was among the highest population densities for its low level of land quality. Meanwhile, Wyoming's highest land quality by this measure is the commuting zone including Cody, which continues to have a very low population density.

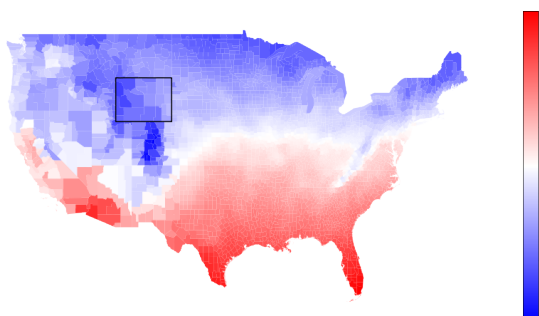
Figure 5: Land quality heatmaps of Wyoming relative to the US (Panel A), neighboring states (Panel B), and across Wyoming's Counties (Panel C)



Source: own mapping, based on Henderson, et al. (2022)

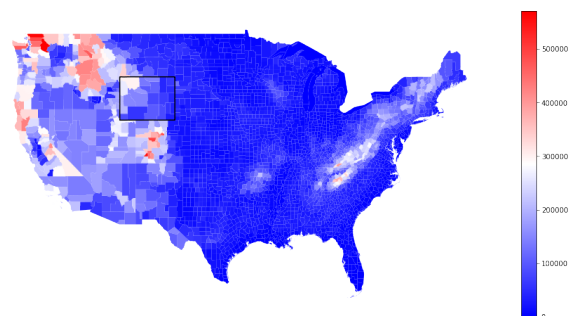
Figure 6: Select Geographic Conditions by County: Average Temperature (Panel A); Ruggedness (Panel B); Elevation (Panel C); Average Wind Speed (Panel D)

Panel A: Average Annual Temperature (°F)
from 1990 – 2020



Source: Climatic Research Unit (University of East Anglia) and Met Office (2021)

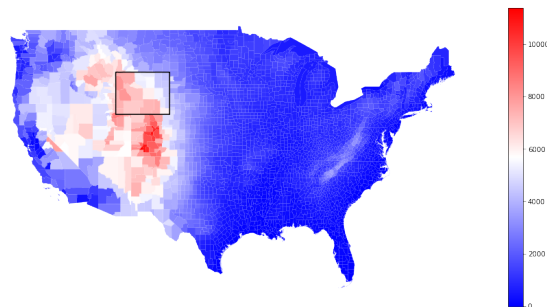
Panel B: Terrain Ruggedness Index¹



Source: Nunn & Puga (2012)

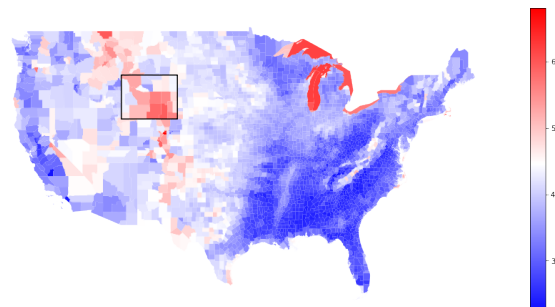
¹ Index Measuring topographic heterogeneity and variation, based on data from the US Geological Survey (2016). The number should be interpreted in relative terms. <https://diegopuga.org/data/rugged/#grid>

Panel C: Elevation (red higher – blue, lower)



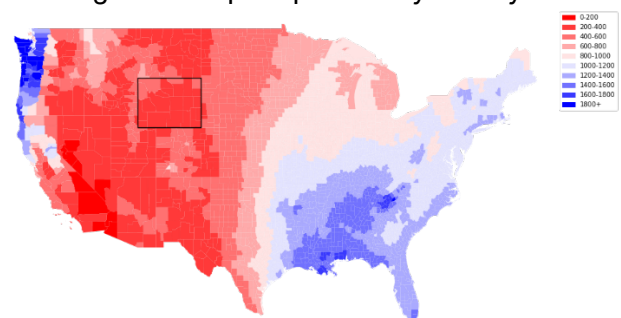
Source: SRTM Digital Elevation Data Version 4

Panel D: Mean annual wind speed in m/s



Source: Wind Speed At 10 meter above Surface Level. The Wind Integration National Dataset, National Renewable Energy Laboratory.

Panel E: Mean average annual precipitation by county in mm (1970-2000)



Source: WorldClim

Panel F: Aggregate Statistics

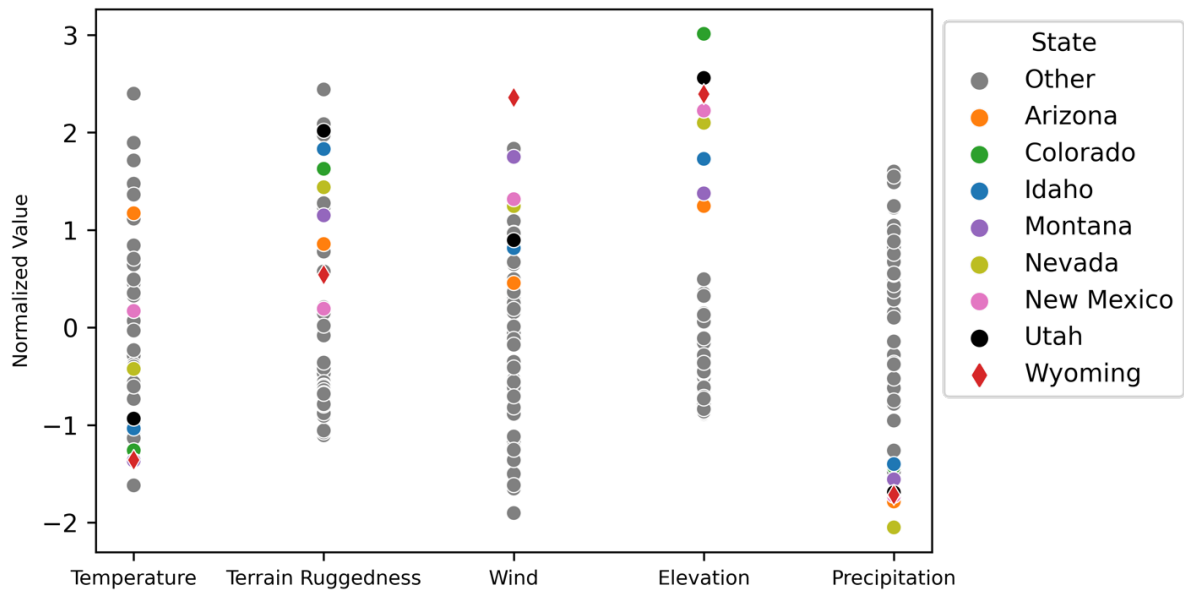
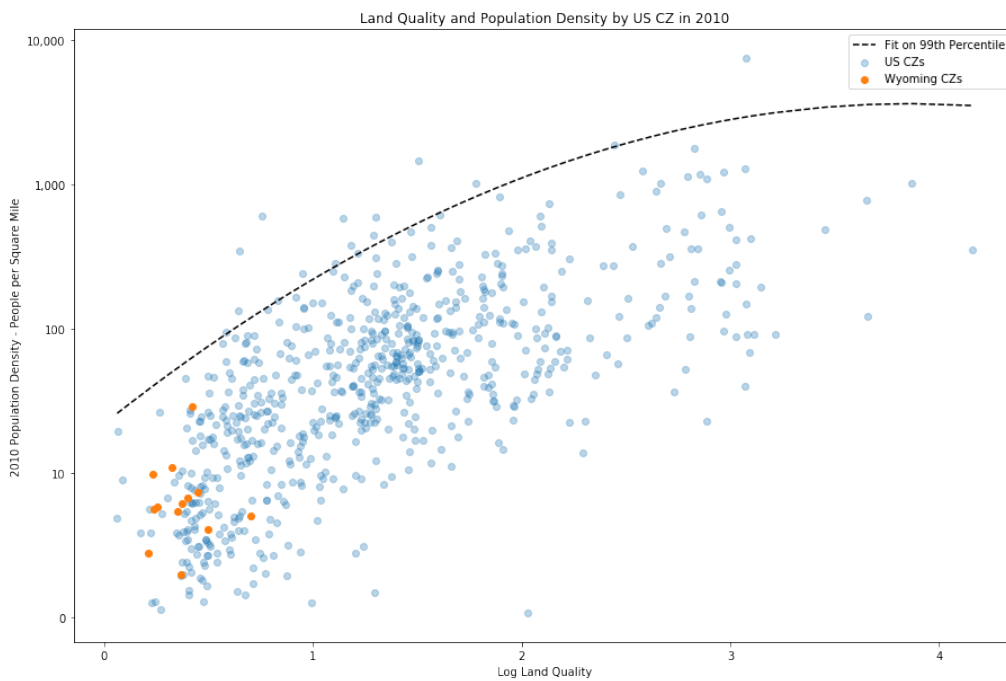


Figure 7: Land Quality and Population Density among US Commuting Zones

Panel A (Population Density in 1900)



Panel B (Population Density in 2010)



Source: Henderson et al. (2022), US Census Bureau

These patterns suggest that Wyoming's innate geography has likely placed significant limits on its population growth and agglomeration. Most other Commuting Zones with similar levels of land quality have retained low levels of population density throughout history. Nevertheless, the relationships in Figure 7 also suggest that Wyoming may yet have meaningful room to grow. Most of its Commuting Zones have approximately average levels of population density for their levels of land quality, and it is possible based on land quality alone that by moving to above average levels Wyoming could, in principle, at least double or triple its population. Thus, an important question is what has prevented Wyoming from moving to higher population density even under limitations on the land quality's carrying capacity.

Box 2: Understanding Higher Population Density of Select Western Cities

Numerous cities of the Mountain West states were able to overcome somewhat limited land quality at different points of their history. This includes large agglomerations in the Mountain West such as Denver and Salt Lake City; smaller agglomerations close to Wyoming, including Fort Collins, Boulder, Provo, Logan, Pocatello; and other larger cities in other parts of the west, including El Paso or Midland in Texas, Santa Fe or Los Alamos in New Mexico, and Las Vegas, NV. Other large Mountain West cities like Phoenix, Tucson, Boise and Albuquerque have higher values in the Land Quality Index, despite sharing some of the geographic difficulties of the region. An ongoing literature review and data analysis suggests common historical aspects, early economic conditions, and technological enablers that enabled higher population growth and agglomeration in these cities despite their location-specific geographic constraints.

The Mountain West cities listed all originated under at least one of the following activities: (1) proximity to hard rock mines; (2) the establishment of agricultural communities; or (3) trading posts where travelers resupplied during the westward expansion of the United States. Some had all three. Denver developed an agricultural base around an early gold mine that was quickly depleted but helped build some local wealth and relationships with investors in the U.S. East Coast that allowed the city to quickly become connected to the transcontinental rail. Later, Denver's economy further bolstered under a local silver boom (Gitlin, et al., 2012; Denver.org, 2022). Salt Lake City and cities in Utah developed early agricultural communities that were able to trade surpluses with the rest of the country once they were connected by rail (Smith, 2015). Phoenix also developed an agricultural economy to provide food for nearby copper mines, and Tucson did similarly but with livestock and cotton (Shermer, 2013; Dobyns, 2019). El Paso, meanwhile, was an early extension of current Ciudad Juarez and an agricultural community before it became an international border town and gained military importance in the late 19th century (Britannica, 2022). Other cities like Albuquerque, Boise, Las Vegas, Midland, and Pocatello developed as trading centers on either historic trail routes or on rail crossings, not unlike many population centers in Wyoming (Boyle, 1949; Land & Land, 2004; Boise Sesquicentennial, 2013; Gale Encyclopedia of US Economic History, 2015).

While each of the cities had their own pathways, the history of agglomerations in the Mountain West underscore three key enablers that catalyzed local economies and industries over time:

- (1) Rail Connectivity: Rail connection was critical to the development of many Mountain West cities as it connected them to global economies (Abbott, 1995; Baron, 2018). Rail facilitated agglomeration through two different channels. First, rail connections linked existing local agrarian economies and surpluses, and hard rock mines (i.e., gold and copper) to other markets, as in Denver, Salt Lake City and Phoenix, by bringing in and increasing access into processing facilities elsewhere in the country. Second, rail connection and crossings

facilitated the establishments of trading posts for travelers like in Albuquerque, El Paso, Pocatello, and early Las Vegas, or the discovery of minerals along tracks, like in Midland, Texas. Later in the 20th century, improvements in highways with the 1956 Interstate Highway Act and access to cars further improved the connectivity of the economies of these cities (Fishman, 2000), but also created new connections to others as roads displaced rail in the movement of people. Several Wyoming counties had the advantage of early rail connectivity but lacked the mineral and agricultural advantages that other places had and thus did not have surpluses to trade via rail.

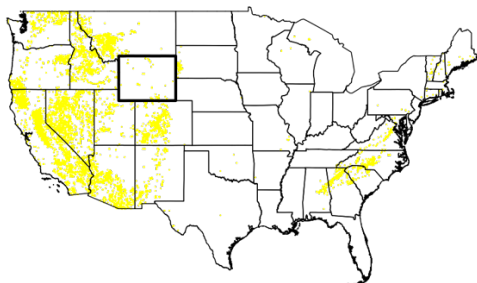
- (2) Water Access and Air Conditioning: The relatively dryer conditions of the Mountain West imposed a carrying capacity on population size and economic activities that require water as an input. Yet, these conditions could be overcome with water conveyance infrastructure and new technologies. This was important, especially in the hot and dry Sunbelt cities after 1900. The most dramatic case is Las Vegas with the construction of Hoover Dam in 1930, which enabled the transformation of a small trading community at a rail junction to grow a tourism industry that built on already existing road connections into the city from both East and West. Phoenix and Tucson also benefitted from the construction of the Roosevelt Dam in 1911, although these cities had larger populations than Las Vegas prior to the construction of the dam. Water piping and transport was also critical to building an early agricultural base in Salt Lake City. The case of Boise differs as early farmers and ranchers from southwestern Idaho moved there because of the mild climate and the fact that the city had good water access. Beyond water itself, Sunbelt cities in Texas, New Mexico, southern Nevada and Arizona also experience extremely hot and dry summers, that make livability hard. While some of the cities like Phoenix, Tucson, Albuquerque, Las Vegas, and El Paso already had some economic activity and population density prior to 1950, these cities were still smaller than Denver and Salt Lake City. With the introduction of household-size air conditioning in the 1950s, livability, driving and industries in the Sunbelt became much more feasible (Badger & Blinder, 2017). Phoenix quickly overtook all Mountain West cities by 1960, but all Sunbelt cities experienced an acceleration in population growth. Wyoming counties had more moderate water disadvantage than today's desert cities and did not have similar challenges with heat.
- (3) Federal Defense and Research: While the military played an important role in establishing settlements and forts during early westward expansion, it was not until the mid-20th century that strategic industry establishments and relocations from the Federal Government brought further growth in Mountain West agglomerations. The fact that Mountain West cities were remote and distant from coasts was a key strategic advantage following WWII and throughout the Cold War, as the Federal Government relocated agencies and defense manufacturing into already existing and increasingly more accessible centers. Cities like Denver and Phoenix that had already some manufacturing and research capabilities became bases for defense manufacturing to supply the army (Abbott, 1982; Shermer, 2013). In the case of Los Alamos, Santa Fe, and even in Las Vegas, the deployment of defense research from the Manhattan Project brought a significant population rise (Land & Land, 2004; Weigler, 2010, Britannica, 2017). These shifts in population and economies into more advanced manufacturing in aerospace and defense, and into research and development provided the base to move into digital industries and pharmaceuticals that now occur across the Sunbelt cities, Denver, Salt Lake City, and even smaller cities. Laramie County benefited from this same trend with the presence of Warren Air Force Base, but population growth remained limited.

Mineral Endowments

Wyoming features a strong mineral resource economy today, and resource booms (such as gold rushes) have historically driven population growth in numerous places around the world. It is thus important to understand how Wyoming's mineral endowments have shaped its historical population growth. Figure 8 shows that while Wyoming does not have rich deposits of precious metals (such as gold or silver) nor industrial metals (such as copper, nickel, iron, or aluminum), it is well endowed with energy resources. While a gold rush thus could not have occurred in Wyoming's history, it must be investigated how its fossil fuel endowments contributed to population growth.

Figure 8: Location of Gold (Panel A); Silver (Panel B); Copper (Panel C); Nickel (Panel D); Iron Ore (Panel E); Aluminum (Panel F); Coal (Panel G); Uranium (Panel H); and Oil and Gas (Panel I) Mines and Wells across the United States

Panel A: Old and Current Gold Mines



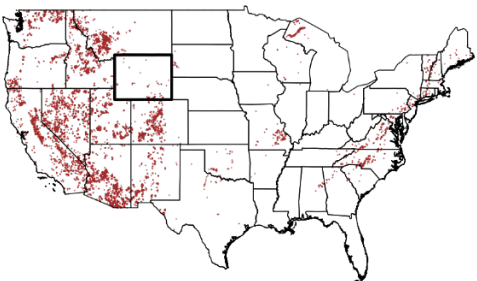
Source: Mineral Resources Data System (1996), USGS

Panel B: Old and Current Silver Mines



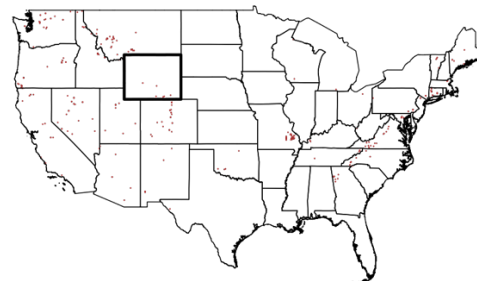
Source: Mineral Resources Data System (1996), USGS

Panel C: Old and Current Copper Mines



Source: Mineral Resources Data System (1996), USGS

Panel D: Old and Current Nickel Mines



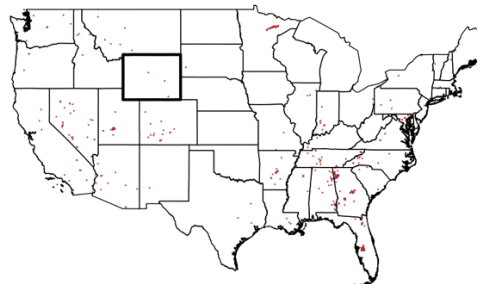
Source: Mineral Resources Data System (1996), USGS

Panel E: Old and Current Iron Ore Mines



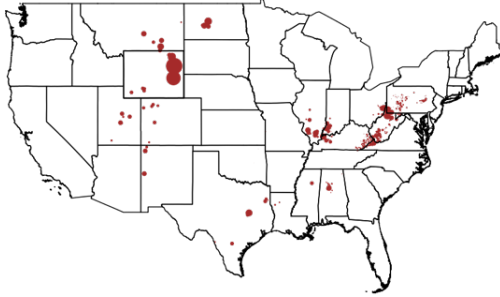
Source: Mineral Resources Data System (1996), USGS

Panel F: Old and Current Aluminum Mines



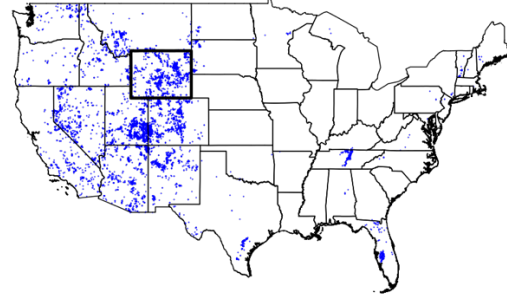
Source: Mineral Resources Data System (1996), USGS

Panel G: Current Coal Mines



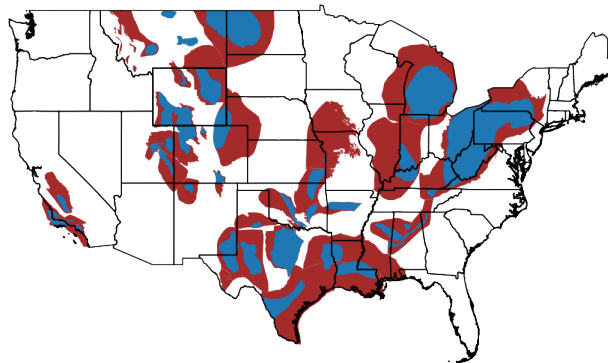
Source: Energy Information Administration 2020

Panel H: Uranium Deposits



Source: Mineral Resources Data System 1996, USGS

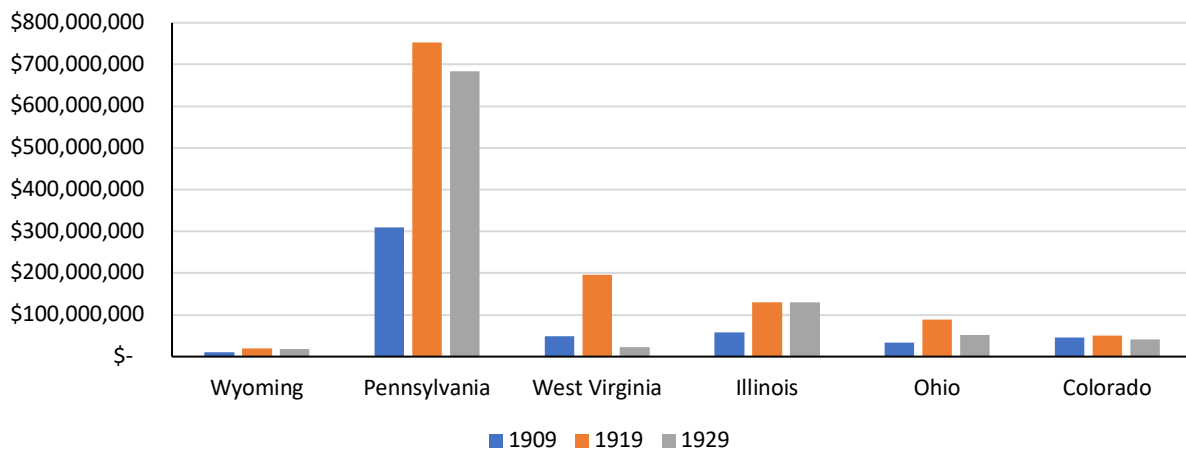
Panel I: US Oil and Gas Wells (2017) – Red: Oil and Gas Basin, Blue: Shale Play



Source: EIA (2017)

Despite these impressive fossil fuel endowments, Figure 9 shows that the dollar value of the minerals extracted in Wyoming was smaller than other leading states in the early 20th century. Although Wyoming is the top U.S. coal producer today, at this early point in history Wyoming's natural resources evidently were not leveraged on a large scale. This may have been due to the relative inaccessibility of Wyoming's mineral deposits at that point in history: the bulk of the US industrial economy was still concentrated on the east coast, and transportation over long inland distances could still be quite expensive. Regardless of the reasons why, the comparatively limited value of extracted minerals in Wyoming's early history meant this channel could not drive very large in-migration. Thus, while population plausibly grew in California and Colorado due to historical gold rushes, and in Pennsylvania due to large and easily accessible coal deposits, this effect was limited in Wyoming's early history. Later, Wyoming's underground resources did gain value, and the limited population growth dynamics of that period will be explored later in this chapter.

Figure 9: Dollar Value of All Mineral Output by State and Year, in 1929 Dollars

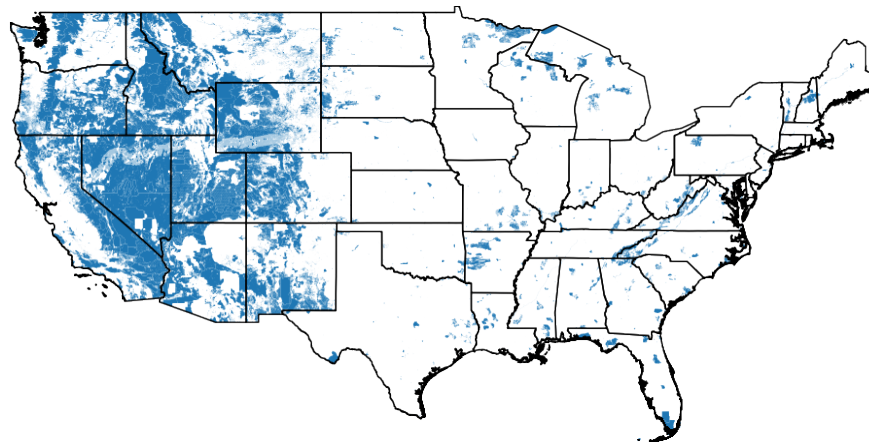


Source: 1930 US Census of Mines and Quarries

Restricted Land Availability

One possible reason why Wyoming's population is not somewhat larger is the administrative unavailability of much of its land for human settlement. Large portions of the Western United States, including roughly half of Wyoming's territory, are held by the federal government (Figure 10). This sharply limits the space in which human habitation is permissible today. However, numerous surrounding states with higher populations and larger urban agglomerations are similarly affected. Thus, while this division of land ownership may have helped to suppress Wyoming's population growth in an absolute sense, it may not be a decisive factor that explains why Wyoming's population is so small and rural in comparison to other states. It may also be the case that this regional pattern of federal land ownership is the natural response of early population growth patterns rather than a cause of low population growth. Moreover, federal land use rules may have become more restrictive with time, allowing for easier population growth in the presence of federal lands in earlier stages of western expansion. Whatever the direction of causality, though, federal land remains a relevant feature that has impacts on future population growth.

Figure 10: Map of Federal Lands in the US.



Source: Bureau of Land Management

How have Wyoming's population and economic drivers co-evolved?

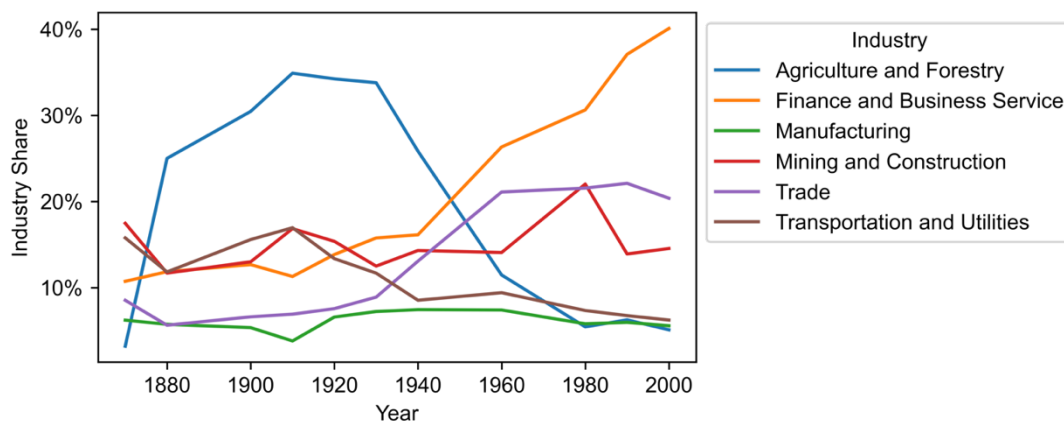
The specific industries which Wyoming has specialized in and those that it has largely failed to enter over the course of its history have been intimately shaped by the way its population has grown. The small, rural nature of the state has placed industries tied to the natural land — such as mining, ranching, and tourism — front and center in its economic history. Yet its limited population density has also made Wyoming remote, and thus less conducive to industries dependent on urban concentrations of knowhow such as manufacturing and modern services. This subsection walks through the evolution of the regional economy and how Wyoming's economic concentration and population trajectory have diverged over time.

The high detail of industry data can obscure overall patterns. Figure 11 overviews how Wyoming's specialization in different sectors have changed over time, and Figure 12 shows sectors in comparison to other Mountain West states over time. These graphs show the share of jobs in aggregated economic sectors for each state over time. Some stylized facts that follow from these figures include the following:

- Wyoming's early concentration was in transportation and construction, driven by the transcontinental railroad. This was later surpassed by agriculture, which grew and fell as an employment share along with the region.
- Wyoming has a generally high concentration of jobs in mining and construction over time, which generally increased from the 1940s onward while mining employment shares in peer states decreased substantially. Thus, from 1950 onwards Wyoming's mining and construction employment share outstripped all its peers.
- Wyoming's persistently low employment share in manufacturing from 1910 onwards indicates that it has consistently missed out on the growth seen in numerous peers.
- Wyoming's saw a large growth in employment shares in trade and, especially, finance and business services since the middle of the 1900s. This growth follows the general dynamics of the U.S. economy and states in the region but is in fact more limited than the comparator states.

Figure 11: Employment Share in Wyoming for Aggregated Sectors over 1870-2000

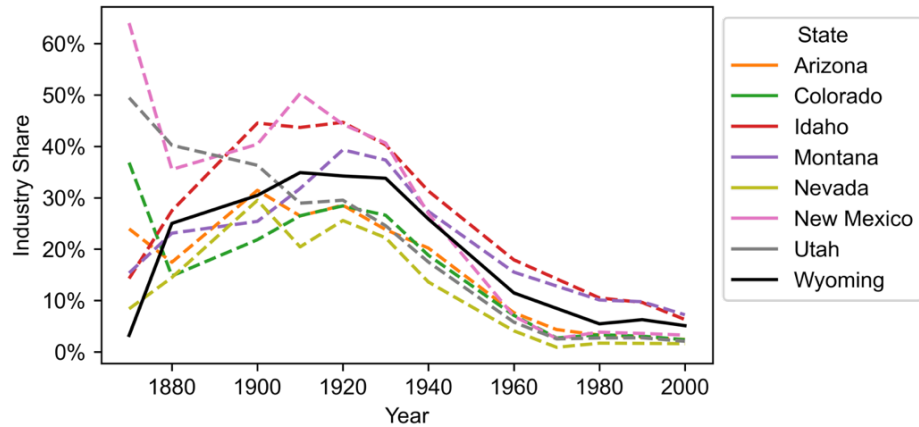
Panel A: Evolution of Wyoming's Employment Share in all industries



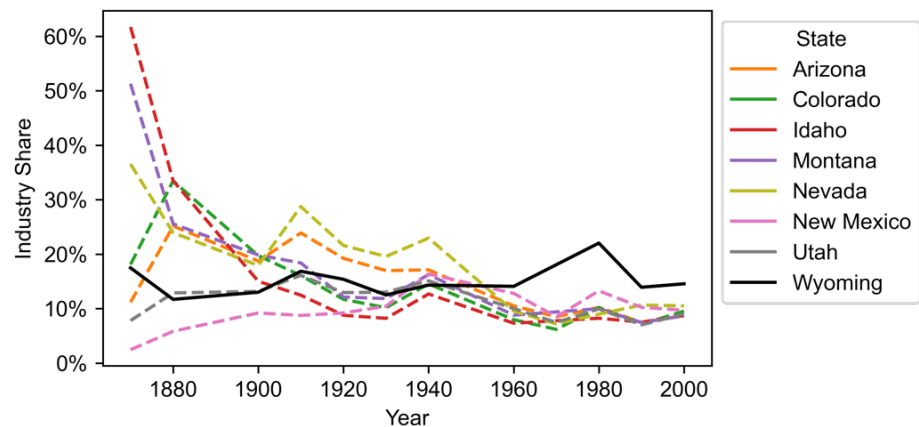
Source: US Census Bureau (2022), own calculations

Figure 12: Wyoming and Comparator States' Employment Shares in Agriculture (Panel A), Mining (Panel B), Manufacturing (Panel C), Wholesale & Retail Trade (Panel D), and Other Services (Panel F) over 1870-2000

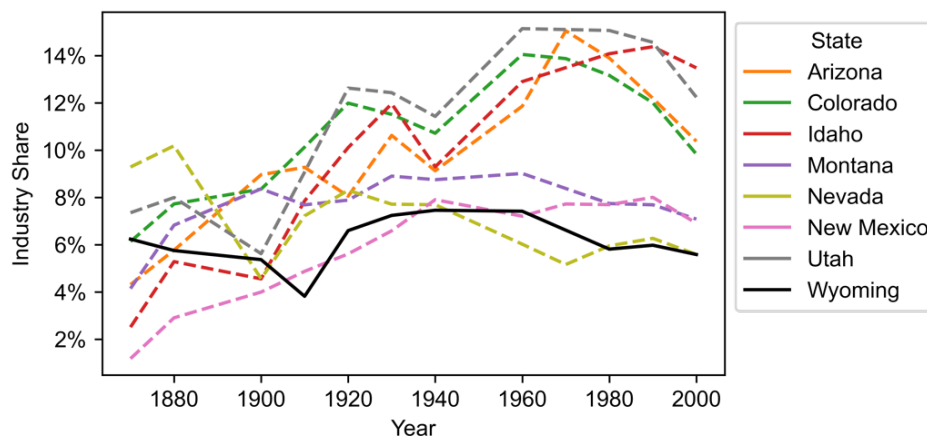
Panel A: Evolution of Agriculture Employment Share in Wyoming and peers



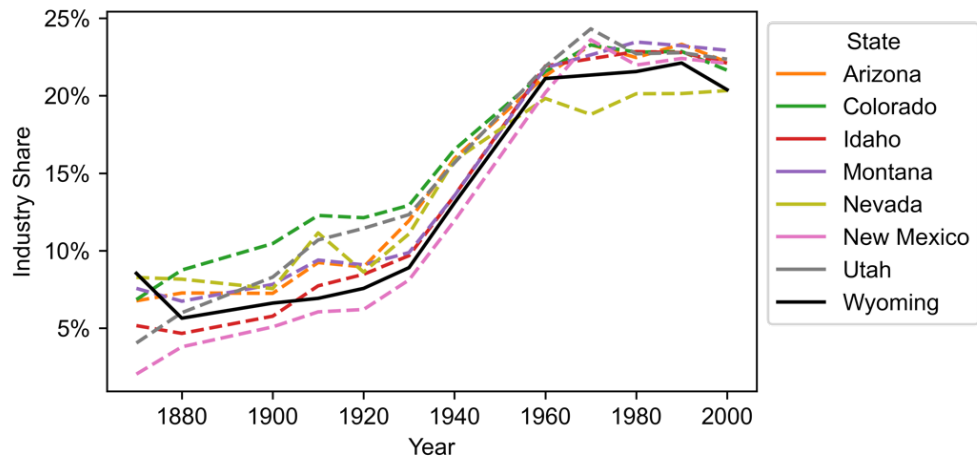
Panel B: Evolution of Mining and Construction Employment Share in Wyoming and peers



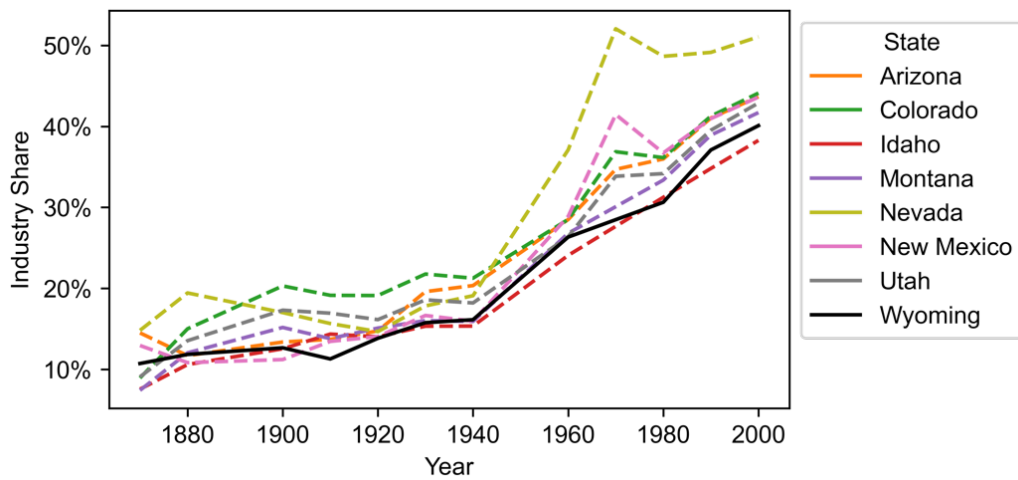
Panel C: Evolution of Manufacturing Employment Share in Wyoming and peers



Panel D: Evolution of Wholesale & Retail Trade Employment Share in Wyoming and peers



Panel E: Evolution of Other Services Employment Share in Wyoming and peers



Source: US Census Bureau (2022), own calculations

Initial Settlement, Up to 1870

The “westward expansion” of settlers into Wyoming and the surrounding areas followed the existing paths and routes laid by Native Americans. Prior to the arrival of white Europeans, Wyoming was inhabited by nomadic Native American nations with a complex network of trails that were used for trade, hunting, harvesting, and war (Larson, 1990).^{2,3} The nations that inhabited the region by the 19th Century were the Arapahoe, Arikara, Bannock, Blackfeet, Cheyenne, Crow, Gros Ventre, Kiowa, Nez Percé, Sheep Eater Sioux, Shoshone and Ute (wyo.gov, 2022).⁴ Each of these nations adapted to Wyoming’s geography and had some similar customs. During summer months, groups moved into the state’s mountains and moved back into prairies during cooler times of spring and fall, following the migration of wildlife and game animals, while making the best use of forage and edible plants (Nickerson, 2019).⁵ Overall, the Native American population of Wyoming was not accounted for in census years prior to 1880, but the population has been estimated at 2,000 inhabitants.⁶ The early expeditions of explorers, fur traders, and settlers moving west in the 19th century used the same routes that native populations used in their own pursuit of fur, land, gold and other minerals (Nickerson, 2019).⁷ Before 1860 Wyoming’s population remained sparse and the only permanent settlements were military bases. After being incorporated into the United States after 1803, the first white explorers were beaver skin trappers before 1830, who were later followed by the establishment of two military bases: Fort Laramie and Fort Bridger (Gardner & Flores, 1989).

The construction and operation of the transcontinental railroad brought permanent migrants into Wyoming and defined the economic structure of Wyoming by 1870. The United States’ first transcontinental railroad was completed in 1869, with the portion in Wyoming constructed over 1867-68. The railroad was a response to rising demand for minerals from a growing manufacturing industry on the east coast and the need to access markets by a growing population in the west. Southern Wyoming became a critical corridor to connect gold miners in Oregon and California with the U.S. population to the east. The rail also allowed Mormon farmers with grain surpluses to sell to the rest of the country.⁸ Before the construction of the railroad, early settlers, travelers, explorers, and the army had found and begun exploiting coal in small amounts. To feed the expansion of rail and locomotives, Union Pacific became the owner of mines in the south of Wyoming (Gardner & Flores, 1989).⁹

Figure 13 shows the structure of Wyoming’s economy in 1870 and summarizes how it compared to other Mountain West states. These types of graphs will be used to capture the structure of Wyoming’s economy and Mountain West comparators at various points in time. The first tree map captures both the relative size of employment in specific industries in Wyoming (by size of the box) and whether Wyoming had a revealed comparative advantage in this industry (by color, with blue reflecting higher RCA). As seen in Panel A of Figure 13, jobs in Wyoming in 1870 were

² Larson, T. A. (1990). *History of Wyoming*. U of Nebraska Press.

³ <https://www.wyohistory.org/encyclopedia/trade-among-tribes-commerce-plains-europeans-arrived>

⁴ <https://www.wyo.gov/about-wyoming/wyoming-history>

⁵ <https://www.wyohistory.org/encyclopedia/wyoming-american-indian-geography-and-trails>

⁶ <https://accessgenealogy.com/wp-content/uploads/2011/07/page232.jpg>

⁷ <https://www.wyohistory.org/encyclopedia/wyoming-american-indian-geography-and-trails>

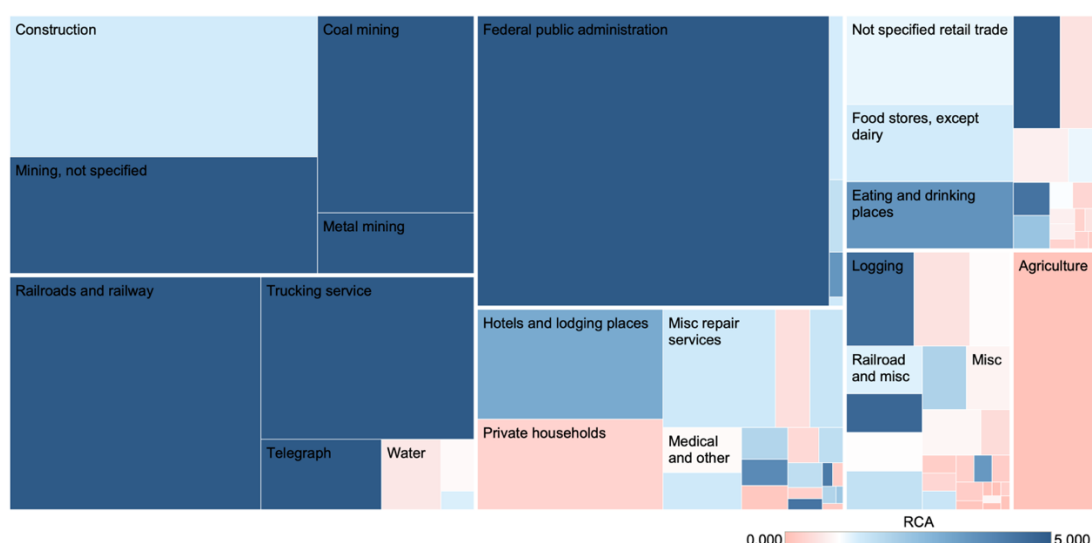
⁸ According to Gardner & Flores (1989), Mormon settlers were also interested in ways of shortening the journey into the Great Salt Lake for other Mormons too, so they began supporting the expansion of rail.

⁹ Gardner, A. D., & Flores, V. R. (2019). *Forgotten frontier: A history of Wyoming coal mining*. Routledge.

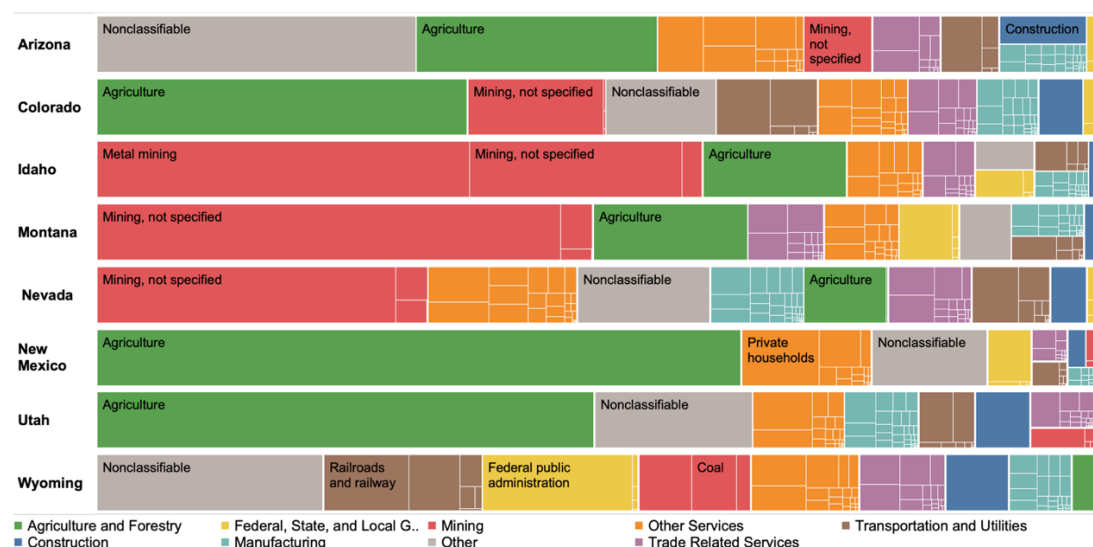
primarily in coal mining, rail transport, trucking, and federal administration employment (i.e., military in this case). Wyoming also had a comparative advantage expressed in the industries of metal mining, logging, liquor stores, and beverage manufacturing, though they were smaller sources of total employment. Construction represented a noteworthy share of employment, while agriculture employment was small. Panel B of Figure 13 summarizes the economic composition of Wyoming in 1870 compared directly to other Mountain West states. Colors on this graph reflect sectors and boxes reflect specific industries. On the whole Montana, Idaho and Nevada were specialized in mining whereas New Mexico, Utah, and Colorado were more specialized in agriculture. Both these industries were small in Wyoming compared to others.

Figure 13: Distribution and RCA of Employment in Wyoming Relative to Peers (1870)

Panel A: Distribution of employment by industry and RCA in Wyoming - 1870



Panel B: Employment distribution by industry in Wyoming and peer states – 1870



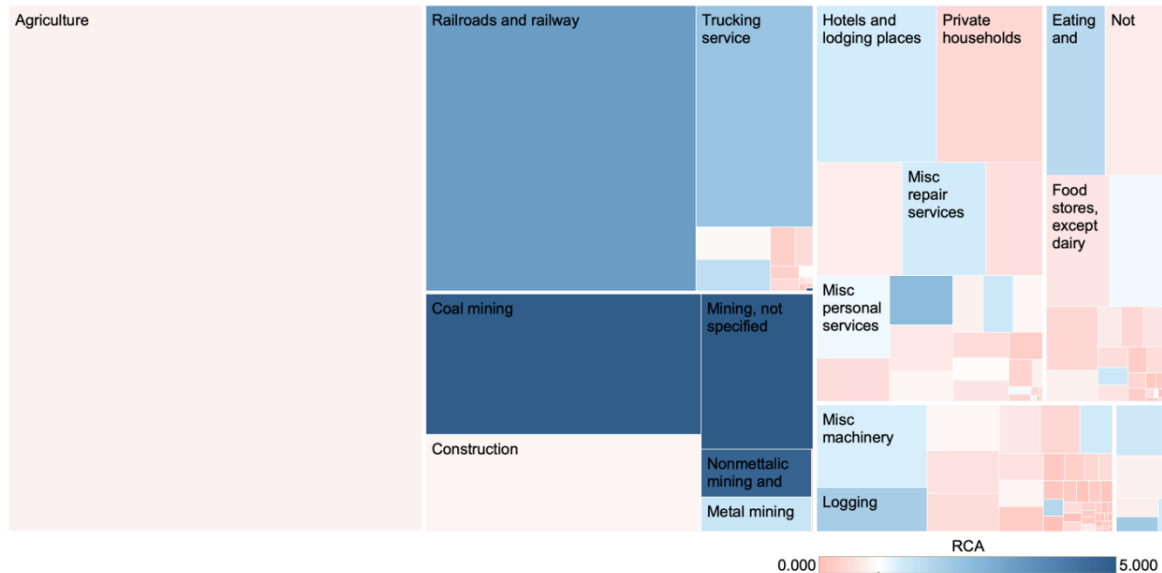
Source: own calculations, US Census Bureau (2022)

Wyoming's Establishment as a State, 1870-1900

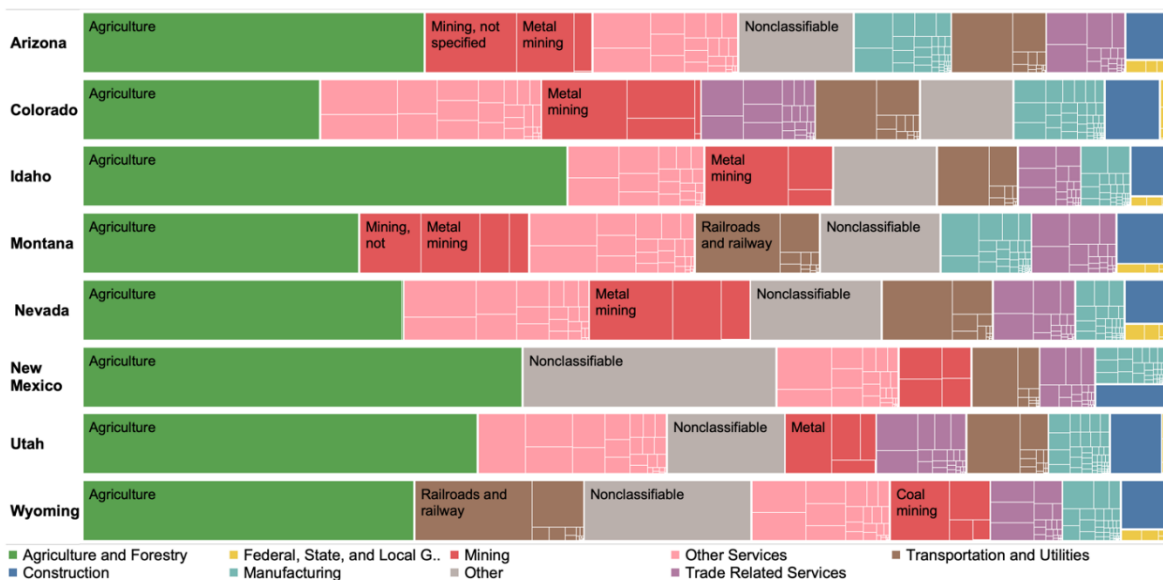
From 1870-1900 Wyoming's population grew by a factor of roughly ten and its revealed comparative advantages began to narrow (Figure 14). By 1900, Wyoming was already on the lowest population growth path among its neighbors (see Figure 2).

Figure 14: Distribution and RCA of Employment in Wyoming Relative to Peers (1900)

Panel A: Distribution of employment by industry and RCA in Wyoming - 1900



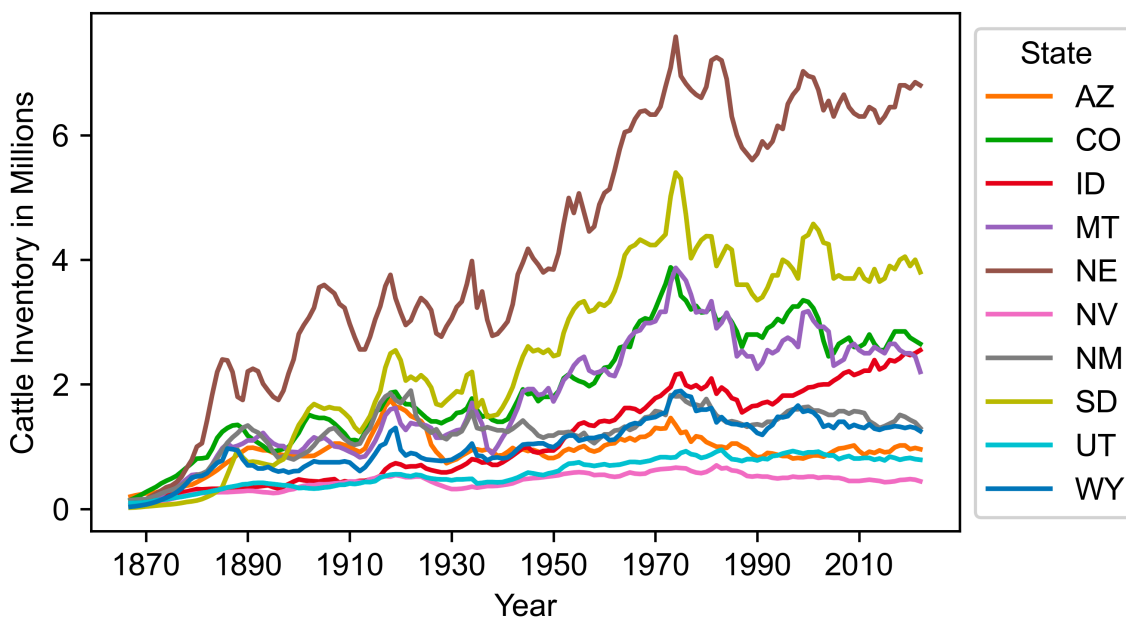
Panel B: Employment distribution by industry in Wyoming and peer states – 1900



Source: own calculations, US Census Bureau (2022)

By this time, Wyoming's economy had a clear comparative advantage in coal mining and continued to have a larger-than-normal concentration in federal administration jobs. Wyoming still had a comparative advantage in railway jobs, which also made up a significant share of employment, as well as in hotels, eating and drinking places, logging, and metal mining, though these were smaller sources of employment. Agriculture made up more than a third of employment in Wyoming in 1900, which was now in line with the rest of the region. As of 1900, none of the states stood out as more diverse than the others, with the potential exception of Colorado. Agriculture was the largest source of employment by broad sector for all the Mountain West states, including Wyoming. However, Wyoming did not have a comparative advantage in agriculture-based employment. Initial farms in the state were mostly in small plots directed for consumption by mining families and free grazing cattle and sheep ranches (Gardner & Flores, 1989). By 1900, agriculture in Wyoming was dominated by cattle ranching, sheep herding, and small farms of dry crops, especially non-irrigated corn (Western, 2014; Hallberg, 2014). The state experienced a cattle boom between 1868 and 1886 driven by the arrival of rail, better technologies in cold storage, and rising demand for tinned beef after the Civil War. Despite the importance of cattle inside Wyoming, total inventories were smaller than in most Mountain West states (Figure 15). Wyoming's cattle prices began dropping in 1885, leading to an early and slow decline of the sector, as prices declined nationally, and some farmers diversified into sheep that had more stable prices (Western, 2014).¹⁰ Dry crops included mostly non-irrigated corn throughout eastern Wyoming, especially in Laramie County around Cheyenne (Western, 2014). However, production was dwarfed relative to neighboring plain states and even some Mountain West states including Idaho and Colorado.

Figure 15: Cattle Count in Wyoming and Peer States (1867 – 2022)

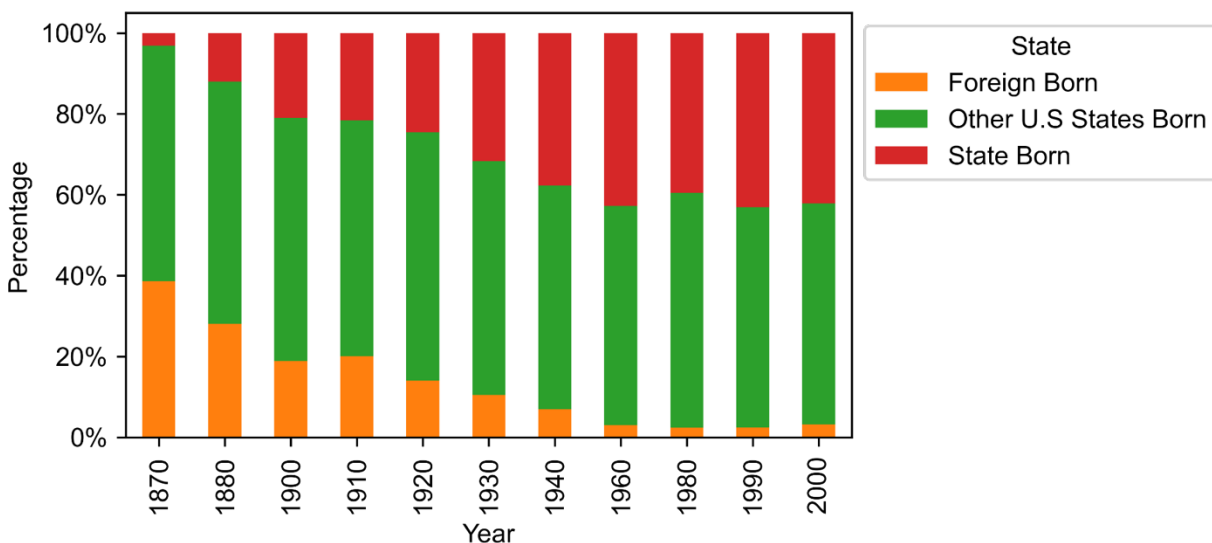


Source: USDA (2022)

¹⁰ <https://www.wyohistory.org/encyclopedia/wyoming-sheep-business> ,
<https://www.wyohistory.org/encyclopedia/wyoming-cattle-boom-1868-1886>

Building the economy required substantial inward migration, even if population growth was slower than neighboring states. Figure 16 shows where the population of Wyoming was born over time. Before 1900 and in several subsequent decades, Wyoming's population grew primarily through people moving into the state from other states. Population flows into Wyoming during 1870 to the early 1900s were largely driven by the coal mines and rail. According to Gardner & Flores (1989) these first migrants were brought mostly by Union Pacific to bring in mining expertise. Then Union Pacific made the explicit choice to bring workers from diverse backgrounds as a strategy to curtail unionization. Overall, by 1900, there were two foreign born coal miners for every American (US born) miner in Wyoming (Gardner & Flores, 1989). Compared to other states, by 1900 the dominant foreign nationality in Wyoming (English) comprised about 15% of all foreign-born residents. Compare this to Kentucky or Indiana where Germans represented more than half of the foreign-born population.

Figure 16: Composition of Wyoming's Population According to the Place of Birth (excluding Native American population)



Source: own calculations, based on Census Data, IPUMS (2022)

As of 1900, around one in five people living in Wyoming were born abroad, and this share fell over time. Migration into Wyoming in this early period of statehood was motivated Union Pacific to operate the state's first mines. As the mine operator, Union Pacific played a key role in attracting migrants and providing the basic facilities to settle mining towns. This was true across the southern border of the state but varied by degree. According to Gardner & Flores (1989), in Kemmerer and Rock Springs, less than 4% of households lived in non-company-owned homes, relative to 15% in Cheyenne or Laramie. Although Census data only captures the breakdown of populations of the original counties along Wyoming's southern borders, migration within the state was not restricted to those counties. Some settlers ventured into northern Wyoming where the main activity was cattle farming and some small-scale mining.

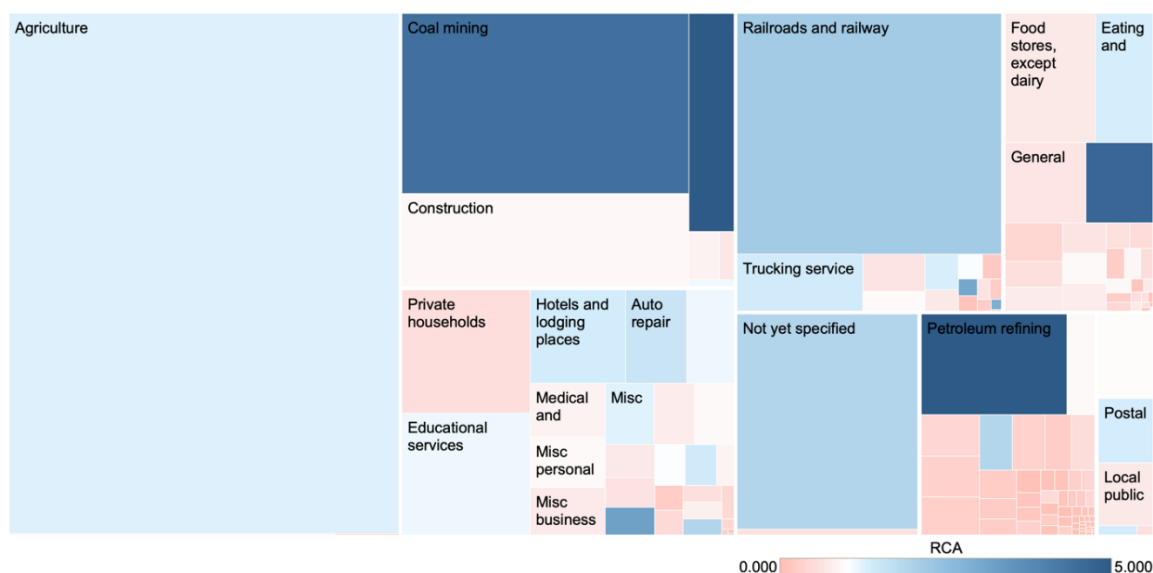
Early Development and Divergence, 1900-1920

The period from 1900 to 1920 marked a significant change in population fortunes for Wyoming versus neighboring states. As can be seen in Figure 2, the population of Wyoming roughly doubled over this period, supplied by continued migration from other states as well as growth of the Wyoming-born population. This may seem like rapid growth by today's standards, but it amounts to just 3.5% per year and represented a slowdown from the pace of initial population growth. Meanwhile, neighboring Mountain West states of Colorado, Montana, Idaho, and Utah all saw population growth accelerate over this period such that their populations began to far exceed that of Wyoming. More like Wyoming, Nebraska and South Dakota saw their population growth decelerate over this period, but they had significantly larger populations by this time than Wyoming. Census data also shows a striking pattern where Wyoming stood out in the low share of its population that was female. Women represented roughly 30% of the state's population, compared to 40-50% in all neighboring states.

Seemingly small but important changes in industry structure took place over this period as well. Figure 17 captures Wyoming and the region in 1920. At the level of broad industries, the graphs for Wyoming and peer states look much like they appeared for 1900, even as the size of unclassified industries decreased. Importantly, though, Wyoming developed comparative advantages for crude petroleum, petroleum refining, and petroleum products during this period. This allowed for mining to jump to the third largest broad industry for Wyoming in terms of total employment. Agriculture remained the largest source of employment across all the states. Rail and mining were among the top five largest sources of employment as of 1920 for only Wyoming, Nevada, and Arizona, while services were second for Wyoming and all mountainous neighbors, except for Nevada. Manufacturing started to grow in importance for several states, notably Colorado, Idaho, and Utah. Wyoming, at this time, had some employment in manufacturing with a low comparative advantage. Trade also began to grow in importance, especially in Colorado.

Figure 17: Distribution and RCA of Employment in Wyoming Relative to Peers (1920)

Panel A: Distribution of employment by industry and RCA in Wyoming – 1920



Panel B: Employment distribution by industry in Wyoming and peer states – 1920



Source: own calculations, US Census Bureau (2022)

Accelerated Divergence from the Region, 1920-1950

Over the next generation from 1920 to 1950 Wyoming's economic structure greatly diverged from the rest of the region. This was a period of significant change, including the Dust Bowl, Great Depression, World War II, and New Deal policies. Nevertheless, the driving engines of the Wyoming economy did not change by very much. In fact, the 1920-40s were depression years (Larson, 1990). Figure 18 summarizes economic compositions in Wyoming and the Mountain West for 1950. Wyoming continued to have a strong comparative advantage in coal mining, crude oil, petroleum, and railroad-related jobs. However, coal jobs declined as a share of the economy, influenced by the increasing use of oil and gas relative to coal for power generation, home heating and shipping. This was buffered somewhat by war-related demand for coal. At the same time, the productivity of coal mining increased, especially strip mining. In total, these shocks led to significant changes for mining towns that were abandoned after shocks and as mining employment moved (Gardner & Flores, 1989). The role of agriculture as a source of employment also decreased sharply in Wyoming, which was common across Mountain West states.

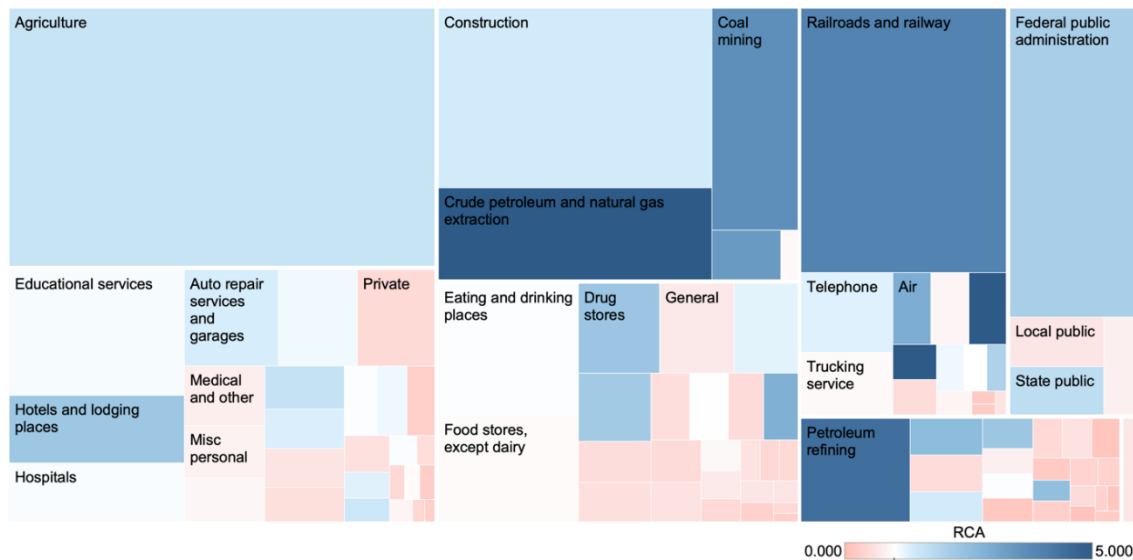
Wyoming's economic composition as of 1950 reflected only a limited amount of the change that much of the region experienced. Across the region finance and services grew in importance and became the leading source of jobs for all the states except Montana, Idaho, and Wyoming. This category included education and healthcare and a range of other services, including the tourism industry.¹¹ Trade also grew rapidly across states, with the emergence of many more retail jobs across a variety of types of stores. Wyoming's economic composition experienced some of these shifts as well, but at a much slower speed. Agriculture and mining continued to play a larger role than in the region overall. Yet, Wyoming also saw a growth in retail jobs and the re-emergence of

¹¹ While the state had several protected areas since the early 1900s, the tourism industry started growing during the post-war economy, especially as domestic tourists began visiting National and State Parks (Larson, 1990).

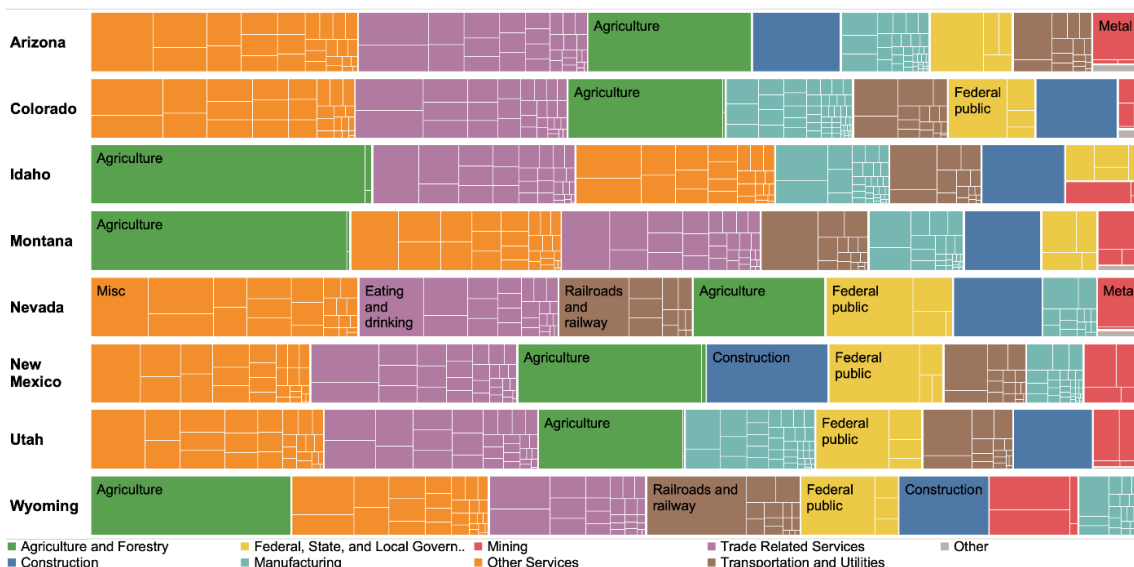
some types of retail that have had a long presence in the state. Over this period, Wyoming maintained its linear rate of population growth, continuing to lose pace with Colorado, Utah, and Idaho. Montana, however, followed a similar population growth trajectory as Wyoming, which is consistent with the states' similar economic structures. Wyoming's population growth in the generation up to 1950 was noteworthy in that it was driven by growth in the Wyoming-born population for the first time in the state's history. The foreign-born population, meanwhile, had fallen sharply by this time to well under 10% of the overall population.

Figure 18: Distribution and RCA of Employment in Wyoming Relative to Peers (1950)

Panel A: Distribution of employment by industry and RCA in Wyoming – 1950



Panel B: Employment distribution by industry in Wyoming and peer states – 1950



Source: own calculations, US Census Bureau (2022) [1% sample]

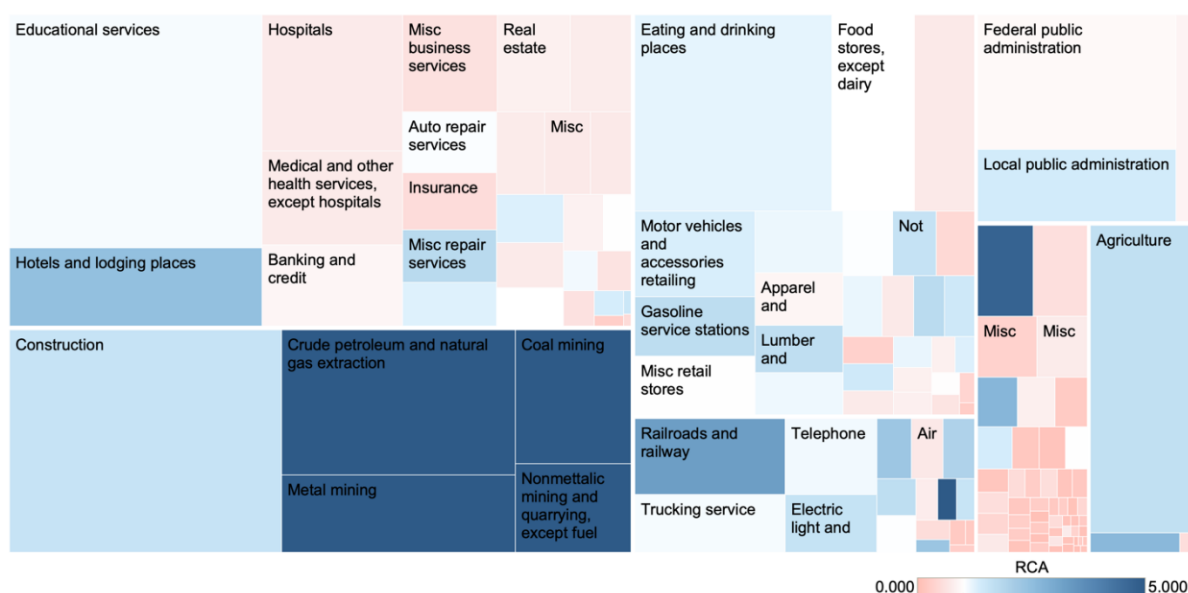
Wyoming's mineral-dependent tax revenue structure also emerged the 1920s with the rise of oil and the decline of agriculture in the state and has been consolidating since. Mineral taxation has been a contested topic since Wyoming's constitutional convention. An initial compromise was reached through a personal property tax on mineral production that granted the legislature the authority to set the rates. The state would therefore depend on property and sales taxes alone, as Wyoming decided at the time to forgo income taxes and remains today one of the seven states without them. The Mineral Leasing Act of 1920 imposed taxes on oil and gas extracted on federal lands that were to be shared with producing states, a decision that allowed Wyoming to benefit from rapidly rising production after World War II.

Energy Expansion, 1950-1980

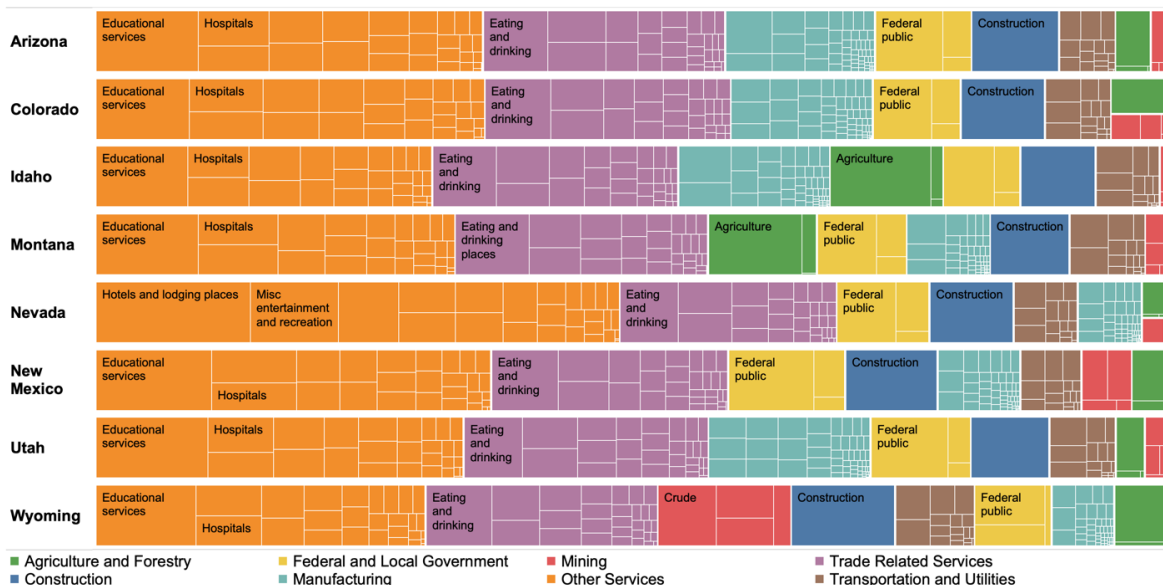
By 1980, Wyoming's economy reflected a recent boom in energy prices. The mining sector represented a much larger source of employment than in other Mountain West states (Figure 19). In all Mountain West states, including Wyoming, services and trade-related activities dominated employment shares, especially in Nevada. Wyoming was the only state where mining and petroleum remained a highly relevant sector of employment, and its revealed comparative advantages in the sector remained consistent with earlier periods. Manufacturing gained larger participation in Colorado, Idaho and Utah, and agricultural employment was also critical in Idaho and Montana. In Wyoming, manufacturing and agriculture had the lowest shares of employment. The only manufacturing subsector where Wyoming had comparative advantage in the 1980s was petroleum refining. In addition, construction and transportation became more important sectors in Wyoming than in the rest of the Mountain West states. Federal Government employment was relatively less important in Wyoming than in peers.

Figure 19: Distribution and RCA of Employment in Wyoming Relative to Peers (1980)

Panel A: Distribution of employment by industry and RCA in Wyoming – 1980



Panel B: Employment distribution by industry in Wyoming and peer states – 1980



Source: own calculations, US Census Bureau (2022) [1% sample]

Wyoming's mining industry experienced two exogenous positive shocks in the 1960s and 1970s that drove population growth in mining cities. The 1965 Clean Air Act from the EPA and the 1973 shock to oil prices increased revenues from oil and increased demand for Wyoming coal. Demand for Wyoming coal increased because it complied with the 1965 act's sulphide regulations. After 1973, demand for Wyoming oil and coal further increased as powerplants in the U.S. returned to coal for electricity generation when international oil prices soared following OPEC's production cut. These shocks also encouraged the U.S. Congress to enable more federal land for oil and gas exploration. At this point, Wyoming's population centers, housing supply and utility sectors came under pressure to accommodate a larger and increasing population from this new commodity boom and Wyoming relied heavily on government transfers to maintain its economy (Gardner & Flores, 1989; Larson, 1990).¹² This dependency and pressure motivated significant policy changes like the introduction of the severance tax in 1968, to capture rents from the state's mining industry to build public goods for a rising population. At the federal level, Congress changed the Mining and Leasing Act, demanding that half of the royalties collected for mining remained within states, increasing an income source for Wyoming (Western, 2014).¹³ A sustained campaign throughout the 1960s to increase mineral taxation succeeded with the passage in 1969 of a 1 percent severance tax that was raised to 4 percent in 1975, and one year later, the US Congress agreed to increase the share of mineral royalties from 37.5 to 49 percent. Since then, a series of upward and downward adjustment on the severance tax rates applicable to different minerals have been made to maximize the present value of mineral taxation.

Even with a spike in population in Wyoming during the commodity price boom of the 1970s, total population diverged significantly from neighbors by 1980 (Figure 2). This was most striking for states with a larger manufacturing base. Wyoming's population was half of that of Idaho, a third of that of Utah and a fifth of that of Colorado. Within Wyoming, population grew rapidly but then fell in oil-rich counties, such as Natrona, Sweetwater, and Carbon (Figure 3). Meanwhile, population

¹² Gardner, A. D., & Flores, V. R. (2019). *Forgotten frontier: A history of Wyoming coal mining*. Routledge.

¹³ <https://www.wyohistory.org/encyclopedia/leasing-federal-minerals-wyoming-and-west>

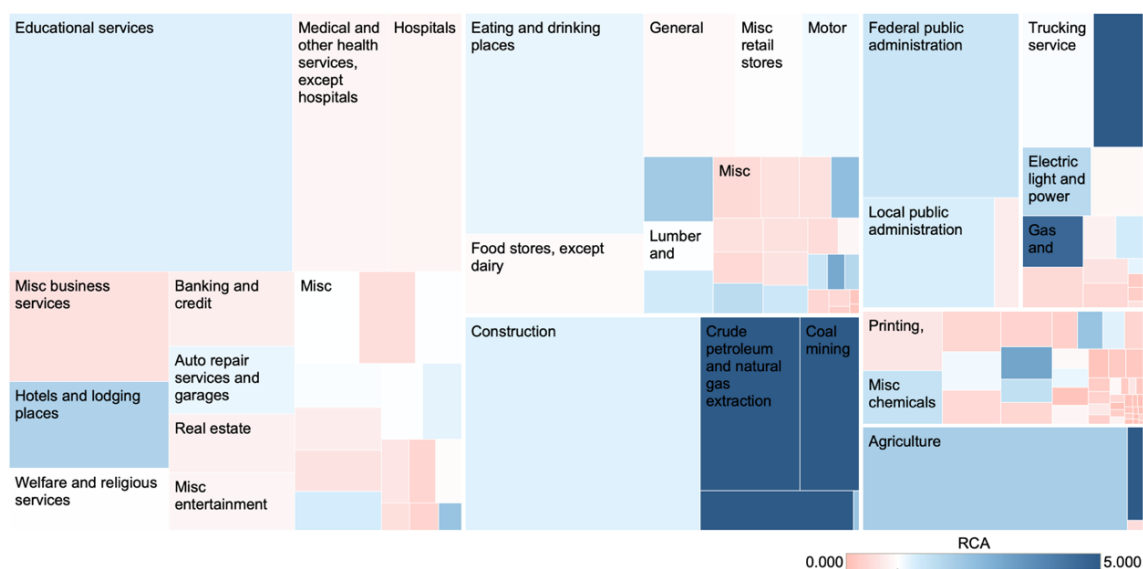
growth was sharp and sustained in Campbell County. According to Larson (1990), between 1950 and 1970, manufacturing in Wyoming was driven mostly by petroleum refining and lumber work. The owners of manufacturing companies cited the lack of skilled labor, high wages, lack of financial assistance, increased competition and high input costs as important factors affecting manufacturing growth in Wyoming during these boom years. A higher population may have addressed several of these constraints, such as providing a larger pool of skilled labor; providing a wider pool of labor competing for wages beyond those in the mining industry; and facilitating the development of deeper financial capital. Indeed, these may be some important reasons why manufacturing industries took off more strongly in neighboring states instead of Wyoming.

Modern Era, 1980-2000

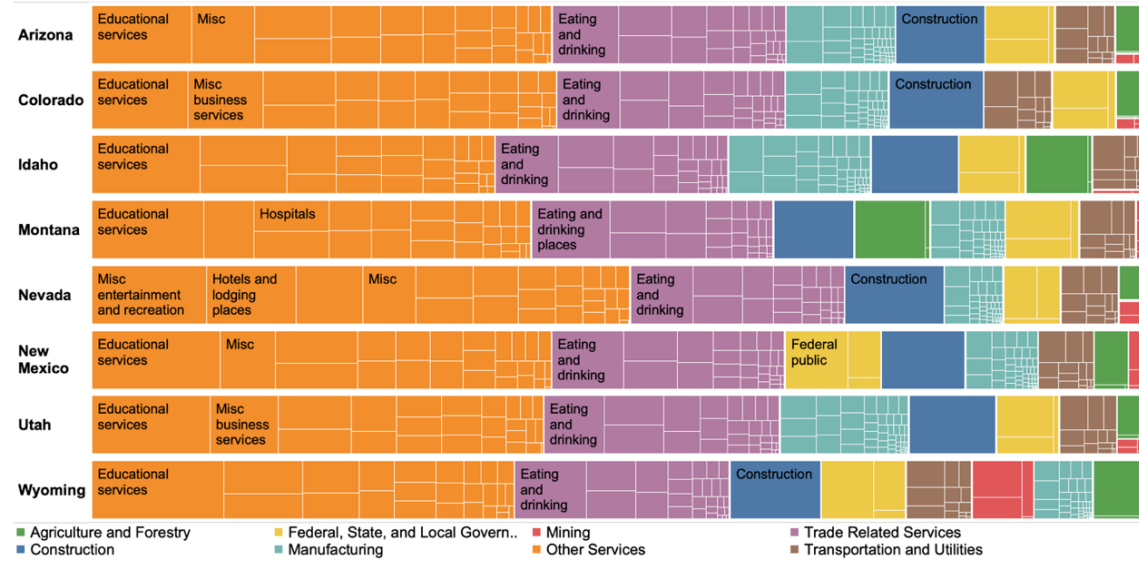
By the end of the 20th Century, Wyoming's economic structure remained more rural and commodity-based than peer states (Figure 20). As of 2000, employment across all Mountain West states continued to be focused in services. Arizona, Colorado, Utah, and Idaho's manufacturing sectors had grown and remained relatively large, while agriculture and mining in these states had small employment shares (except for agriculture in Idaho). While mining employment was no longer as large in Wyoming by 2000, the state had the highest mining employment share among Mountain West states and maintained a high comparative advantage in mining industries relative to the rest of the United States. Despite being the smallest industry in Wyoming, the state's employment shares in agriculture remained comparable to Idaho and Montana, and with a modest comparative advantage when compared to the rest of the U.S. In addition to these, by 2000, construction and federal employment were the third and fourth largest employers in Wyoming, displacing the role observed for mining in 1980. In terms of population growth, Wyoming's population trajectory flattened. Population between 1980 and 2000 in other Mountain West states diverged further from Wyoming, including Montana around the turn of the century, which had mirrored Wyoming over the long term.

Figure 20: Distribution and RCA of Employment in Wyoming Relative to Peers (2000)

Panel A: Distribution of employment by industry and RCA in Wyoming – 2000*



Panel B: Employment distribution by industry in Wyoming and peer states – 2000*



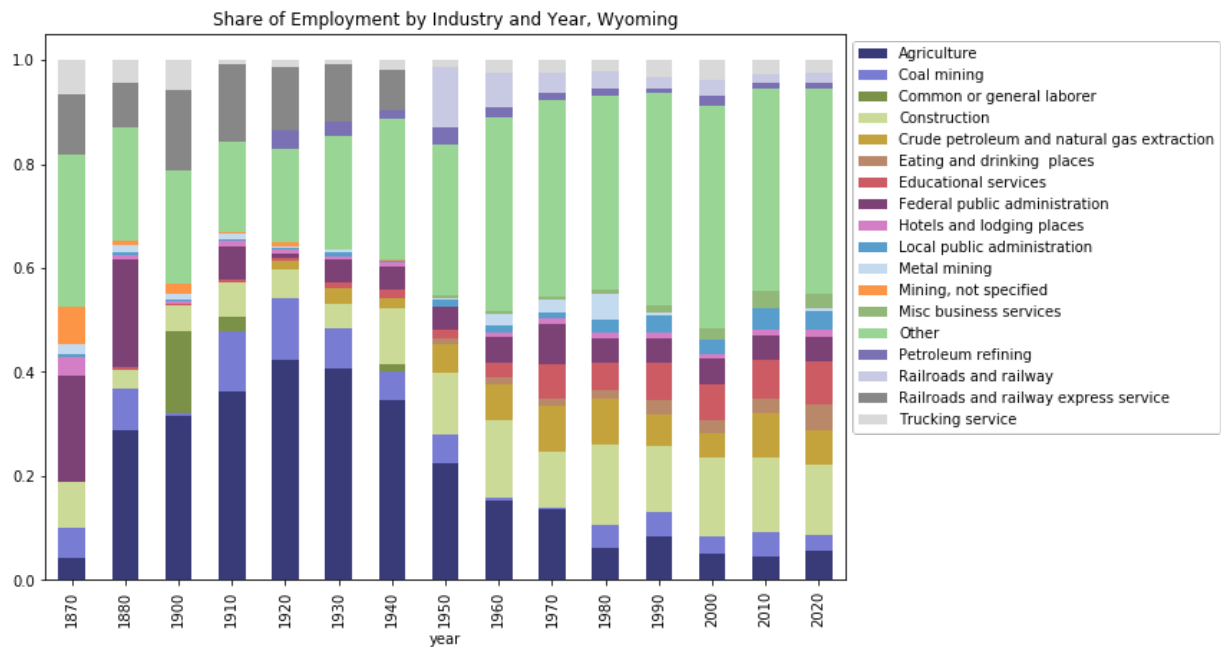
* The data is based on 1% sample of the 2000 census.

Long-Term Growth in Summary

Due to its persistently limited population growth and associated remoteness, Wyoming has missed certain points in time where other states developed larger agglomerations that were more able to leverage changing technologies and drivers of the national and global economy. Wyoming has faced a long-term geographic disadvantage that has played an important role in its low population and remoteness, yet land quality does not explain Wyoming's low population in its entirety. The nature of Wyoming's natural resources also represented a distinct difference from numerous other Mountain West states who experienced more robust population growth throughout their histories. As national and global changes took hold, other economies in the region evolved their economic specialization and sources of jobs more rapidly than Wyoming. By contrast, Wyoming developed a reliance on its energy wealth, yet did not develop large population agglomerations. As peer mountain states diversified into manufacturing and services during the mid-20th century by building on the capabilities, these activities represented relatively lower employment shares in Wyoming. Instead, after the 1950s, and with the commodity boom of the 1970s and subsequent bust in the 1980s, the state's employment and economic structure changed very little (Figure 21).

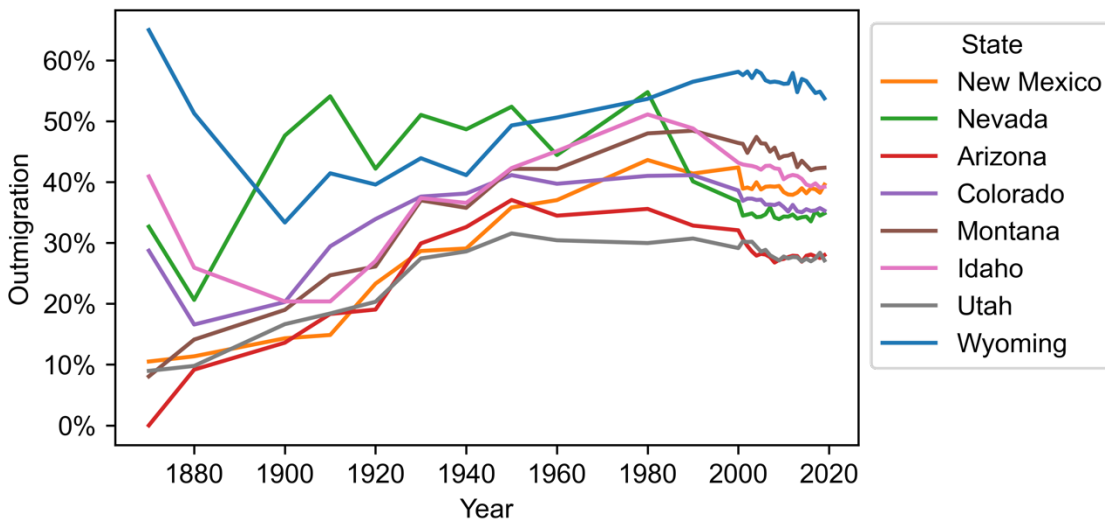
An important associated challenge has been the long-term tendency of Wyomingites to leave Wyoming. Figure 22 shows that, except for Nevada in the first half of the 20th century, Wyoming has persistently suffered from a high share of those born in the state choosing to leave the state. Especially in early and recent years, the gap between Wyoming and other states is large. The state's long-term migration patterns reflect a significant transient population, which over time amounts to lower population today. This contributes to a chicken-and-egg problem: Wyomingites may continue to leave the state at least in part due to the higher availability of jobs in certain industries elsewhere, but the unavailability of those jobs in Wyoming is strongly related to the limited population to begin with.

Figure 21: Share of Employment by Industry and Year, Wyoming (1870 – 2020)



Source: own calculations, based on US Census Bureau – IPUMS (2022)

Figure 22: Share of Population Born in States Living Elsewhere (1870 –2020)



Source: own calculations, based on US Census Bureau – IPUMS (2022)

3. Medium-Term Growth

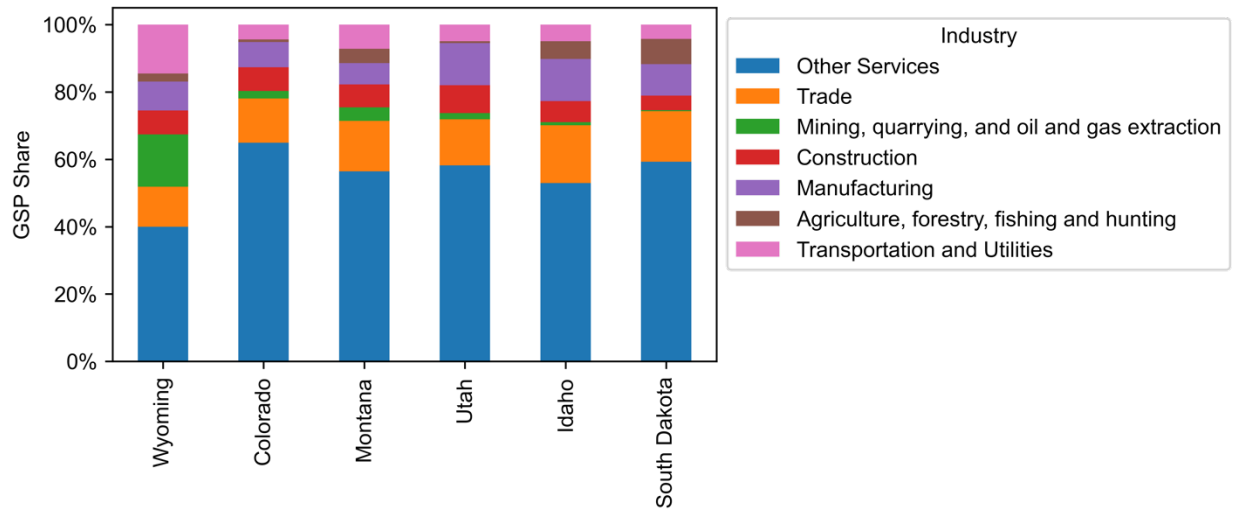
Wyoming's historic lack of economic diversification has made it strongly susceptible to boom-bust cycles. This dynamic has played out in recent decades as it has in the past, driven by changes in national and global demand for mining production in Wyoming. In the absence of significant non-resource sources of tradable income, these busts can have significant negative consequences on Wyomingites. As we will explore in this section, some of these consequences may be shared across the state, but the bust may be felt very differently across different parts of the state. These past two decades have been problematic in key respects for the Wyoming economy and for some places within the state. Some local economies have found pathways to greater resilience while others have not. This section will first provide a snapshot of Wyoming's contemporary economy to establish several important features. Next, it will describe the most recent boom-bust cycle from the early 2000s to the onset of the COVID-19 in detail to show its outcomes and its drivers. The section will then decompose changes across the state. Finally, it will begin to explore missed diversification opportunities that several peer states have captured while Wyoming has not.

A Snapshot of Wyoming's Contemporary Economy

As throughout much of its history, Wyoming's economy over the last generation remained heavily specialized in resource extraction. This can be seen in multiple ways. Figure 23 shows that a far larger share of Wyoming's Gross State Product comes from mining, oil, and gas than surrounding states. Figure 24 shows that mining, oil, and gas also accounts for a much larger share of employment in Wyoming than among peers, and that, conversely, industries like manufacturing and professional services are proportionally smaller in Wyoming. However, a large majority of total jobs in Wyoming do not come directly from the mining sector. Figure 25 shows that Wyoming's international exports are largely accounted for by trona, while several peers export more in agriculture and electronics. Figure 26 shows that Wyoming's domestic exports are uniquely dominated by coal and other minerals, whereas peers have more diversified export baskets. For the size of its population, Wyoming's scale of natural resource extraction is impressively large. Its relatively high exports per capita — both international and domestic — exist thanks to its resource industries.

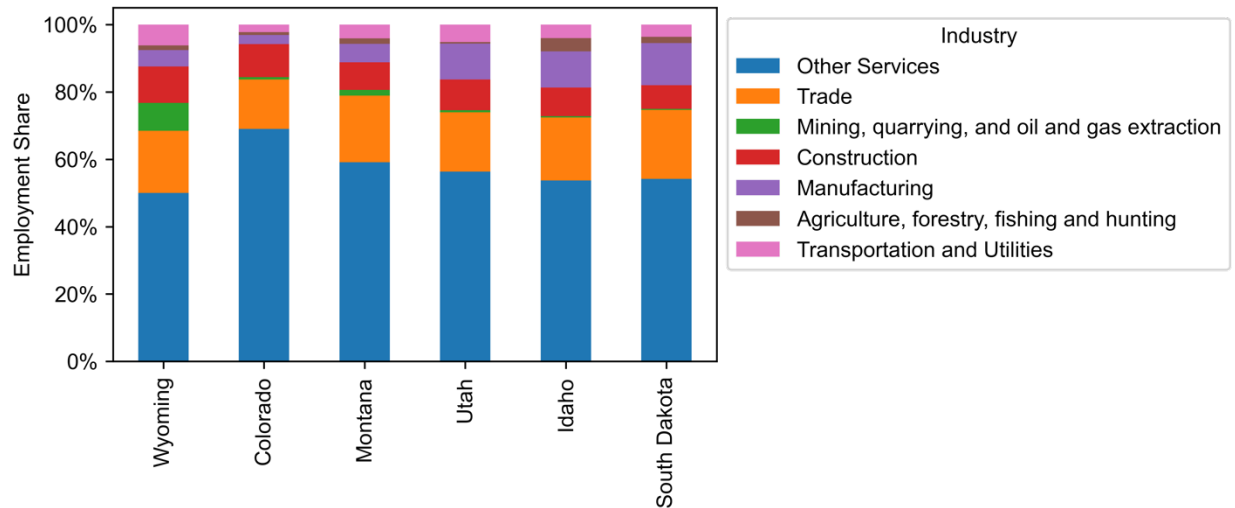
Given the scale of Wyoming's resource economy, it is important to understand the systemic role that this part of the economy plays in generating tradable income. Tradable income is any income that is generated from industries that are sold outside of the local economy. At the state-level, tradeable income can come through selling goods and services to other states or internationally. At the county, city, or local level, tradeable income can additionally come through other goods and services that are sold to other parts of the state. Coal, oil, and gas are highly tradable industries at the state level. By selling these products beyond the state, income flows into the state that is circulated through the rest of the economy, including largely non-tradable industries like retail and restaurants — though when those industries serve out-of-state tourists, they are also tradeable. At the local level, many other industries serve as a tradeable base to the local economy. For example, a farm or hospital that serves the surrounding area delivers some amount of income locally that then circulates. At the state level, Wyoming's mineral wealth has historically supported high income levels. Figure 27 shows that median household income is relatively high, at just above \$64,000 in the year prior to the COVID-19 pandemic, even though Wyoming has not developed agglomerations and highly dynamic populations as other states in the region have.

Figure 23: Shares of Gross State Product by Industry and State, 2020



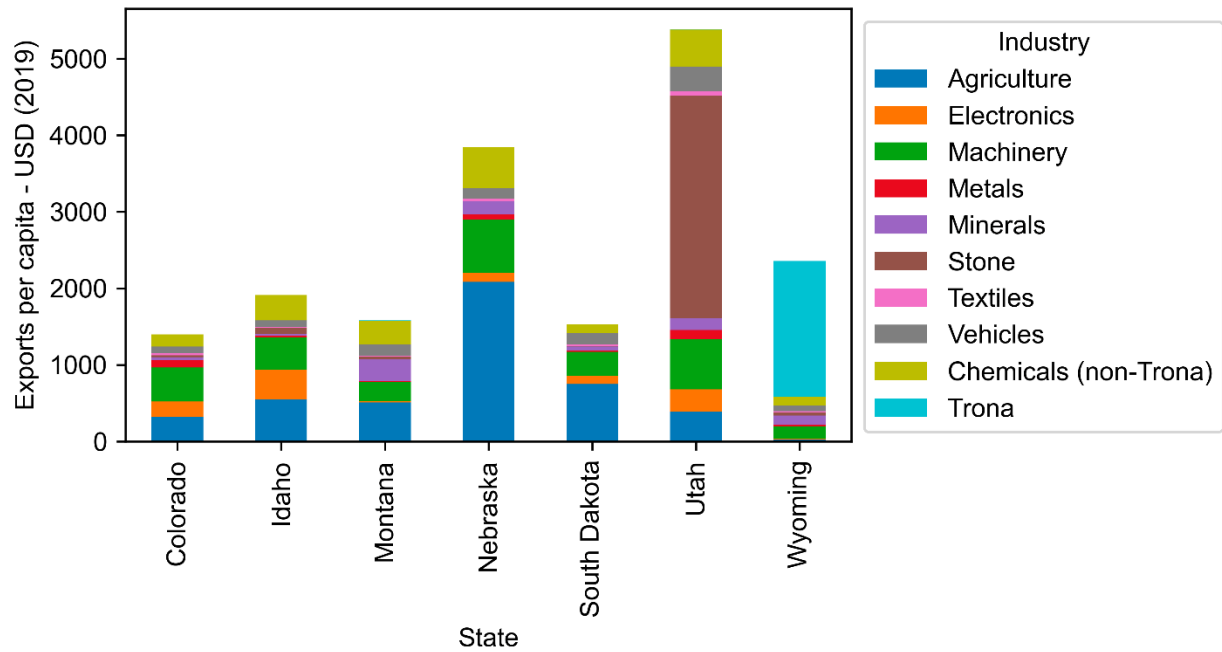
Source: US Bureau of Economic Analysis

Figure 24: Shares of Employment by Industry and State, 2020



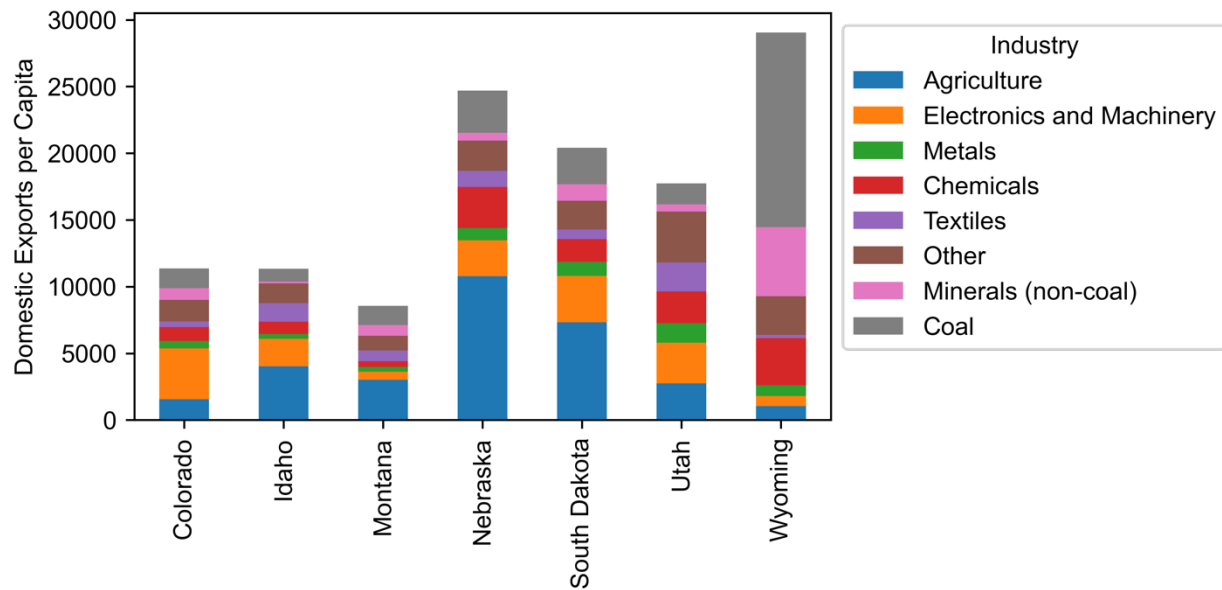
Source: US Bureau of Economic Analysis

Figure 25: International Exports by State and Composition, 2019



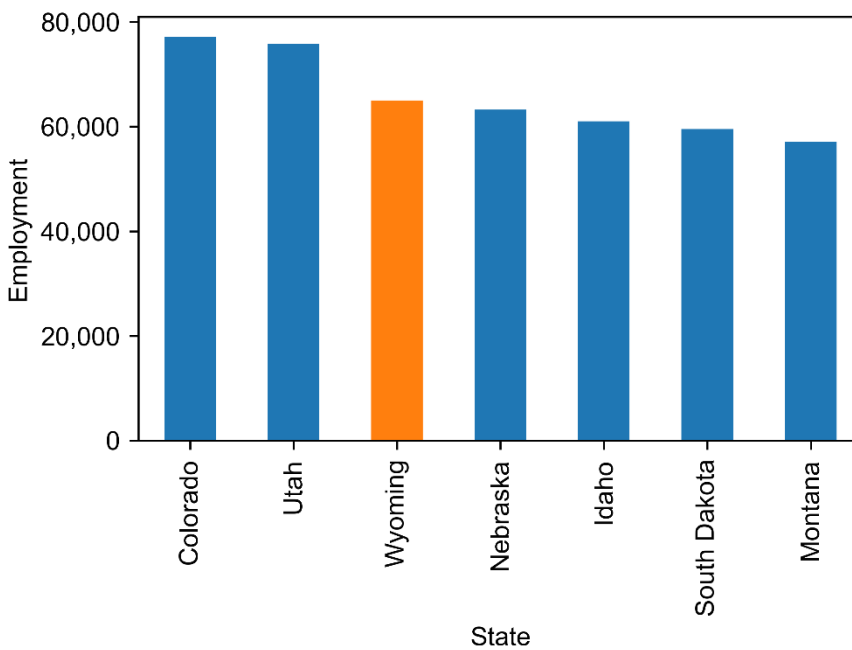
Source: USA Trade Online

Figure 26: Domestic Exports by State and Industry, 2017



Source: US Commodity Flow Survey

Figure 27: Median Household Income by State, 2019



Source: American Community Survey – 1 Year Estimates

In addition to its economic dependence on resource wealth, Wyoming's fiscal dependence on the mining sector is also extremely high, even when compared to other resource-intensive U.S. states. As seen in Table 1, Wyoming leads the nation in fossil-fuel revenues, both in per capita terms and as a share of own-source revenues, almost doubling those of second-place North Dakota. Texas and California have significantly higher fossil fuel revenues in total, but their population levels are disproportionately higher and their economies and tax bases much more diversified.

Table 1: State and Local Fossil Fuel Revenues, 2015-2019 (Averages; 2019 US\$)

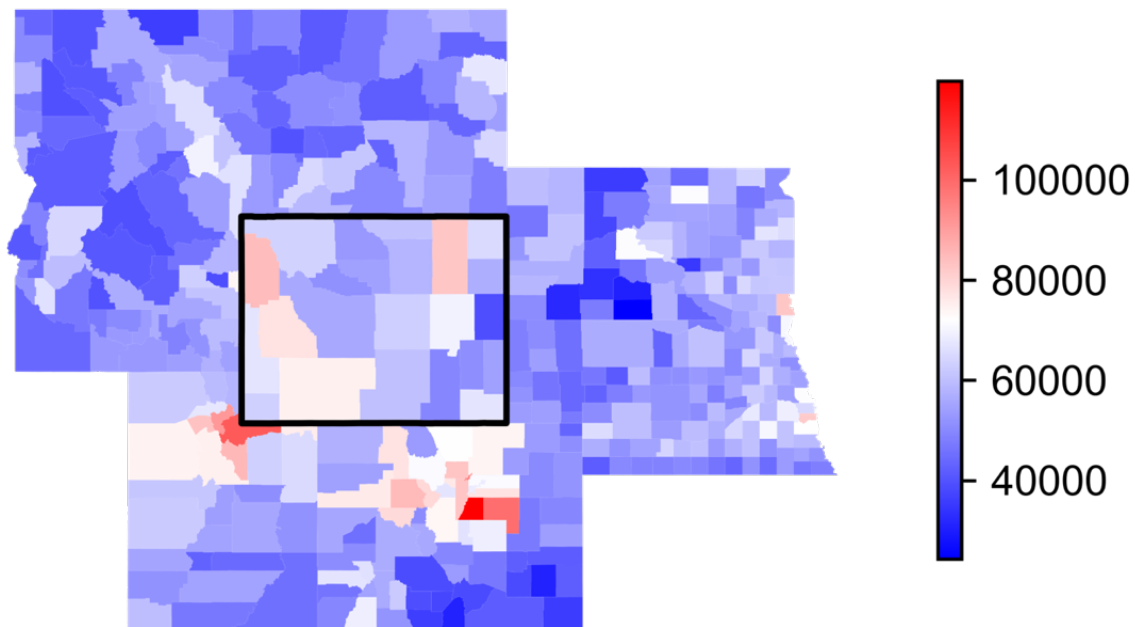
State	Total government fossil revenue in US\$ million (1)	State	Per capita government fossil revenue (2)	State	Government fossil revenue as a share of state and local own-source revenue (3)
Texas	14,591	Wyoming	7,339	Wyoming	59%
California	7,823	North Dakota	3,854	North Dakota	31%
Pennsylvania	4,422	Alaska	2,713	Alaska	21%
Wyoming	4,264	New Mexico	1,303	New Mexico	15%
North Dakota	2,917	West Virginia	698	West Virginia	9%

Source: [Raimi et al \(2022\)](#)

While Wyoming's relatively high median income affords Wyomingites a generally high standard of living, the geography of the state's prosperity is uneven. Figure 28 shows that a few counties — such as Teton, Campbell, Sublette, and Sweetwater — enjoy high median household incomes in the range of \$70,000 to \$80,000 per year, whereas others in the east and center of the state

are instead closer to \$50,000 or in some cases \$40,000 per year. This is not an exceedingly high level of inequality in comparison to the region, however. Wyoming is notable for lacking extremely poor counties seen in other states, including Colorado, Idaho, Montana, and South Dakota. By the same token, however, it does not have any counties that support very high levels of median household income like Denver and Salt Lake City.

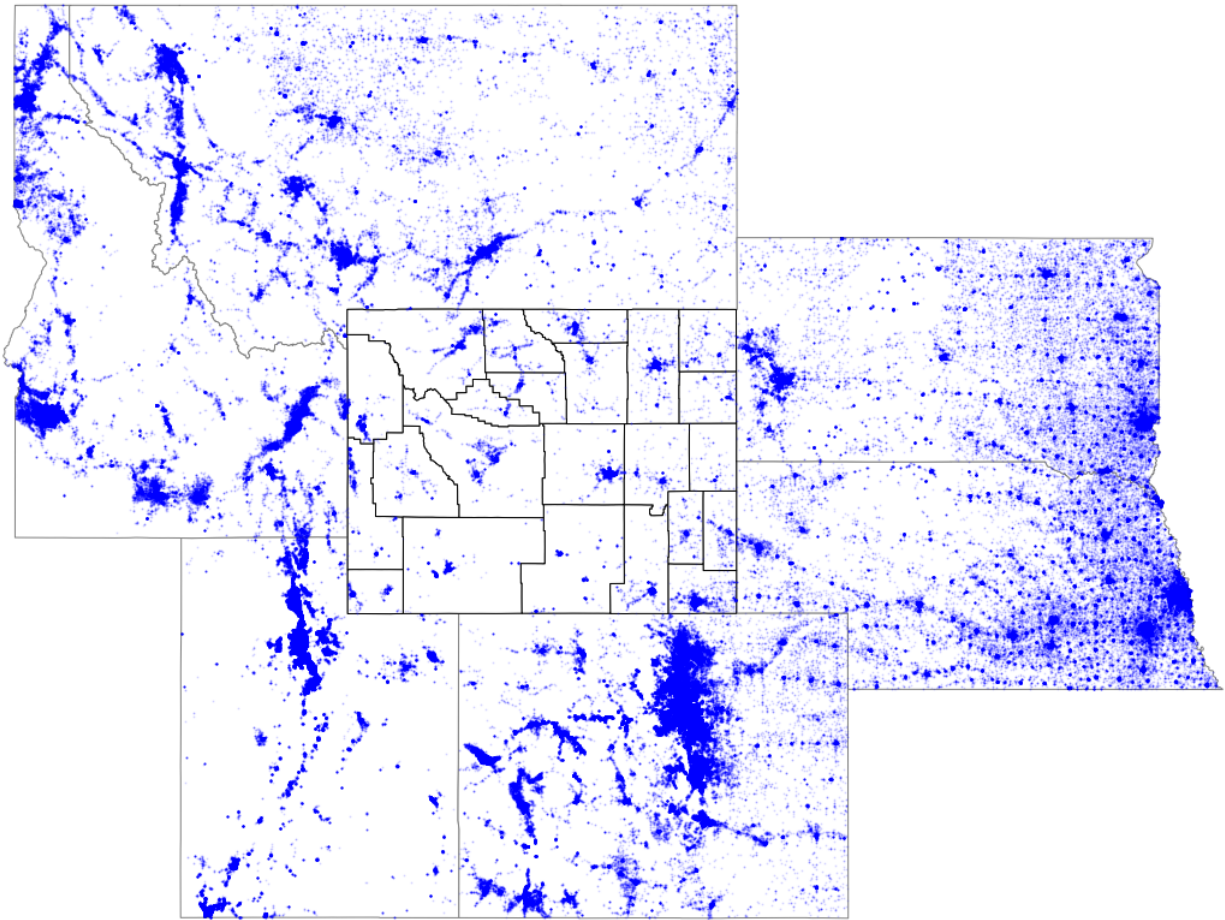
Figure 28: Median Household Income by County in the Mountain West Region, 2019



Source: US Census Bureau

One feature of Wyoming's low population and remoteness is that Wyoming's economic concentration is defined by small geographic clusters that are largely disconnected from one another. Figure 29 shows a map of business locations in Wyoming and surrounding states. In surrounding states, there are large agglomerations or collections of smaller agglomerations in closer proximity to one another. Wyoming, by contrast tends to have one or a few primary centers of business activity — which correspond to centers of population — in each county. For many parts of the state, the nearest larger agglomeration is out of state. This is the case for Cheyenne (southeast corner of the state) to Denver and the Front Range and the southwest of Wyoming to Salt Lake City, but other parts of Wyoming are also close to Idaho Falls, ID, Billings, MT, and Rapid City, SD. These patterns of economic geography have implications for tradeable income at the local level, since each distinct geographic cluster in Wyoming will need to provide goods or services to other economies — either within the state or outside — to sustain and grow their own levels of income. Since roughly half of Wyomingites live in towns of fewer than 10,000 people, this is an important aspect of the contemporary economy.

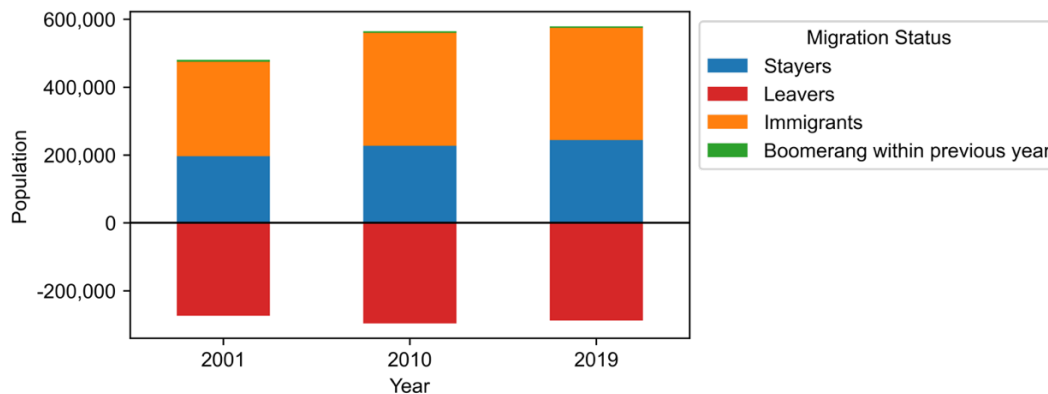
Figure 29: Distribution of Business Activities in the Mountain West Region



Source: Dun & Bradstreet Database of Business Establishments

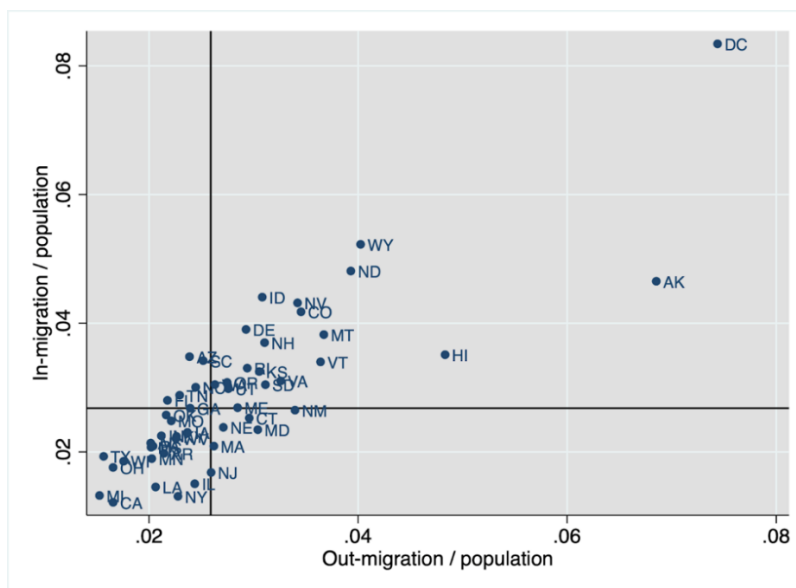
As established in the long-term section, Wyoming sees a lot of individuals leave the state. But the state also sees a significant amount of incoming migration for its size (Figure 30). A majority of people who reside in Wyoming (the positive parts of the graph) were born in another U.S. state, while the number of people born in Wyoming who have left the state to reside elsewhere exceeds the total number of those that remain. There is also an important group that is sometimes referred to as the “boomerang” population — those who were born in the state, lived elsewhere, but have returned to the state. Public data does not allow for a full estimation of the size of this population but Figure 30 estimates those who were born in in the state, lived elsewhere, and returned within the previous year. This is a small share of the total but may be significant if it could be aggregated across all years. These rates of in- and out-migration are high compared to other states. Figure 31 shows in- and out-migration as a share of population by state in 2019; Wyoming is notable for having comparatively high rates on both measures.

Figure 30: Wyoming's Migration Patterns Over Time



Note: Immigrants include those moving from other states to Wyoming.
Source: U.S. Current Population Survey

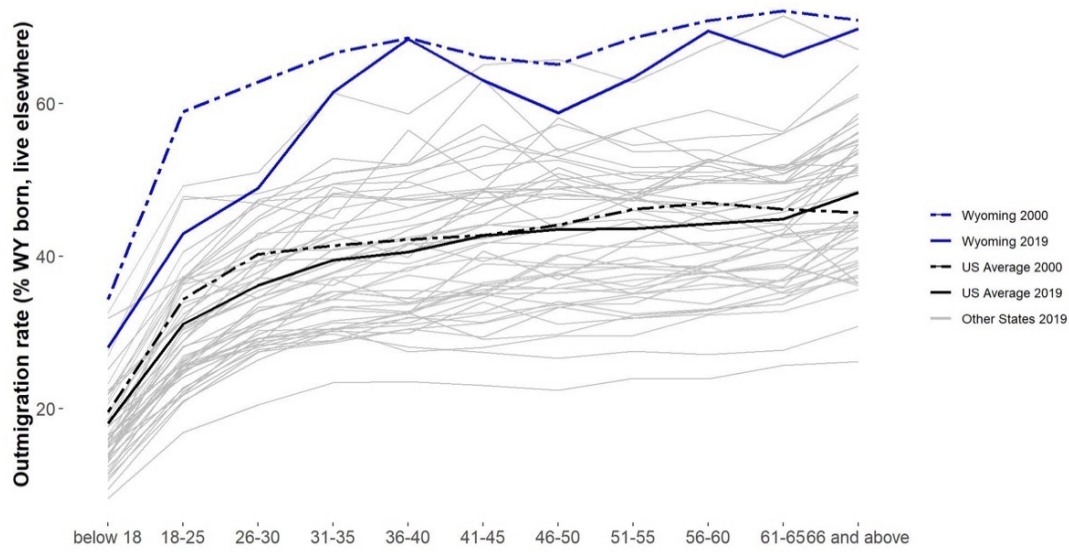
Figure 31: Wyoming's In- and Out-Migration Compared with Other States, 2019



Source: U.S. Current Population Estimates

Importantly, the types of people who leave and move to Wyoming are not the same. Figure 32 breaks down patterns of outmigration by age bracket for all states in 2019 and shows this calculation for Wyoming and for the U.S. on average in 2000 to observe changes over time. At almost any age bracket, Wyoming has the highest overall outmigration rate of any state. However, the shape of the curve means that people tend to leave before they are 40 years of age in 2019. It is possible that after reaching 40 Wyomingites still in Wyoming choose to stay, or that there is a mix of outmigration accompanied by return migration – a “boomerang” effect of people who previously left the state making it their home once more. There is a clear difference in 2019 versus 2000, when the rate of outmigration was exceptionally high at lower ages as well. A decline in the outmigration rate of young Wyomingites aged 18-30 is noteworthy though outmigration of individuals in that age range is still amongst the highest of any state.

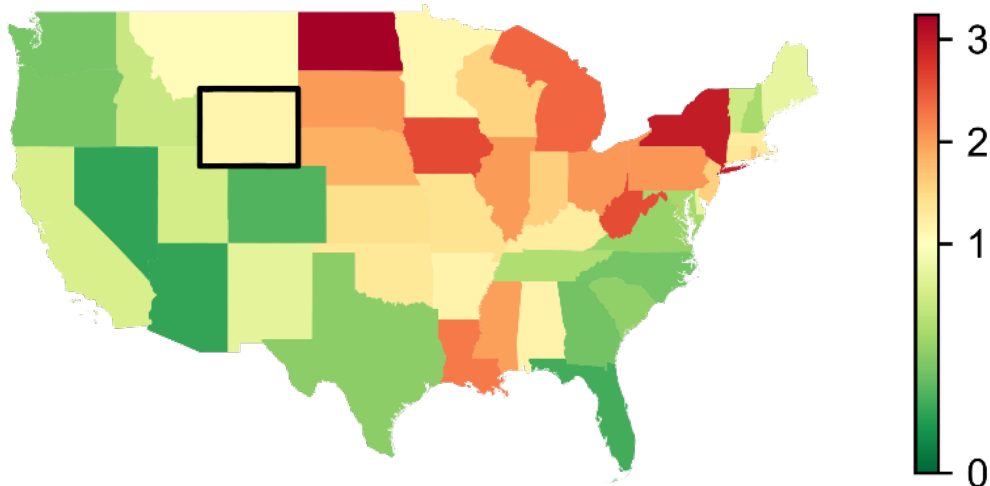
Figure 32: Wyoming's Outmigration by Age Bracket



Source: IPUMS and ACS

Out-migrants and in-migrants to Wyoming differ along other important dimensions than age as well. Both out- and in-migrants tend to have higher levels of education, for example. On the whole Wyoming experiences a slight brain drain of highly educated people (i.e., those with a college degree). Figure 33 shows the ratio of highly educated out- to in-migrants by state in 2019. In Wyoming the ratio is 1.15; although this indicates a slight brain drain it is remarkably balanced in the wider context of the US. Several nearby states experience substantially worse ratios.

Figure 33: Ratio of Highly Educated Out-migrants over In-migrants by State in 2019



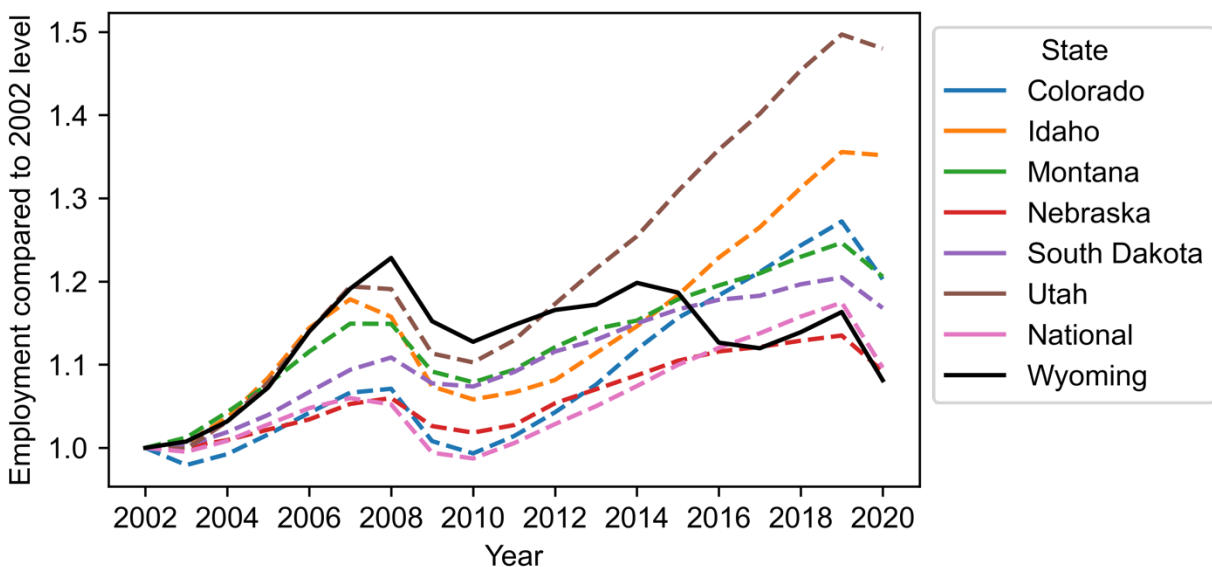
Source: American Community Survey

Wyoming's contemporary economy is, overall, marked by high income and living standards, largely thanks to the role that resource-dominated state-level exports have played in providing tradeable income to the state economy. The state's revenue base is also highly dependent on fossil fuels. Income is not distributed evenly across the state, as median household income varies substantially across the state, though geographic inequality is less than in other states with much larger centers of agglomeration. Wyoming's remoteness also manifests in a geography of small yet distinct economic clusters, without the level of geographic connectivity seen in other states in the region. A snapshot of migration into and out of the state shows that Wyoming continues to have high levels of flows in both directions. Young people continue to leave the state in high numbers looking for opportunity elsewhere, though perhaps not as high as a generation ago, which contributes to an overall brain drain. With this snapshot in mind, we next look more closely at roughly the last two decades of growth in Wyoming to understand what is changing.

The Modern Boom-Bust Cycle

The latest boom-bust cycle of Wyoming's mining-dependent economy played out over the two decades leading up to the COVID-19 pandemic. One major outcome of this cycle can be seen in Figure 34, which shows the growth of the number of jobs in Wyoming and surrounding states from 2002-2020. Wyoming was expanding jobs faster than any state in the region and far faster than the national average over 2002 to 2008. Following the Global Financial crisis, Wyoming lost jobs like all the peer states, but then fortunes began to diverge after 2010. Recovery of job growth after 2010 was more limited in Wyoming than most of the peer states until 2014, at which point Wyoming experienced an overall drop in jobs for the rest of the decade while the comparator states continued to grow. This second and unique drop in employment levels in the state was the clear consequence of an end to the general global commodity supercycle and the related decline in demand for the main sources of Wyoming's state exports.

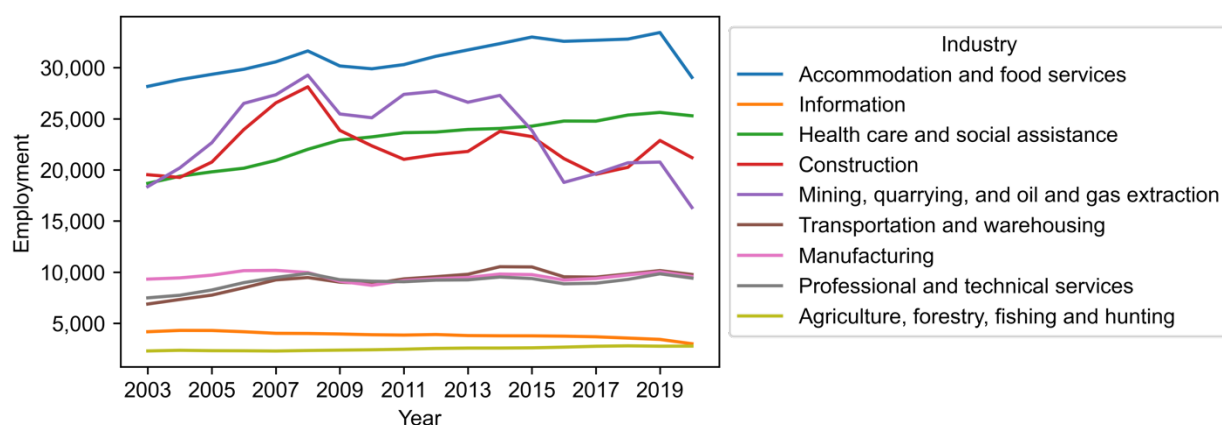
Figure 34: Relative Growth of Jobs in Wyoming and Peer States, 2002-2020



Source: US Bureau of Labor Statistics

The industry drivers behind Wyoming's job growth and subsequent job decline can be seen in Figure 35. The pattern of strong initial job growth, stagnation after 2008, and then further decline after 2014 come from the mining and construction sectors. These two industries are responsible for similar levels of employment in Wyoming, and their fortunes are closely related since mining creates demand for construction. From peak to subsequent trough these industries experienced cumulative losses of just over 24,000 jobs. The information sector experienced a smaller but still notable loss of approximately 1,000 jobs but this sector has been declining in jobs in Wyoming for the full two decades. Overall losses were partly offset, however, by gains in healthcare (of nearly 6,000 from 2003–2020) and, before the pandemic, in accommodation and food services (of an additional 6,000 from 2003–2019). Each of these industries can be considered partially tradeable — certainly at the local level but also at the state-level if demand (or simply insurance payments in the case of healthcare) comes from out of state.

Figure 35: Employment by Large and Tradable Industries in Wyoming, 2003-2020

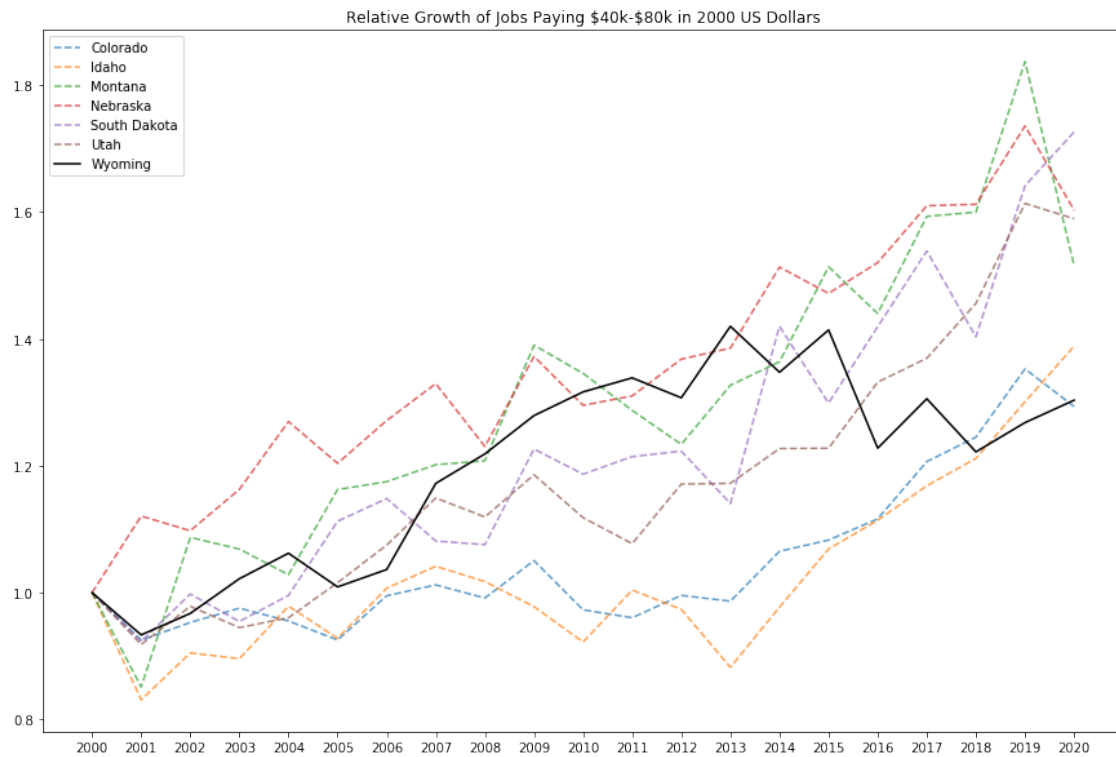


Source: US Bureau of Labor Statistics

The bust in this cycle was problematic for jobs that could be specifically considered ‘middle-class’ — here defined as paying \$40,000 to \$80,000 in 2000 dollars (Figure 36). For these jobs there is again a pattern of Wyoming leading the pack for a period but diverging after 2010 and especially after 2014. As of 2010, Wyoming had the largest cumulative growth of middle-income jobs, but by the end of the decade it had the lowest cumulative growth in the region. By contrast, the steady rise of Montana and South Dakota is especially notable. These are not very high-population states (1.1 million and 880,000 people, respectively), but they maintained an impressive growth rate of middle-class jobs throughout the observed period. This indicates that alternative, potent economic strategies may be possible with population levels not exceedingly far from those of Wyoming.

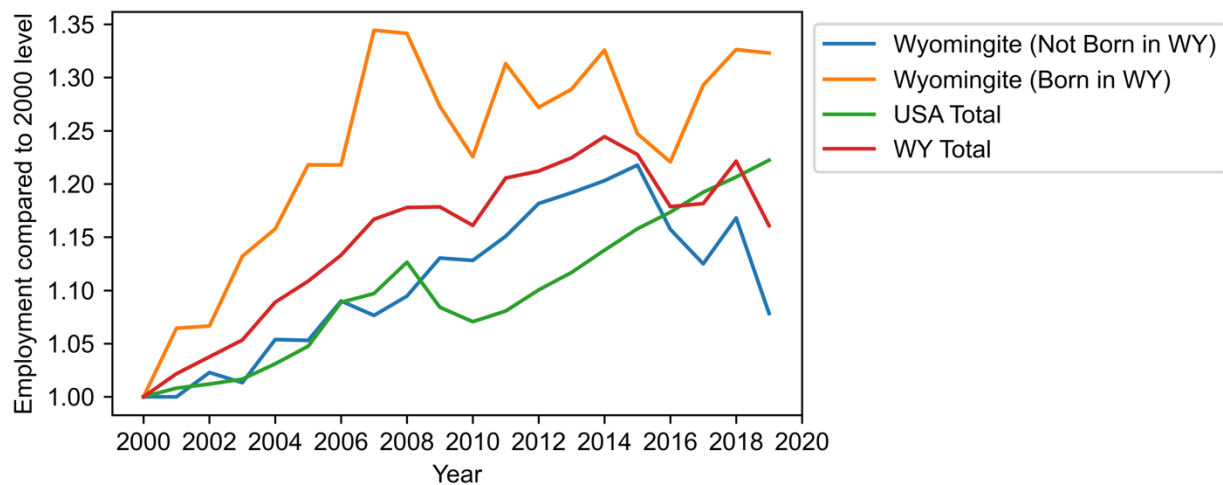
Many of these job losses, however, were absorbed by non-Wyomingites working in Wyoming, which signals that the bust was not as bad as other ones in Wyoming's past. Figure 37 shows that from 2014 onward, people who were not born in Wyoming lost jobs at a high rate. Meanwhile, those born in Wyoming saw a modest recovery in jobs from 2016 onward. Many non-Wyomingites simply relocated out of the state, as Figure 38 confirms. Evidently, the economic conditions for remaining Wyomingites were, in general, sufficiently fair to prevent a large net outflow from the state. It must be noted that the outflows of non-Wyomingites nevertheless represent lost population that, in the long run, may have instead contributed to the state economy. What's more, the net gains in jobs and population of Wyomingites from 2000–2008 flatlined thereafter.

Figure 36: Relative Growth of Jobs Paying \$40k-\$80k in 2000 USD by State, 2000-2020



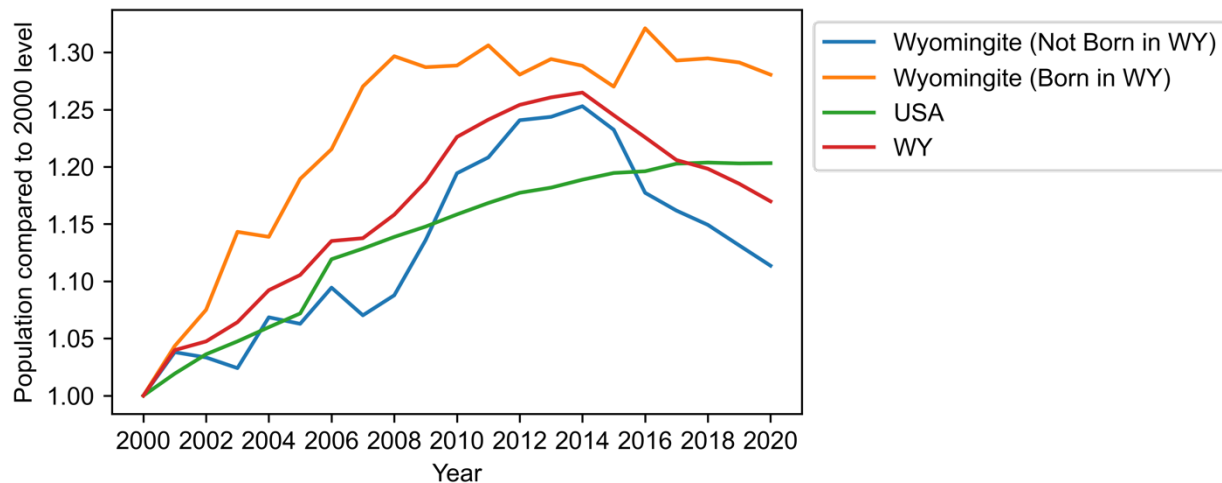
Source: American Community Survey

Figure 37: Relative Growth of Jobs Held by Wyomingites and Non-Wyomingites in Wyoming, 2000-2019



Source: American Community Survey

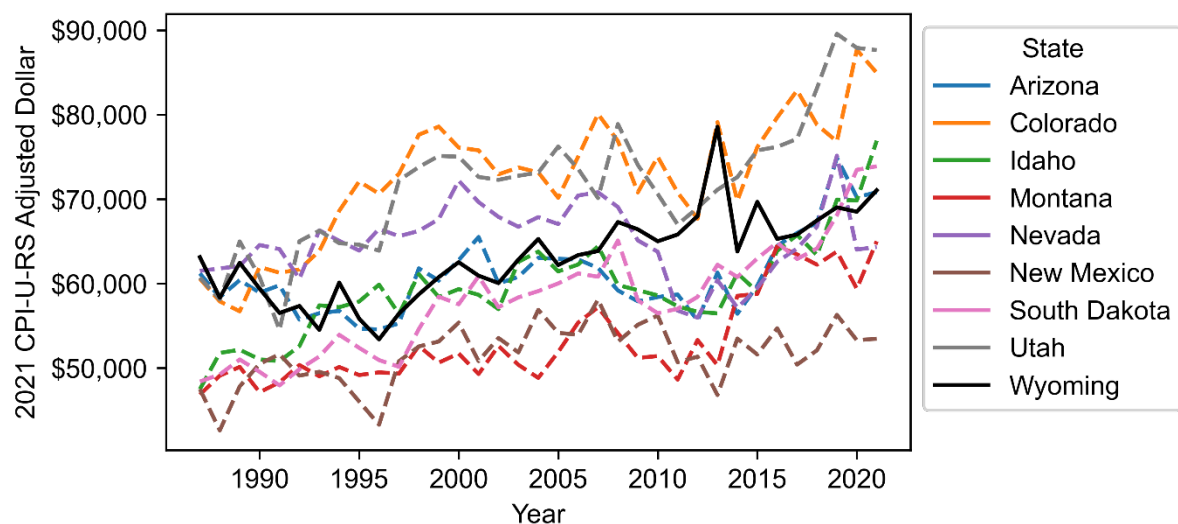
Figure 38: Relative Growth of Population 18-65 Among Wyomingites and Non-Wyomingites in Wyoming, 2000-2020



Source: American Community Survey

The net adjustment from the bust can also be observed in median household income, which — like jobs and migration of Wyomingites — was more moderate. Figure 39 shows that the period from 2000 to 2013 saw a strong expansion of median household income in Wyoming, which briefly peaked to exceed that of Utah and nearly match that of Colorado. After 2014, unlike overall jobs and middle-income jobs, the downward adjustment was not as severe. Median household income in Wyoming continued to grow at a generally positive rate after 2015, though it was eventually overtaken not only Colorado and Utah, but also Idaho and South Dakota at the time of the pandemic.

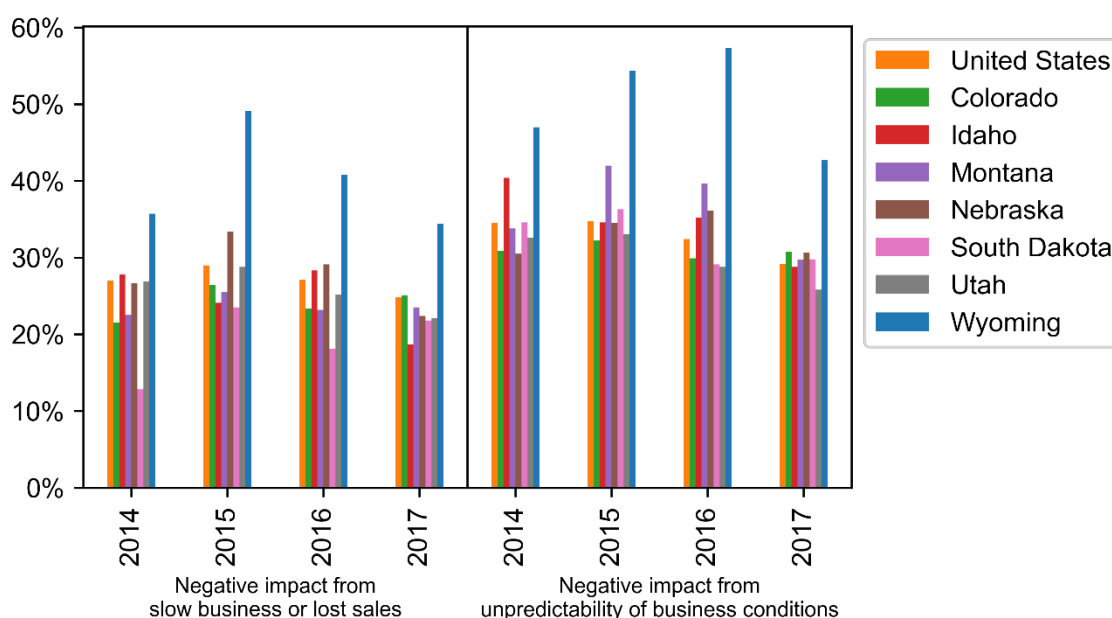
Figure 39: Real Median Household Income by State, 2000-2021



Source: US Federal Reserve

The loss of state-level tradeable income associated with the bust and accompanying instability had noticeable impacts on business across the economy. In business surveys covering the years 2014-2017 (all that was available publicly for review), Wyoming stands out from neighbors and the U.S. average on two questions that relate to a negative business cycle within the state. Figure 40 shows the share of firms (weighted by payroll) responding yes to two questions about issues affecting profits. The first question asked if firms had experienced a negative impact from slow business and lost sales, and the second on if the firms had seen a negative impact from the unpredictability of business conditions. Wyoming clearly stands out from regional peers for the higher share of businesses that reported negative impacts on profits in these two ways. This is a signal of a Wyoming-specific downturn in aggregate demand, which would be consistent with the decline in key industries supporting tradeable income. By 2017, these impacts may have been moderating based on the firm surveys available.

Figure 40: Reported Negative Impacts on Profits Among Businesses by State, 2014-2017

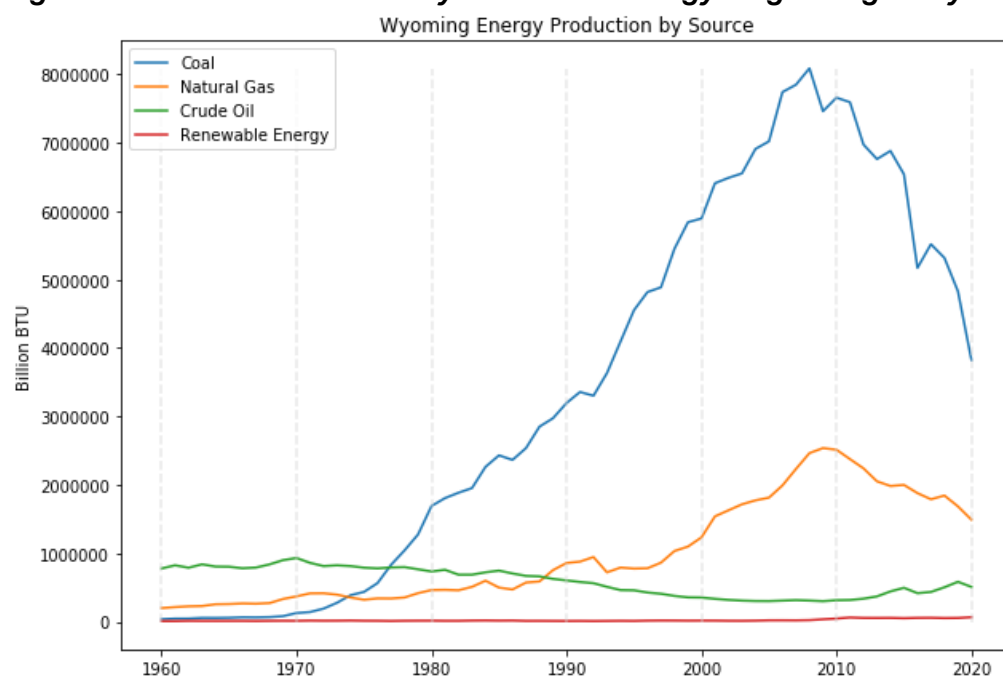


Source: US Census Bureau

Several exercises can help us understand the drivers of the mining and construction downturn in more detail and with a sense of scale. Figure 41 shows production volumes of key energy resources in Wyoming in terms of British Thermal Units (BTUs). By measuring these volumes in energy terms, we can compare quantities in a way that is meaningful across different energy sources and not affected by volatile price swings. For a sense of scale, the figure also shows renewable energy production in Wyoming in energy units. Not surprisingly, given the inflection points discussed above, Wyoming saw a significant change in production of key fossil fuel resources that had been growing before around 2008-10 and an intensifying collapse after 2014. More specifically, coal — the largest by far in energy units — peaked in 2008 and has fallen precipitously and continuously since. This was after an enormous and continuous expansion going back 40 years. This differentiates Wyoming somewhat from the broader commodity supercycle and means that national policies and other states' demand for coal is key to Wyoming. Wyoming also saw a more gradual rise and fall in natural gas production with a peak in 2008-10. In this case, the decline in Wyoming coincides with a rise in natural gas produced from shale formations

through hydraulic fracturing elsewhere in the country. This lowered the price of natural gas and has effectively pushed down production in Wyoming.

Figure 41: Production of Primary Sources of Energy Originating in Wyoming



Sources: Wyoming Oil & Gas Commission, US Energy Information Administration

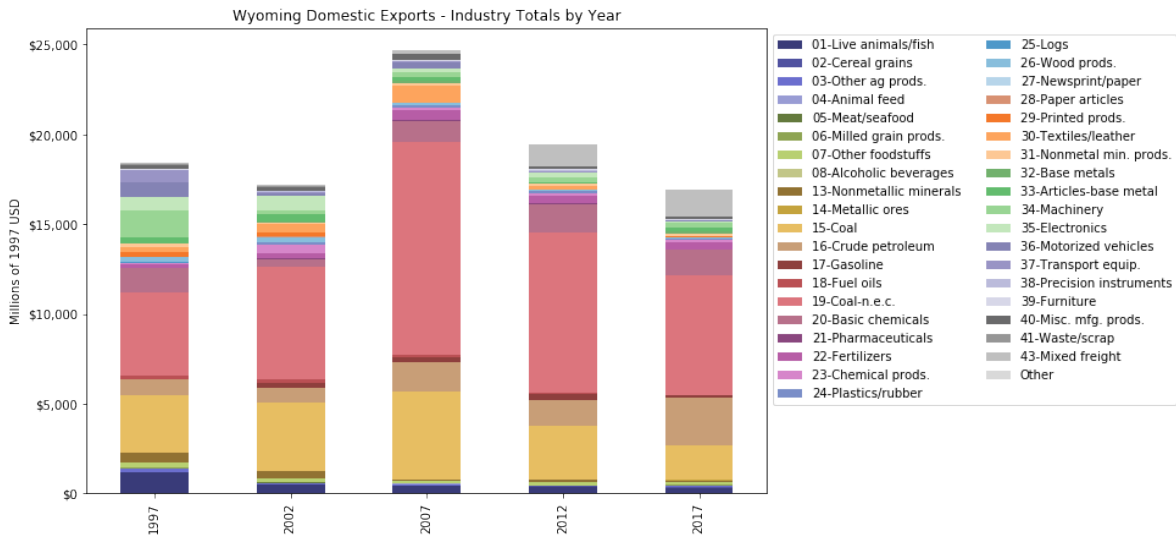
Oil production, conversely, saw a slight recovery of growth after 2008-10 following 40 years of decline in Wyoming. Oil was the primary cause of a much larger economic boom and bust cycle of the 1970s and 1980s. That cycle is not seen here because it occurred more through the price of oil more than the quantity. Finally, the production of renewable energy in Wyoming barely registers in energy terms in relation to the traditional sources of energy wealth of the state. This is one indication of how much wind production and other technologies would need to scale up to replace lost tradeable income from fossil fuel resources of the state.

This boom and bust can also be observed in dollar terms in the evolution of Wyoming's domestic goods exports (the major market for its energy resources), as depicted in Figure 42. Unfortunately, reliable information on domestic exports is only available every five years based on a freight survey — and thus only relevant for goods (as opposed to services). Nevertheless, this captures key tradeable sources for the state. Wyoming's total domestic exports rose markedly from 2002 to 2007, driven by the expansion of coal and to a smaller degree petroleum. They then shrunk by the advent of 2012 and again by 2017. These products dominate Wyoming's composition of domestic exports.

These state-level trends disguise, however, significant differences across the state. Figure 43 establishes each Wyoming county's exposure to natural resource extraction, in terms of the share of employment and wage earnings accounted for mining over time. While data is suppressed in certain years for certain counties, there is a clear pattern where some counties are more dependent on mining overall than others. Figure 44 orders counties by the peak share of wages

accounted for by mining, where five counties (Sublette, Campbell, Big Horn, Sweetwater, and Converse) generated more than one-third of their total wages from mining of various products.

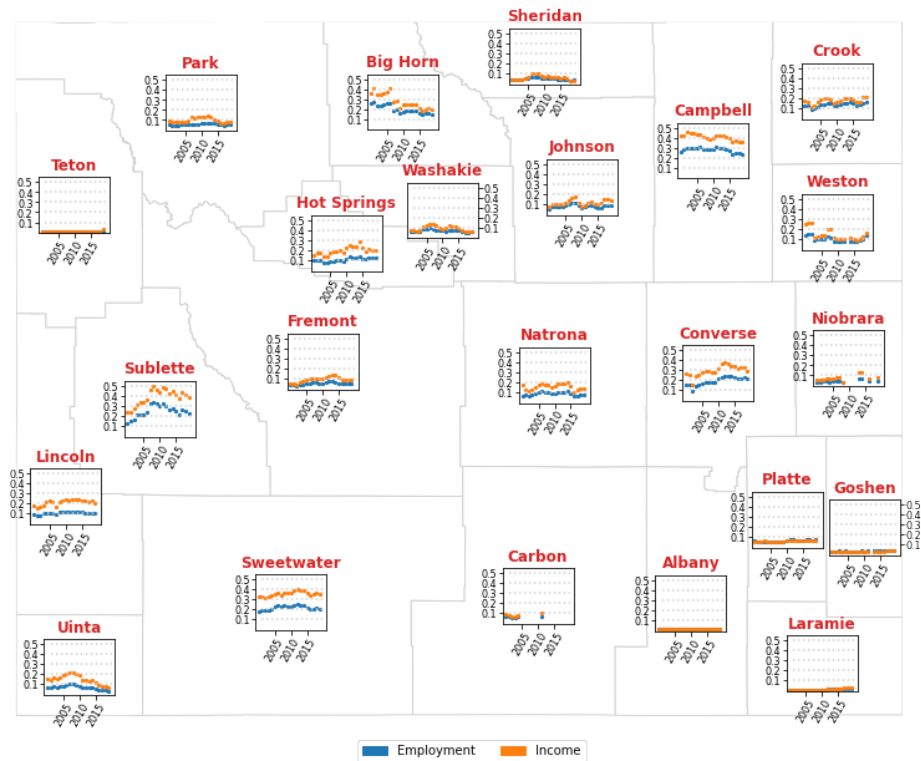
Figure 42: Wyoming’s Domestic Goods Exports over Time



Source: US Commodity Flow Survey

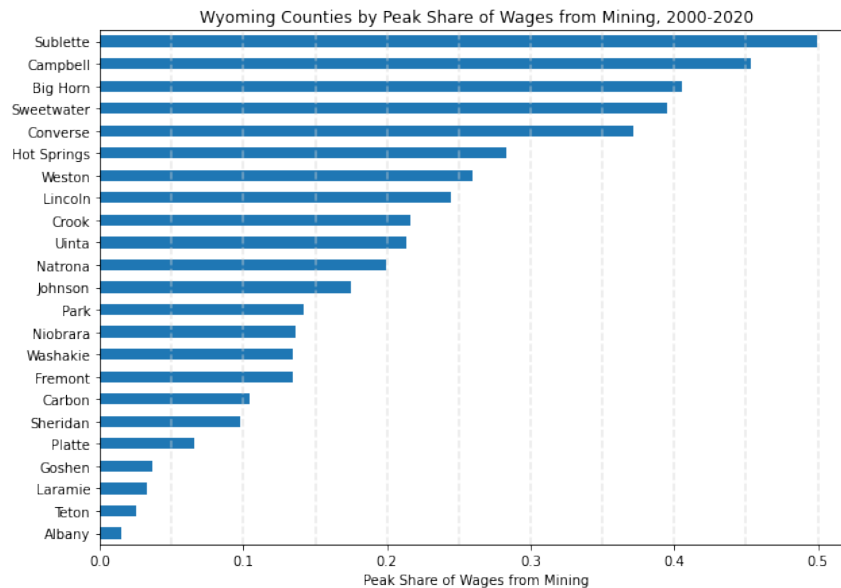
Figure 43: Share of Mining in Employment and Earnings by Wyoming County

Employment & Earnings Shares of Mining Industries by County, Year



Source: US Occupation, Employment and Wage Statistics

Figure 44: Wyoming Counties by Peak Share of Wages from Mining, 2000-2020



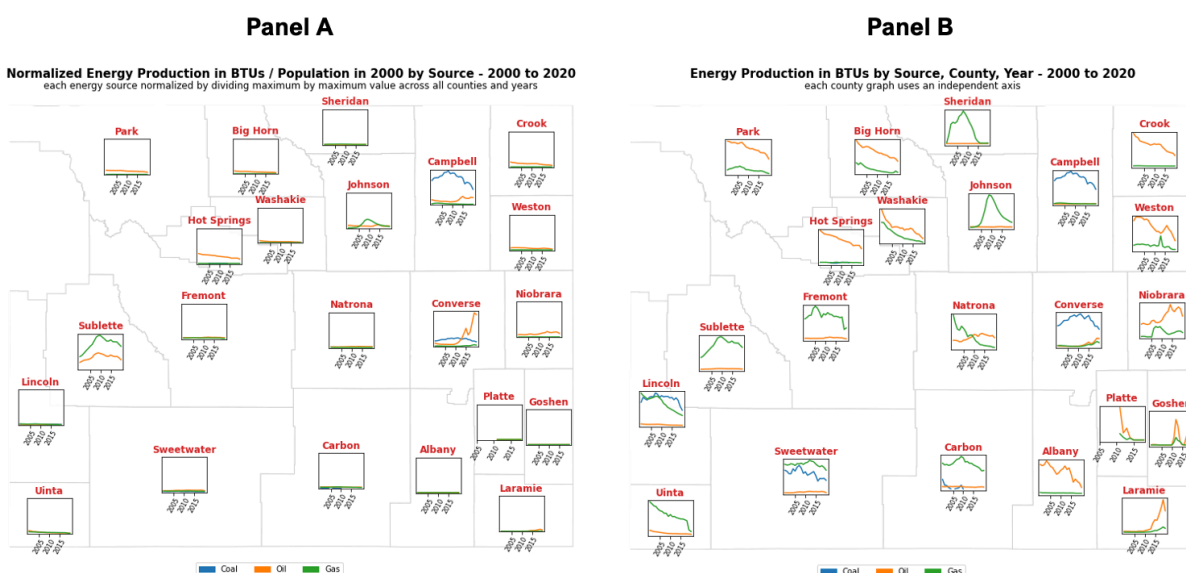
Source: US Occupation, Employment and Wage Statistics

The type of product mined in a location matters because demand trajectories and sources of competition differ. There are key differences in the specific types of fossil fuels mined in each county, as well as mining outside of fossil fuels, including trona production. Figure 45 depicts county-level production of coal, oil, and gas in two ways. Panel A shows the relative magnitude of production sources per capita comparing across different counties, so that it is possible to tell which counties are most intensive overall in the production of coal, oil, and gas. For example, the peak value of the blue line (representing coal) occurs in Campbell County. The trends for coal production in other counties are scaled versus Campbell's coal trend and can be read accordingly. By the same token, the peak production level for oil occurs in Converse County, and other counties' trends for oil are scaled relative to that value. It can thus be observed from Panel A that Campbell County is overwhelmingly the center of coal intensity in Wyoming, though Converse County also sees substantial production per capita. Gas production is most intensive in Sublette County, followed by Johnson County. The time trends of production across counties for coal and natural gas track those discussed at the state level. Oil production, however, follows a different trend altogether. Although it is produced most intensively in Converse County, there are contributions from a variety of other counties. The dynamics of production are also not as uniform across the state. Although Sublette County's oil production followed the boom-bust trend centered around the Global Financial Crisis to an extent, oil production has grown after 2010 especially in Converse County but also to smaller degrees in Laramie and Niobrara counties. Counties such as Park, Big Horn, and Hot Springs saw steady decreases in per capita production from 2000 onward.

Panel B is set up so that each type of production is scaled relative to the total production of other sources within the same county, so that it is possible to tell which types of energy production predominate (in terms of BTUs) in each specific county. Campbell County and Converse County are largely dominated by coal, although Converse County has seen a more recent uptick in oil and gas production. Sweetwater and Lincoln have seen a mix of coal and gas production, along

with trona production in Sweetwater County (not shown). In all cases coal production has generally decreased from a peak. Gas production has been especially prominent in Uinta, Carbon, Natrona, Fremont, Sublette, Johnson, and Sheridan counties. In every case, gas production has decreased from a peak, but the timing differs. Sheridan, Johnson, Sublette, and Fremont have seen a boom and bust, while in contrast Uinta and Natrona have experienced clear decreases from 2000 onwards. Oil production has decreased steadily in several counties — Park, Bighorn, Hot Springs, Washakie, Crook, Weston, Albany, and Platte — but has increased since 2010 in Laramie, Goshen, and Niobrara counties. In Natrona County, oil increased from 2000 to 2010 and then held relatively steady.

Figure 45: Wyoming's Energy Production by County and Source



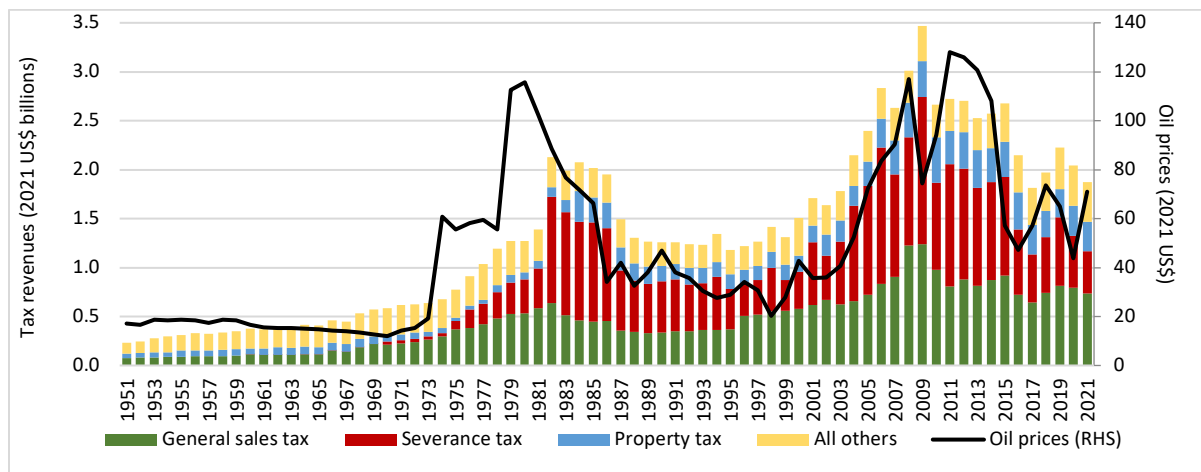
Source: Wyoming Oil & Gas Commission, US Energy Information Administration

The consequence of these differing trends is that while Wyoming experienced a boom-bust cycle hinging around the Global Financial Crisis and the end of the global commodity supercycle, the direct impacts vary significantly across the state, even among mining-focused local economies. We turn our attention to local impacts after briefly reflecting on the impacts on the state's finances.

Fiscal Consequences of the Bust

Driven by the ever-changing fortunes of the mining sector, state tax collections — led by sales and use, severance, and property taxes — have exhibited extreme volatility in Wyoming over the longer-term. According to a Pew Research study, Wyoming exhibits the third highest revenue volatility across U.S. states behind Alaska and North Dakota. This volatility is directly related to energy prices, as shown in Figure 46, which uses the global price of oil as a simple proxy for these dynamics. Tax revenues obviously rise and fall with energy prices. The figure shows that tax revenues took a significant hit, particularly after 2014. Severance taxes follow energy prices closely as expected, but the general sales tax is also affected by the boom-bust cycle.

Figure 46: Wyoming Tax Revenues by Category and Oil Prices, 1951-2020

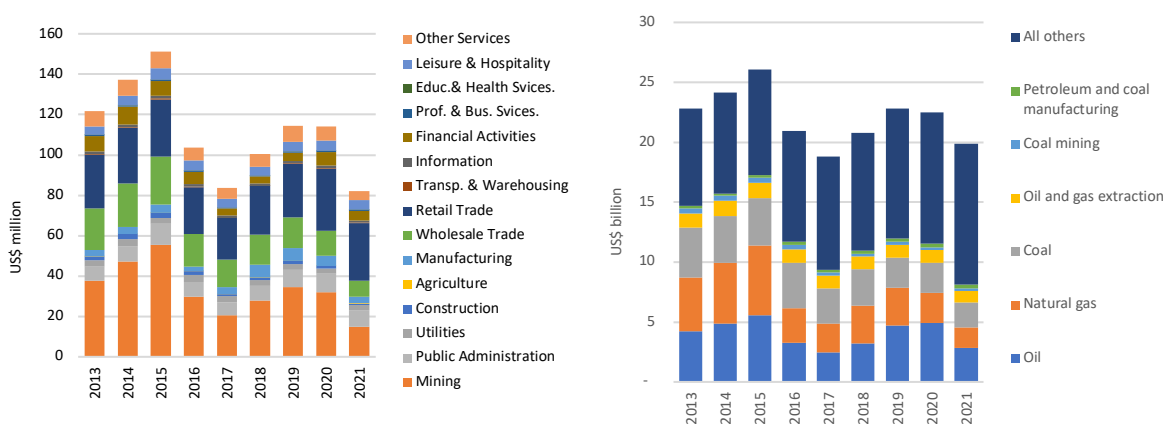


Note: Severance tax assessment changed from being assessed on prior year production to being assessed on current year production in 1981.

Sources: US Census Bureau; BP Statistical Review of World Energy

Despite being applied to a wider tax base, sales and use and property taxes are highly dependent on the fortunes of the mining sector. Oil, gas, and coal are the top direct contributors to property taxes and important contributors to sales and use taxes (Figure 47). The sales and use tax is subject to many exemptions. Mining also contributes indirectly to both revenue streams by through the sector's impacts on demand for other parts of the economy. As can be seen in the figure, neither sales tax nor property taxes returned to their 2015 peak as of 2021.

Figure 47: Sales and Use Taxes by Sector (left) and Property Tax Valuations (right)



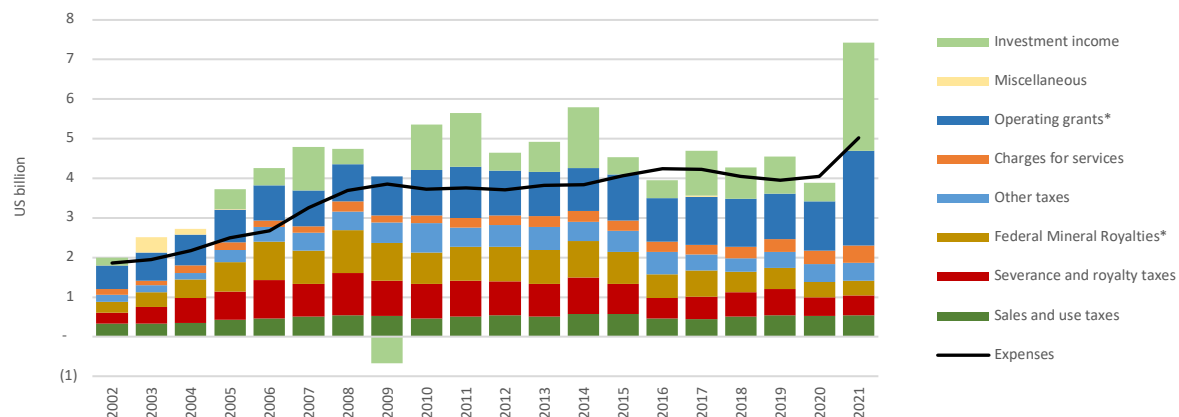
Source: [WY Department of Revenue](#)

Taxes in Wyoming are complemented by two other major revenue sources: (1) Federal Mineral Royalties and lease bonuses; and (2) financial returns from the Permanent Wyoming Mineral Trust fund (PWMTF). A large portion of oil, gas and coal extraction takes place in federal lands and 49 percent of royalties collected revert to Wyoming. The PWMTF was created via constitutional

amendment in 1974 and has since been accumulating a constitutionally mandated severance tax¹⁴ with the goal of building a large principal that is to remain “inviolable” while its returns contribute to the General Fund. The market value of this fund has grown, despite the bust, and amounted almost \$8 billion in 2019, before the COVID-19 pandemic, and had grown to over \$9 billion by 2021. In most years, returns on the principal of the PWMTF can therefore contribute significantly to overall revenues.

The financial operations of the State of Wyoming take place through main profiled accounts: the General Fund, the Budget Reserve Account, the Legislative Stabilization Reserve Account, the Strategic Investments and Projects Account, the School Foundation Program, the School Capital Construction Account, the PWMTF Spending Policy Reserve Account, the CSPLF Spending Policy Reserve Account, and three Water Development Accounts. The fragmentation of revenue streams into different funds complicates the task of assessing their relative importance. Tax rates and distributions for large revenue streams across funds are quite complex and for the most part governed by rules set in the Constitution or specified in legislative statutes. Fortunately, the State Auditor consolidates the financial activities of the State into a single comprehensive reporting entity and in doing so gives us a consolidated perspective (Figure 48) that leads to at least three main findings. First, sustained fiscal surpluses driven by the 2000s commodity supercycle allowed for the accumulation of assets in the PWMTF and other funds. Second, a sizeable and sustained fall in tax revenues after the collapse in commodity prices in 2014 led to an operational deficit (i.e., excluding investment income) that remained in place through the 2021 fiscal year. Third, operating grants and investment income experienced significant temporary increases in the 2021 fiscal year. The former was a result of the federal stimulus associated primarily with the CARES Act and the latter a result of exceptionally favorable financial market returns.

Figure 48: Wyoming’s Comprehensive Statement of Revenues, 2002 – 2021 FY

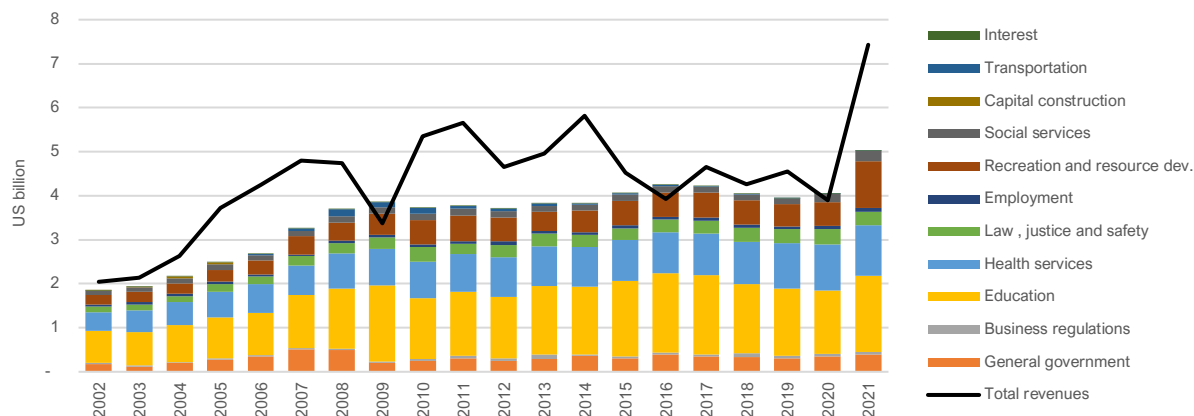


Sources: [Annual Comprehensive Financial Reports](#)

¹⁴ “For its first thirteen years, 2.0 percent of severance tax revenues were used to grow the account. The requirement was lowered to 1.5 percent, and 0.5 percent was diverted into the state’s savings account. In 2005, an additional statutory 1.0 percent was added to the constitutional requirement bringing the total to 2.5% of severance taxes which were deposited in the PWMTF. The Legislature, during the 2016 Budget Session, provided for a diversion of the one percent statutory severance tax from the PWMTF to the General Fund to address an immediate revenue shortfall.” https://wyotax.org/wp-content/uploads/2020/08/PWMTF-Combined_2015.pdf

The rules governing distribution of major revenue flows introduce significant rigidity in the allocation of expenditures and may therefore lead to sub-optimal outcomes — overfunding of some activities accompanied by underfunding of others. Education and health services represent the two major expenditure categories, consuming close to 40 and 25 percent, respectively of total expenditures. As shown in Figure 49, the decline in overall revenues after 2014 forced a small decline in overall expenditures, including on education. This dynamic changed with the sharp rise of available revenues in 2021.

Figure 49: Comprehensive Statement of Expenditures, 2002-2021 FY



Source: [Annual Comprehensive Financial Reports](#)

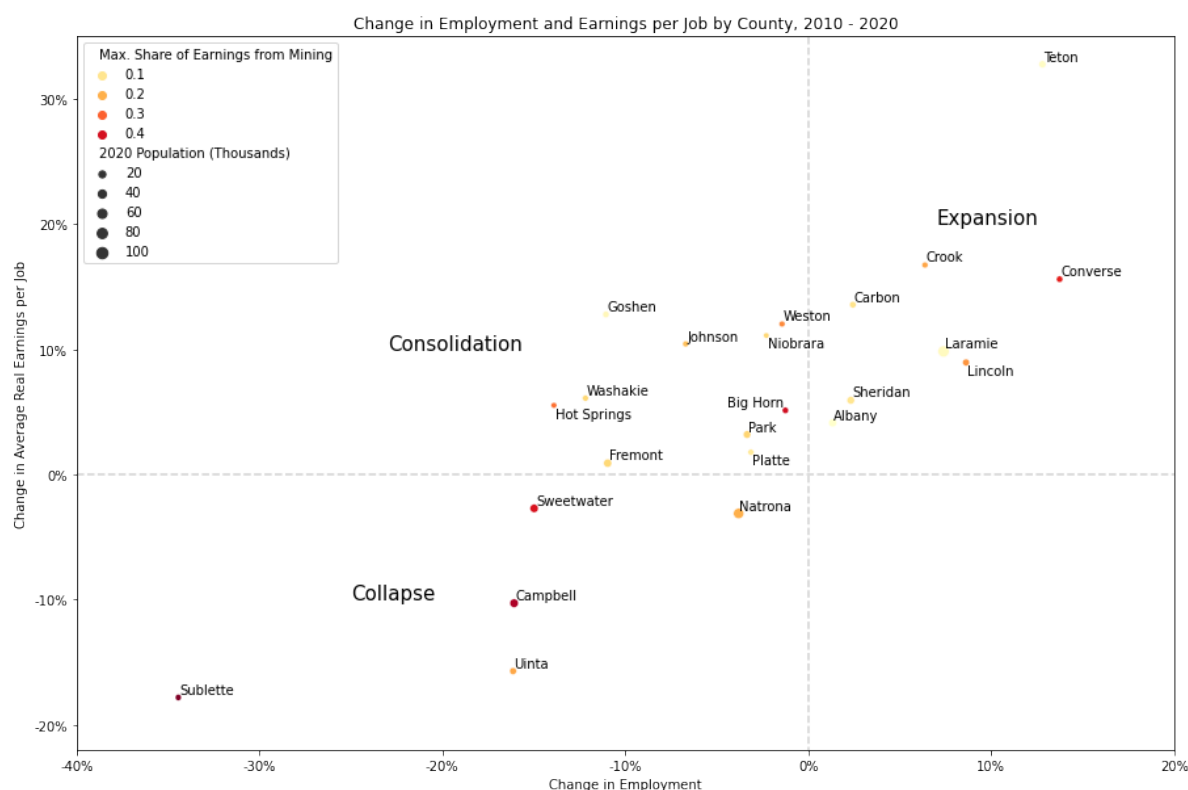
Place-Specific Consequences of the Bust and Drivers of Growth

At the state level, the consequences of this most recent bust have been surprisingly moderate both economically and fiscally. However, local economies across the state have been differentially affected. This is true at the county-level and more so at the local level. As we will see, counties with harder-hit labor markets have often seen shrinking populations and employment rates. This has been doubly true in smaller towns, which constitute the Wyoming communities that have shrunk the most. In several parts of the state these labor market impacts have also been associated with worsening social mobility. Vitally, the sources of the differential performance of counties can be accounted for in terms of industry-level changes. Counties with more robust labor markets often have enjoyed growth in a variety of non-resource sectors.

Figure 50 shows perhaps the most direct labor market impacts of the state-level bust on Wyoming counties from 2010 to 2020, along two dimensions: the change in the number of jobs in the county, and how well those jobs pay on average. Counties are sized according to population and colored according to their peak share of wage earnings from mining industries. Wyoming's counties fall into three quadrants with respect to these variables: expansion of the labor market (top-right); consolidation of the labor market (top-left); and collapse of the labor market (bottom-left). There are not any counties that are in the final quadrant of employment growth but wage decreases. Thus, "expansion" here refers to growth in jobs and average earnings, "consolidation" refers to a reduction in jobs but an increase in average earnings, and "collapse" refers to a contraction in jobs and average earnings.

Several features of this graph are notable. For one, numerous counties in the ‘expansion’ quadrant have economic engines that do not center around natural resources. Laramie County contains the state capital; Albany has the University of Wyoming and its ecosystem; Sheridan has a prominent manufacturing sector; and Teton county has a unique and thriving tourism economy. The counties in the ‘consolidation’ quadrant, interestingly, are largely geographically cohesive. They fall into two distinct sets, one centered in the northwest of the state (Park, Big Horn, Hot Springs, Washakie, Johnson, and Fremont counties) and another along the eastern border (Goshen, Platte, Niobrara, and Weston counties). Several of the most mining-intensive counties, finally, fall into the ‘collapse’ quadrant; but it is interesting that Big Horn and Converse counties (which have also been highly mining-intensive) do not.

Figure 50: Change in Employment and Earnings Per Job by Wyoming County, 2010-2020



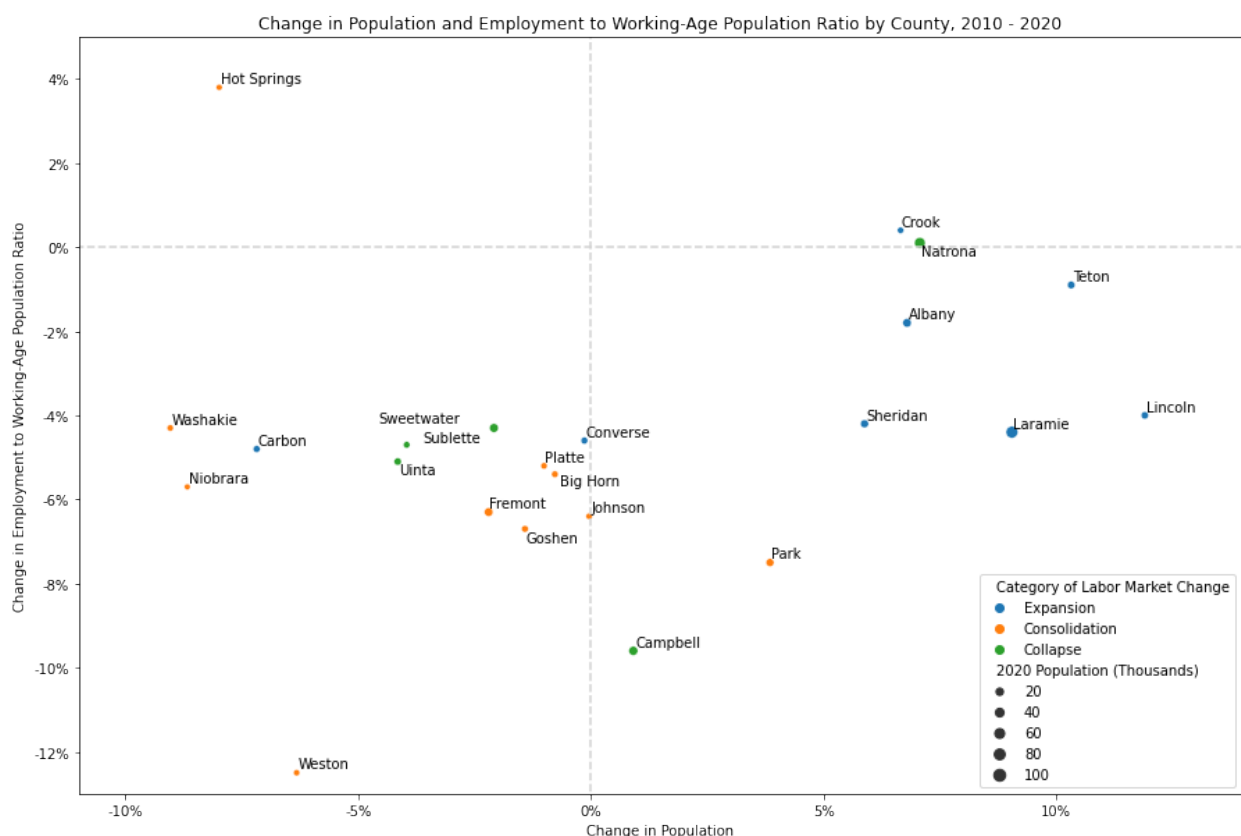
Source: US Census Bureau and Occupation, Employment, and Wage Statistics

Figure 51 shows how, over the same time span, each county’s population changed and how its employment to working-age population ratio (here defined as the share of population 16 and older with a job) changed. These two variables help to capture how, in response to a changing labor market, people made two decisions: whether to enter or exit a job but remain local, and whether to leave or move to a county. Each county is colored according to the type of labor market trend it experienced (expansion, consolidation, or collapse) as depicted previously in Figure 50.

While the employment to working-age population ratio declined across most counties — undoubtedly reflecting portions of Wyoming’s aging population electing to retire — this was more pronounced in some groups than others. A cluster on the right-hand side of the graph, which accounts for six out of the eight counties with expanding labor markets, experienced decisively

positive population growth and lesser reductions in the employment to working-age population ratio than most other counties. Another set in the middle, composed mostly of counties whose labor markets consolidated, experienced a declining employment to working-age population ratio but close to neutral population growth. The bulk of the counties whose labor markets collapsed had either somewhat larger reductions in population (Sweetwater, Sublette, and Uinta counties) or employment as a share of working-age population (Campbell County). Natrona County, notably, had a slightly collapsing labor market but still managed to attract population.

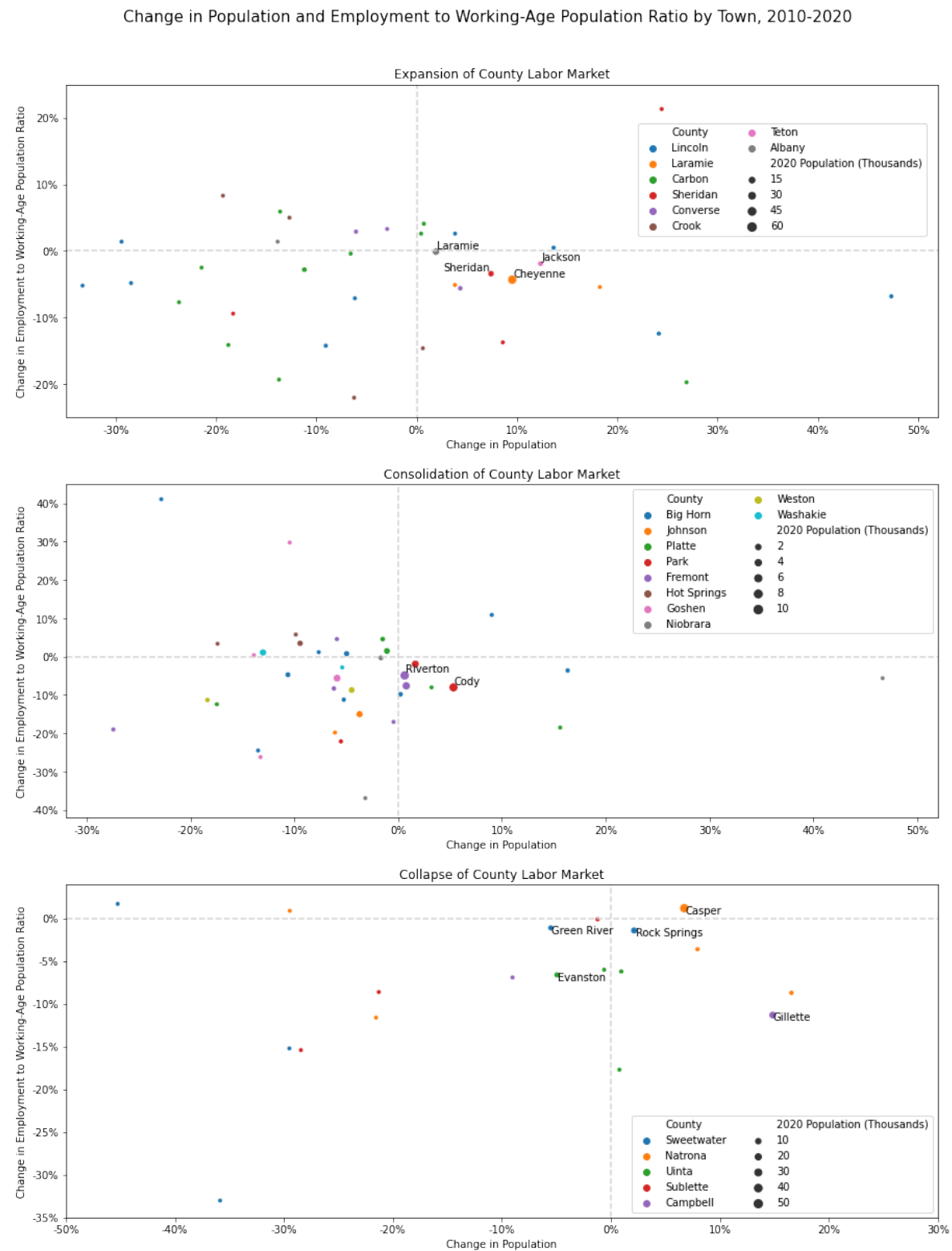
Figure 51: Change in Population and Employment to Working-Age Population Ratio by Wyoming County, 2010-2020



Source: US Census Bureau

Figure 52 shows these same variables, but at the level of cities and towns. In each panel (for each type of labor market), the hardest-hit communities tend to be smaller towns. The largest communities, conversely, fared comparatively well. Any city with more than 10,000 residents is labeled in this figure. Among the counties with expanding or consolidating labor markets, these larger cities all had growing populations. Despite the overall expansion or consolidation of the county-level labor markets, however, many smaller towns and cities lost population and/or saw declining employment as a share of population. Counties with collapsing labor markets still had important examples of larger cities which grew in population, although some also lost population. Casper, interestingly, expanded both its total population and its employment to working-age population ratio, whereas smaller communities in Natrona County experienced substantial reductions in population and/or employment as a share of working-age population.

Figure 52: Change in Population and Employment to Working-Age Population Ratio by Wyoming Cities and Towns, 2010-2020

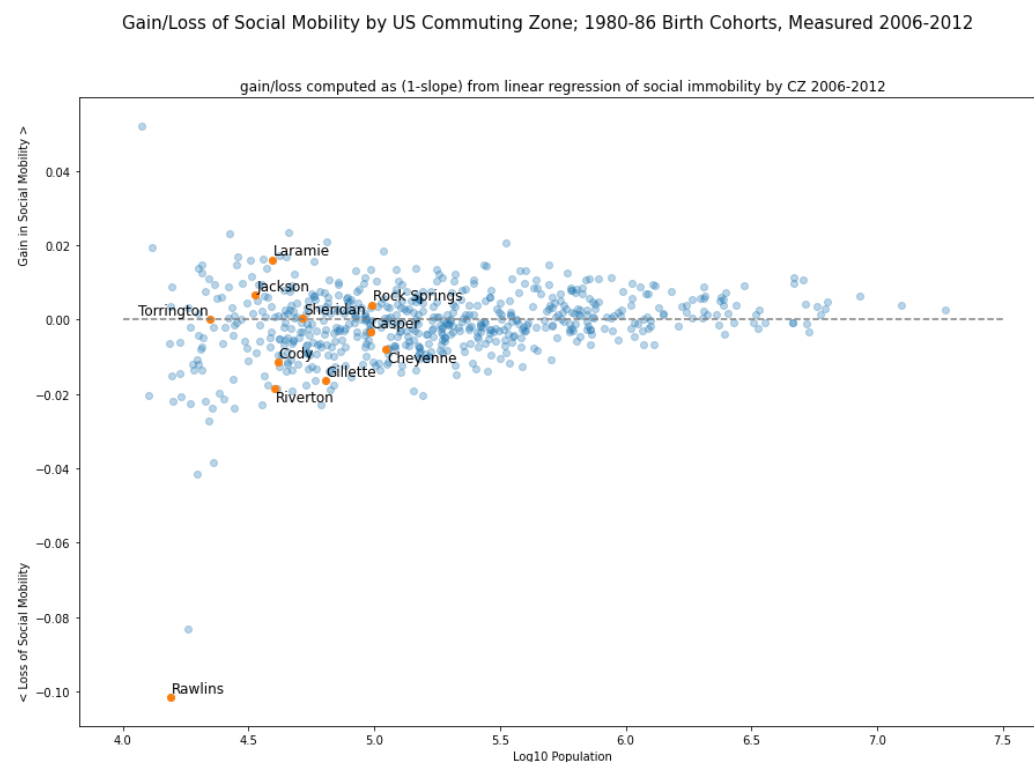


Source: US Census Bureau

Social mobility also worsened over the course of the bust in several parts of Wyoming. Figure 53 effectively captures the average annual change in social mobility by U.S. Commuting Zone from 2006–2012, for cohorts of people born in 1980–1986. In this figure, social mobility refers to the extent to which a person’s observed income can be predicted by what their father’s income was a generation earlier. This captures the extent to which individual economic success depends on being born into a well-off family or can be achieved regardless of the circumstances of one’s birth.

The loss of social mobility from 2006–2012 for birth cohorts from the Casper, Cheyenne, Cody, Gillette, Riverton, and especially Rawlins Commuting Zones appears very concerning. Protzer and Summerville (2021) show how low social mobility is strongly associated with the perception that the economy is unfair,¹⁵ and is thereby a major contributor to political discontent. Most of these areas, as previously shown in Figure 45, experienced some form of loss in resource production over 2006–2012, with the major exception being Cheyenne.¹⁶ Laramie and Jackson, conversely, experienced notable gains in social mobility over the same period. This may have been facilitated by the presence of non-resource economic engines in each Commuting Zone, respectively centered around the higher education ecosystem in Laramie and tourism in Jackson.

Figure 53: Gain/Loss of Social Mobility by U.S. Commuting Zone; 1980-1986 Birth Cohorts, with Outcomes Measured 2006-2012



Source: Chetty et al. (2014)

¹⁵ Importantly, income and wealth inequality have no such effect because people, in general, are more politically sensitive to inequality of opportunity as opposed to inequality of outcomes.

¹⁶ As the state capital and headquarters of many Wyoming companies, Cheyenne could have lost social mobility because those born there may utilize labor markets throughout broad parts of the state.

The contributions of various industries to these differential labor market outcomes across the state can be decomposed from data on employment and earnings. Figures 54 to 58 show decompositions of changes in the number of jobs and in the average earnings per job for each county from 2010–2020. Groups of counties discussed above (collapsing, consolidating, expanding) are shown together in each figure. A few bars in these charts are blank, owing to suppressed data (the effect of which is accounted for in its own bar).

The decomposition of changes for the number of jobs in each county is straightforward as one need only tally the change in the total count of jobs in each industry. The decomposition of changes in average income per job is slightly more involved and employs the widely used method of Bennet (1920). In this decomposition, changes in the overall average earnings per job can be attributed to two categories of change within each industry: a shift in composition (the share of people in the county who work in that industry), or a shift in wages (the average earnings per job in that industry). This makes it possible to determine whether an industry contributed to changes in average earnings simply because it employed a higher or lower share of people, or because it paid more or less.

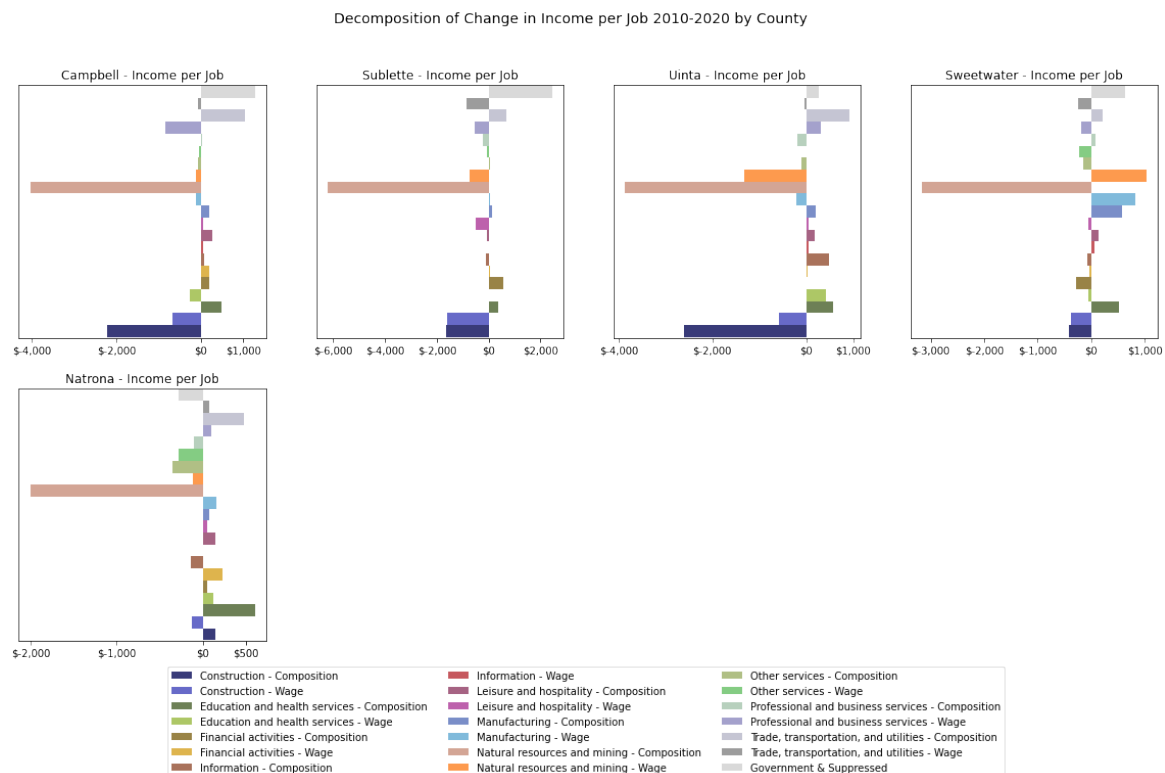
Figure 54 presents decompositions for the most straightforward set of counties — those whose labor markets collapsed. In every case, job losses in mining industries play a very large role. Losses of construction jobs are also often prominent and are indeed the largest force in Uinta County. While all these counties saw job growth in one or more industries, Natrona County is unique in having significant offsetting sources of job growth — education and health services, leisure and hospitality, and trade, transportation, and utilities — which directly helps to explain why it faced a smaller labor market collapse than the other counties in the same figure. Sweetwater County also saw noteworthy job growth in education and health services, but at a small scale in comparison to job losses in other industries.

Mining industries likewise play a highly prominent role as a source of lost earnings per job in the labor market. In every case the negative composition effect from mining dominates, meaning that jobs became less well-paying largely due to the loss of the number of jobs in the mining sector. In Uinta County there is also a notable wage effect from the mining sector, meaning the mining jobs also paid less. In Sweetwater County the case is the opposite, where the remaining mining jobs available became better paying, perhaps as a result of the prevalence of the trona industry there. Sizeable composition and wage effects in the construction industry also contributed to income per job losses in Campbell, Uinta, and Sublette County.

Overall losses to earnings per job were partly offset in every county by positive composition effects in education and health services in addition to trade, transportation, and utilities. Sweetwater County, interestingly, also enjoyed positive composition and wage effects from manufacturing. In numerous instances, these positive earnings per job effects take place despite the same sector having lost jobs overall. That is, even if an industry lost jobs overall there can be a shift towards a higher share of employment in that industry, provided another industry (here, namely mining) lost even more jobs.

In each of these counties, there are clearly important local dynamics that defy simple generalizations, and that could be important for local growth strategies, but overall, these counties did not have significant alternative economic engines to fuel job growth that could offset losses in mining.

Figure 54: Decomposition of Changes in Number of Jobs and Income per Job – Campbell, Sublette, Uinta, Sweetwater, and Natrona Counties (Collapsing)

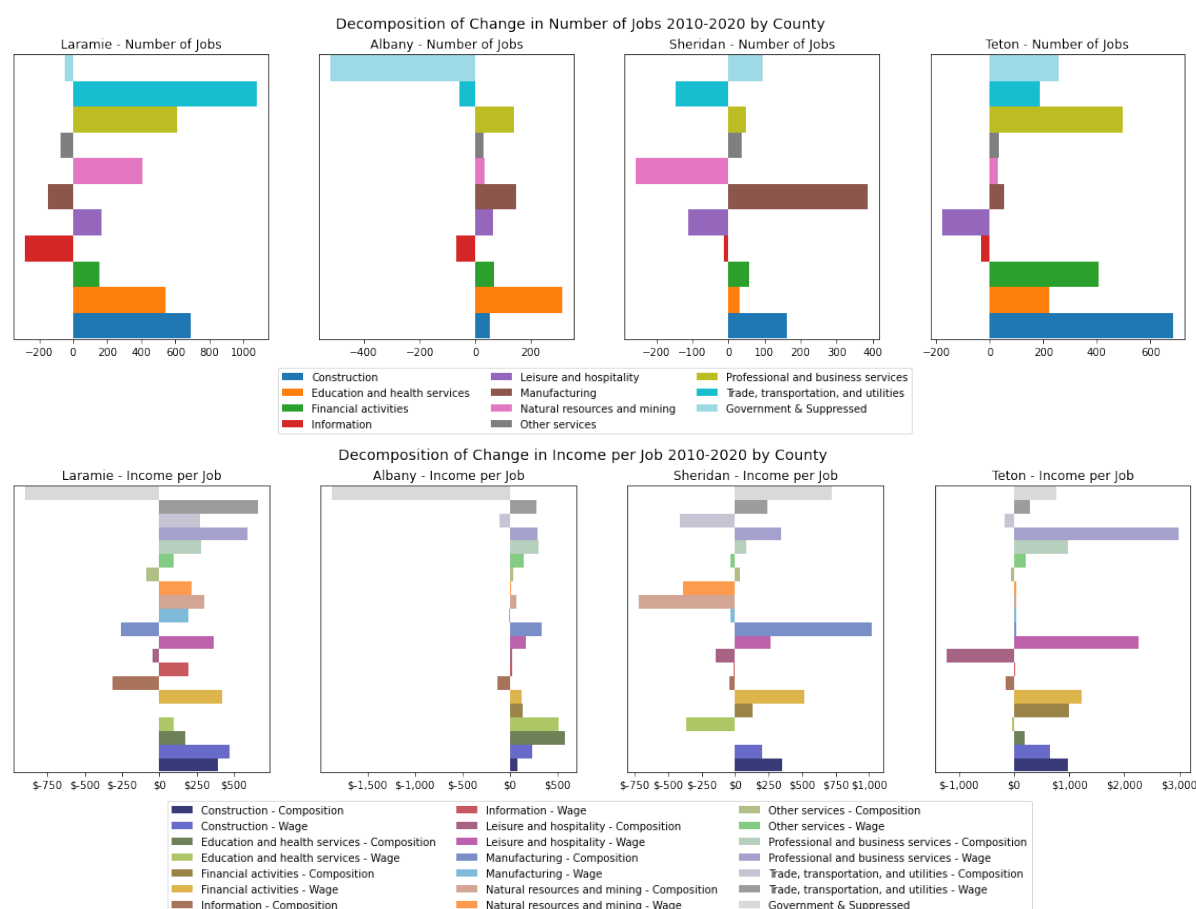


Source: Occupational, Employment, and Wage Statistics

Figure 55 shows the corresponding decomposition for four of the counties with expanding labor markets and larger population centers: Laramie, Albany, Sheridan, and Teton counties. Sources of growth in the number of jobs among Laramie, Albany, and Teton counties are remarkably diversified, with frequent contributions from construction, education and health services, and professional and business services. Albany County has an especially large amount of growth in education and health services, which is understandable due to the presence of the University of Wyoming. Sheridan county's job growth is considerably more concentrated in manufacturing, although this was also a reasonably sizeable source of job growth in Albany County.

Sources of gains in the average earnings per job are highly diversified in both Laramie and Albany counties, although education and health services play a prominent role in Albany County once again. In Sheridan County the composition effect from manufacturing is several times larger than the wage effect; that is, the availability of better-paying jobs was driven more by the number of new manufacturing jobs available than by pay rises in manufacturing. Teton County's growth in earnings per job was buoyed by large wage effects in professional and business services in addition to leisure and hospitality. There were lesser but still sizeable wage and composition effects in financial activities and construction, and a wage effect in other services.

Figure 55: Decomposition of Changes in Number of Jobs and Income per Job – Laramie, Albany, Sheridan, and Teton Counties (Expanding / Large Population Centers)



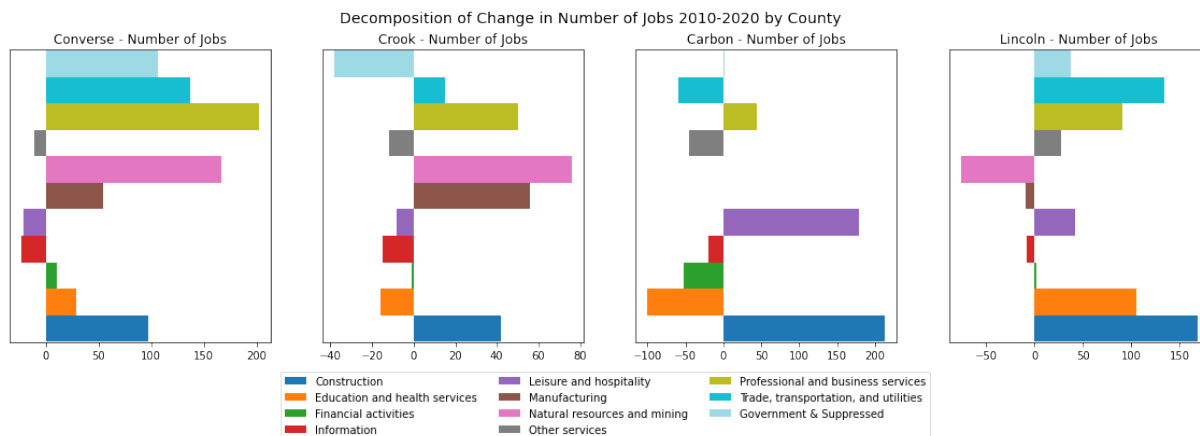
Source: Occupational, Employment, and Wage Statistics

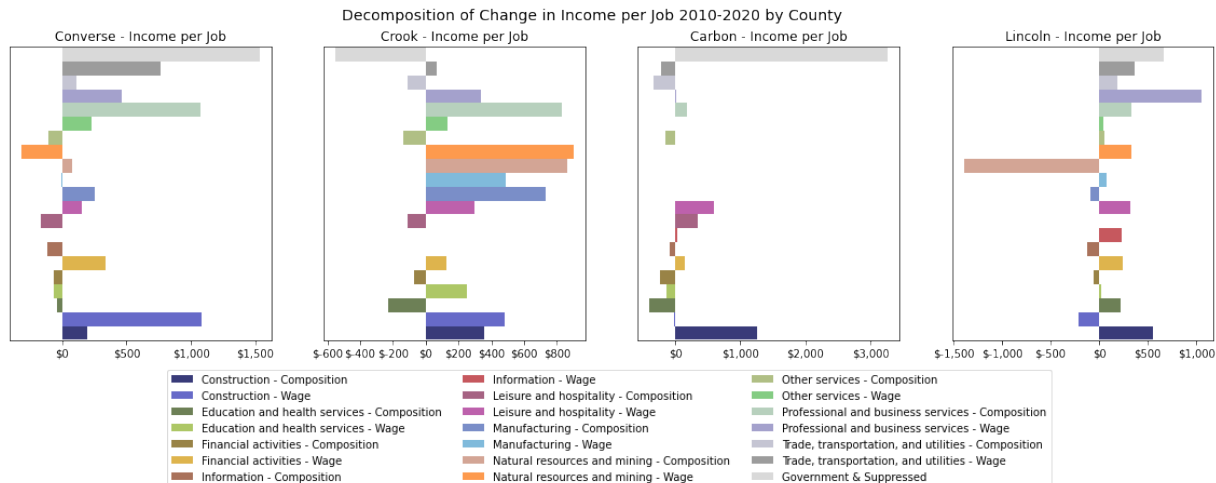
Decompositions for the other four smaller counties that also enjoyed expanding labor markets are shown in Figure 56. A notable difference from the previous group is the role of the natural resources, but these counties derived their gains in jobs and earnings per job from a variety of industries. Natural resources and mining were key factors behind the growth in the number of jobs in Converse County, and in Crook County natural resources also contributed strongly to growth of earnings per job through large composition and wage effects. Natural resource job gains in Converse County can be attributed to rising oil and gas production, as shown previously in Figure 45. Those in Crook County are more likely attributable to the local forestry industry.

In Converse County, natural resources were a strong contributor to gains in the number of jobs but not average earnings per job. Growth of the latter variable was instead powered by large wage effects in construction in addition to trade, transport, and utilities, together with a composition effect in professional and business services. Crook County, meanwhile, also experienced a significant expansion of manufacturing jobs, and both wage and composition effects from the manufacturing sector helped to drive an expansion of average earnings per job. A composition effect from professional and business services also played a key role in Crook County. Given that Crook County has a small population, it may serve as an important example of positive diversified growth in a small place that may hold lessons for the rest of Wyoming.

Lincoln County is notable for having successfully offset a large negative composition effect from mining on earnings per job with gains in numerous other industries, especially a wage effect from professional and business services. Carbon County unfortunately has substantial suppressed data, but nevertheless can be noted for gains both in the number of jobs and earnings per job from construction and leisure and hospitality.

Figure 56: Decomposition of Changes in Number of Jobs and Income per Job – Converse, Crook, Carbon, and Lincoln Counties (Expanding / Small Population Centers)





Source: Occupational, Employment, and Wage Statistics

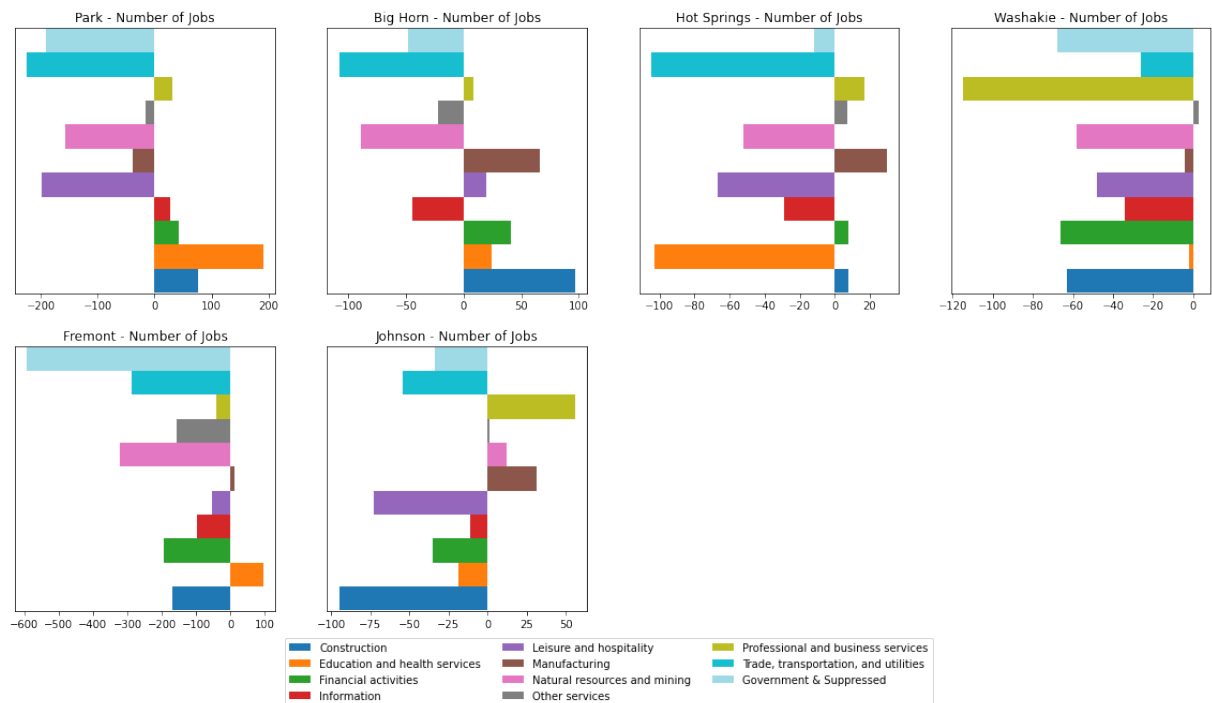
Figure 57 shows a cluster of counties in the northwest of the state that experienced labor market consolidation. In every case at least half of the observed industries experienced job losses; in Washakie and Fremont counties, almost all industries shed jobs. Some prominent offsets to overall job loss occurred in education and health services in Park County, construction and manufacturing in Big Horn County, manufacturing in Hot Springs County, and professional and business services and manufacturing in Johnson County.

It is striking that these counties all experienced increases in average earnings per job over the period, despite all being strongly negatively affected by the natural resources and mining sector in this respect. Park, Big Horn, Hot Springs, and Washakie all experienced large negative composition and wage effects from mining, and Fremont and Johnson counties experienced large negative composition effects. But the overall growth of earnings per job was driven by a variety of industries. Positive composition and wage effects in education and health services helped in Park and Washakie counties, and composition effects for the education and health in Fremont and Johnson counties. Big Horn and Washakie were aided by large positive composition and wage effects in manufacturing. Interestingly, this transpired even though Washakie lost an absolute number of jobs in manufacturing. This indicates that the reason this boosted wages was because other, worse-paying industries lost even more jobs, leading to a higher final share of manufacturing jobs.

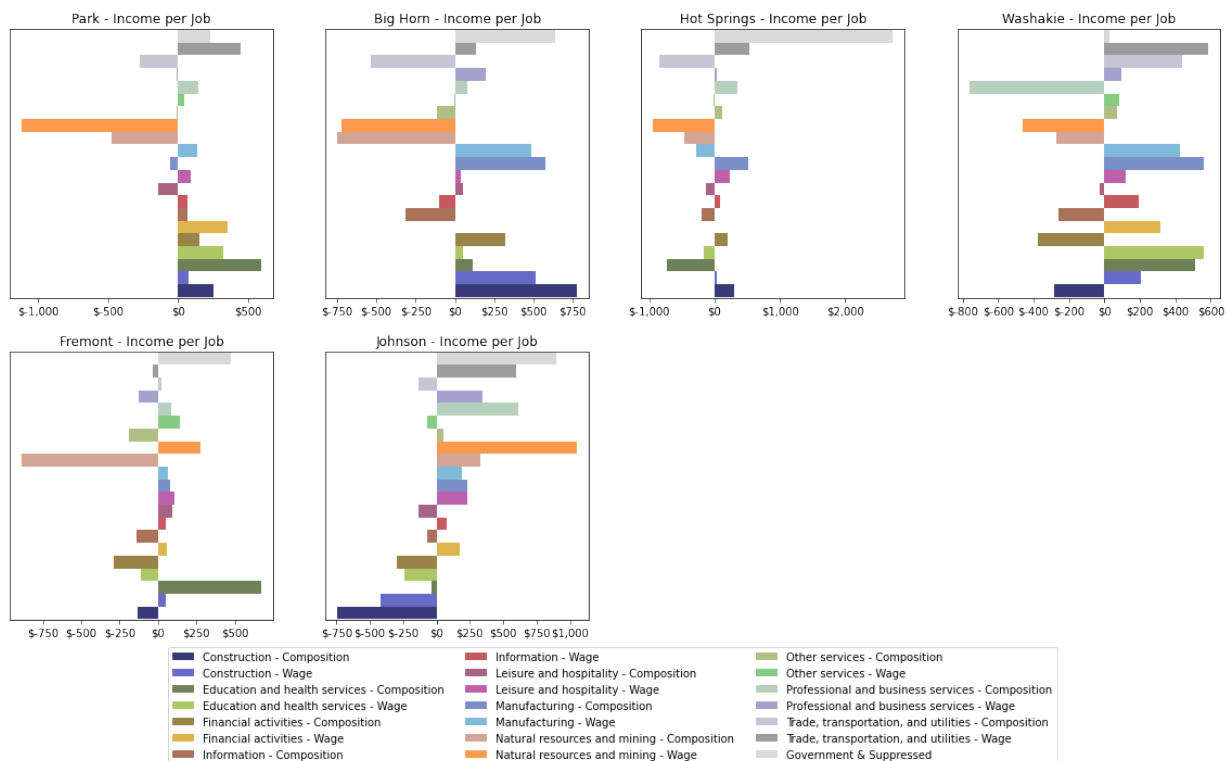
A similar pattern played out in Washakie County in trade, transport, and utilities, which imparted large positive composition and wage effects despite shedding jobs overall. The financial activities industry also contributed with a mix of composition and wage effects in Park, Big Horn, and Washakie counties. Evidently, these counties were able to continue improving the quality of jobs (in terms of wages) even as they lost jobs overall. These gains crucially depended on a variety of non-resource industries.

Figure 57: Decomposition of Changes in Number of Jobs and Income per Job – Park, Big Horn, Hot Springs, Washakie, Fremont, and Johnson Counties (Consolidation / NW)

Decomposition of Change in Number of Jobs 2010-2020 by County



Decomposition of Change in Income per Job 2010-2020 by County

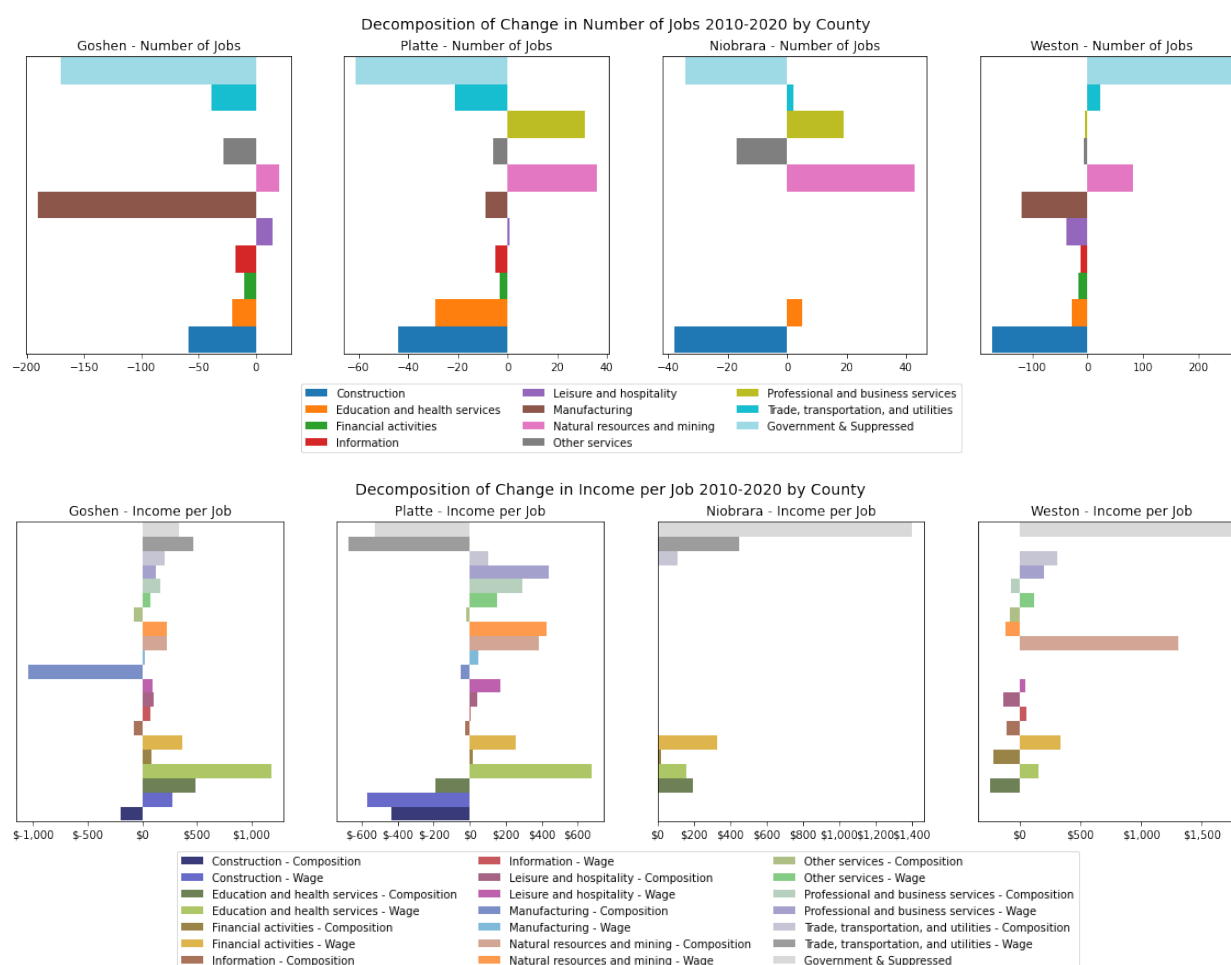


Source: Occupational, Employment, and Wage Statistics

Figure 58 shows the decompositions for the final group of counties, the group in the consolidation category that are geographically concentrated alongside the eastern border of the state: Goshen, Platte, Niobrara, and Weston counties. Manufacturing and construction were generally substantial sources of job loss, as was education and health services in Platte County. In every county, these losses were offset by job gains in natural resources and mining, and in Platte and Niobrara counties by gains in professional and business services. Net positive growth in average earnings per job were substantially aided by wage effects in education and health services in Goshen and Platte counties. A positive composition effect in natural resources and mining helped in Weston County, and positive composition and wage effects likewise helped in Platte County. A positive wage effect in financial activities boosted earnings per job in all these counties. Compared to the counties in the northwest whose labor markets also consolidated, these eastern counties derived their gains in earnings per job from somewhat more narrow sources. This could pose vulnerability in their economies going forward. By the same token, however, their sources of loss were also more concentrated.

Net positive growth in average earnings per job were substantially aided by wage effects in education and health services in Goshen and Platte counties. A positive composition effect in natural resources and mining helped in Weston County, and positive composition and wage effects likewise helped in Platte County. A positive wage effect in financial activities boosted earnings per job in all these counties. Compared to the counties in the northwest whose labor markets also consolidated, these eastern counties derived their gains in earnings per job from somewhat more narrow sources. This could pose vulnerability in their economies going forward. By the same token, however, their sources of loss were also more concentrated.

Figure 58: Decomposition of Changes in Number of Jobs and Income per Job – Goshen, Platte, Niobrara, and Weston Counties



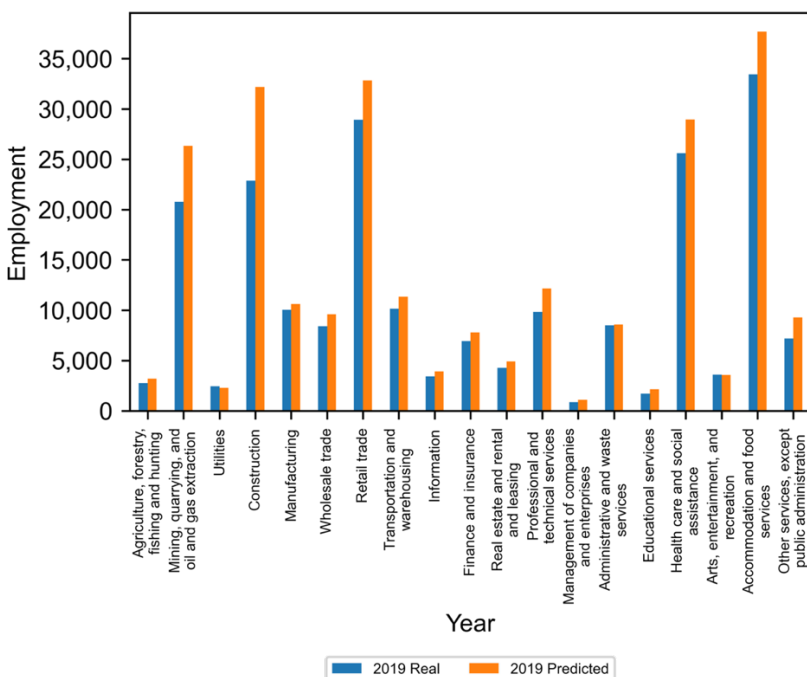
Source: Occupational, Employment, and Wage Statistics

These patterns underscore the importance of economic diversification — particularly of tradeable income sources at the local level — and the need for place-specific economic strategies. The counties that maintained expanding labor markets through the bust did so not by singular silver bullets, but through a variety of industries. In contrast, the worst losses were overwhelmingly concentrated in natural resource industries, among counties which had often specialized heavily in fossil fuel extraction. Moreover, there are clearly different needs in different areas of the state to enable their specific growth opportunities. Albany, Laramie, Teton, and Sheridan counties have promising, varied areas of growth that are supported by their populations centers that could be scaled if those centers can scale. Converse, Crook, and Lincoln counties, meanwhile, have also grown their economies in a variety of areas but their smaller population bases create different opportunities and needs. Campbell, Sweetwater, Sublette, Uinta, and to an extent Natrona County could need novel engines of growth. Clusters of counties in the northwest and east of the state have retained some high-quality jobs but need solutions to expand their number.

Missed Economic Diversification Opportunities

Although there are pockets of promising growth and diversification in Wyoming, these have not been large enough to keep the state’s diversification up to speed with its peers. Figure 59 shows Wyoming’s employment in each industry in 2019 as compared to what it would have been if, starting from 2010 level of employment, that industry had grown at the same rate as surrounding states on average. A lot of the shortfalls are in non-tradable industries, such as retail trade and construction, which reflect depressed aggregate demand resultant from the bust in resource-driven tradable income. At the same time, there are also gaps present in industries with higher tradability, such as professional and technical services, accommodation and food services, information, finance, and manufacturing.

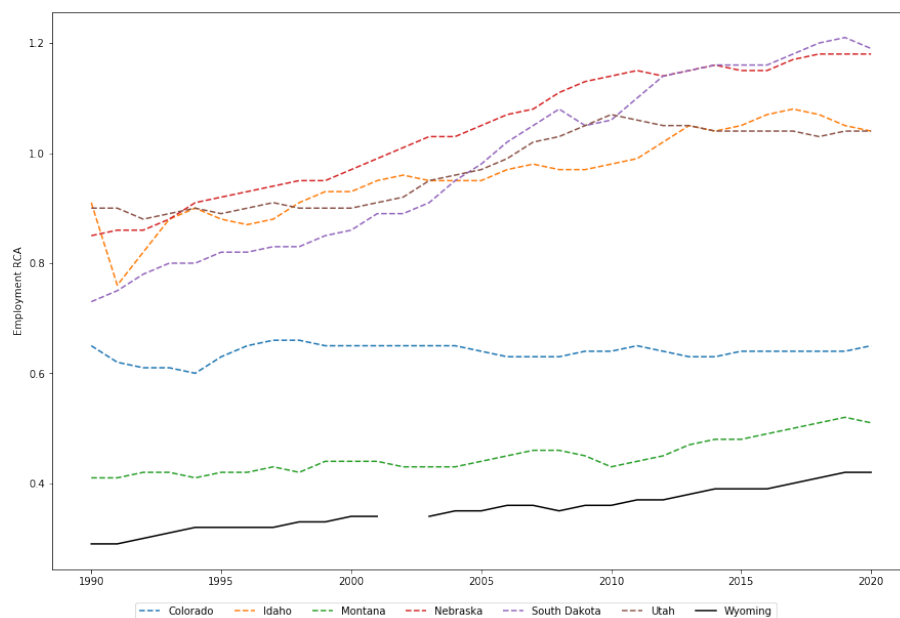
Figure 59: Real vs. Counterfactual Employment by Industry from 2010-2019



Source: US Bureau of Labor Statistics

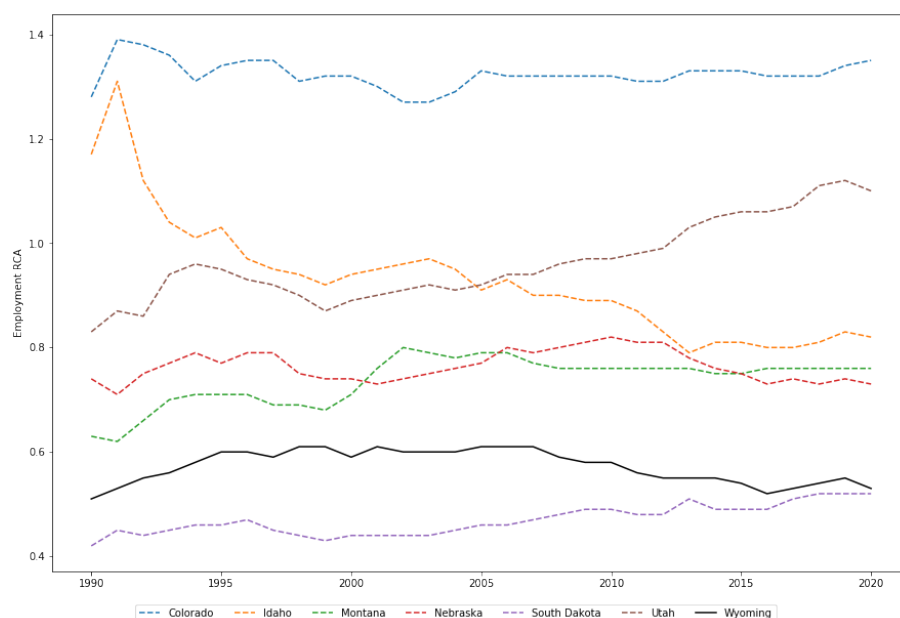
Wyoming's degree of specialization in certain industries that are pivotal for good jobs and economic diversification has also been persistently low. Figures 60 through 63 show that Wyoming's revealed comparative advantage in manufacturing, professional and business services, information, and finance has consistently been among the lowest in the region. Among these sectors, Wyoming's RCA has only been growing — if slowly — in manufacturing.

Figure 60: Manufacturing Employment RCA by State, 1990-2020



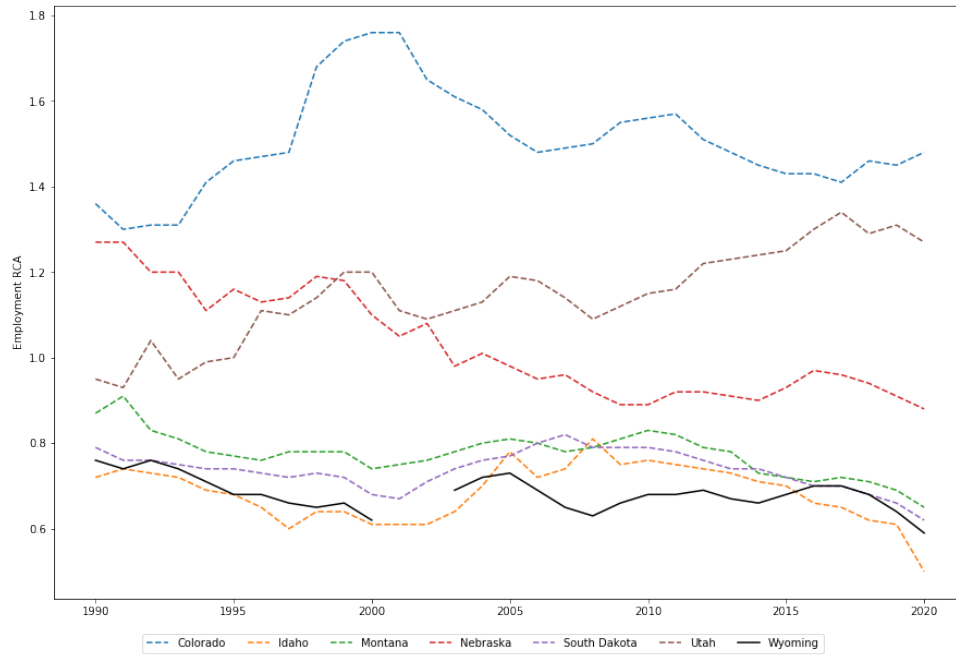
Source: US Bureau of Labor Statistics

Figure 61: Professional & Business Services Employment RCA by State, 1990-2020



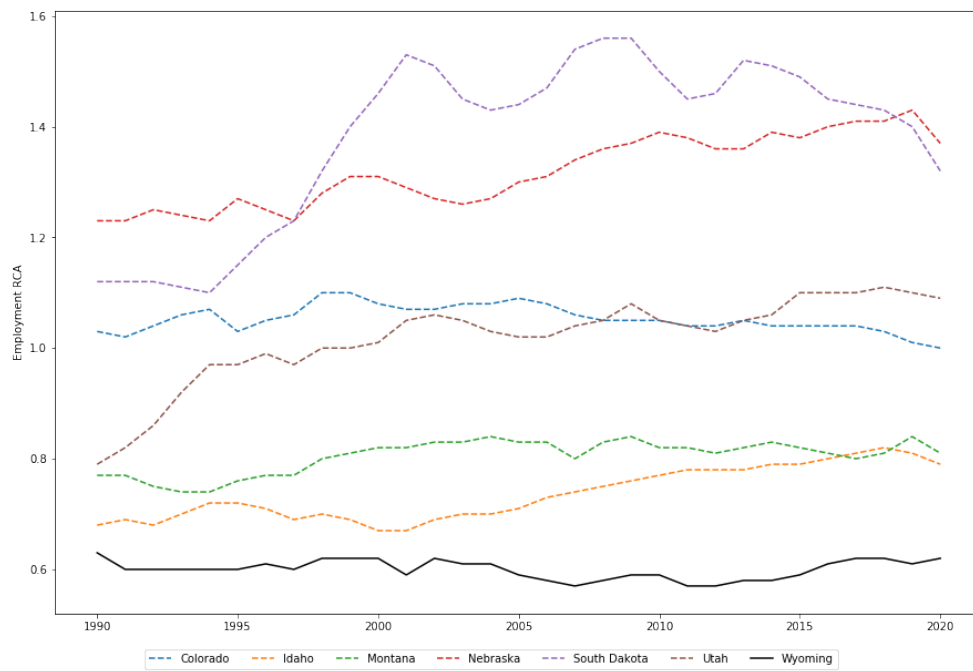
Source: US Bureau of Labor Statistics

Figure 62: Information Employment RCA by State, 1990-2020



Source: US Bureau of Labor Statistics

Figure 63: Finance and Insurance RCA by State, 1990-2020



Source: US Bureau of Labor Statistics

Medium-Term Growth in Summary

Over the medium-term — focusing on the two decades preceding the COVID-19 pandemic — Wyoming continued to face a recurring pattern that it has seen over the long-term. The state economy experienced an overall boom and bust alongside commodity price changes that affected its main source of tradeable income beyond the state's borders. Unlike elsewhere in the region, Wyoming did not gain significant population during the last decade. Instead, it lost jobs overall in the bust period. Much of the adjustment was through non-Wyomingites leaving the state such that negative impacts were relatively subdued for Wyomingites at the state level. The bust was problematic, however, for Wyoming's finances, requiring cuts in expenditures, but the state ultimately had sufficient buffers to weather the storm.

Overall, Wyoming missed opportunities to grow during this period because of its low population base and small geographic agglomerations. By not growing its population during this period, it remains positioned to continue to be vulnerable to shocks to the main drivers of its economy and it will continue to face more limited economic diversification opportunities than other states that are growing more rapidly in population. Perhaps unlike previous causes of declining mineral income over the longer term, the precise drivers of lower demand for Wyoming's energy resources in the recent bust may be less cyclical and more structural. Global and national trends toward decarbonization are driving decline for Wyoming coal outside of the state. Meanwhile, new energy technologies, including hydraulic fracturing, posed a challenge for traditional energy production in the state. Yet new technologies also created opportunities in some instances.

Wyoming continues to provide a high quality of life overall, but it does not create sufficient opportunity for many of its residents. People born in Wyoming continue to leave Wyoming more often than occurs in any other U.S. state, though migration patterns in both directions are complex. Many parts of Wyoming experienced significant losses of jobs, income, and equality of opportunity over the course of the most recent resource bust — especially in counties dependent on natural resources. The worst-hit parts of the state overwhelmingly lost jobs and income in mining, without significant offsetting growth in other industries. The worst-affected communities tended to be smaller towns, which in numerous instances shrunk substantially. These issues point toward a challenging economic picture for much of the state, and one that could worsen as global trends in decarbonization further reduce demand for traditional fossil fuels.

Meanwhile, several parts of Wyoming grew even as the state economy faltered. Many counties and cities experienced expanding labor markets, at times growing jobs, income levels, and populations during the overall. Where successful, counties and cities offset lost income, especially lost tradeable income, through a variety of industries. The pathways for this were more robust in several higher-population parts of the state, but smaller population centers also grew through more niche industry opportunities suited to their advantages. These patterns strongly suggest that economic diversification is needed to build resilience against weakening demand for fossil fuels at multiple levels in the state economy. Economic strategies to meet the diversification challenge will need to be carefully considered. There is no single industry that serves as a silver bullet, nor can one strategy be applied uniformly throughout the state. To inform place-specific growth strategies, future work will have to methodically identify which diversification opportunities are workable for different parts of Wyoming and identify what holds these back in different communities.

4. Short-Term Growth

The COVID-19 pandemic was a major shock for the economy of Wyoming from which it has not yet fully recovered. The pace of the recovery in Wyoming has been significantly slower than in neighboring states, which is largely driven by the longer-term decline in the mining industry alongside limited growth in other tradeable industries, discussed in the previous section. This section will explore how major economic indicators have evolved — at the state-level and across the state — in the short-term, which we define as the time since COVID-19 emerged as a global shock. While previous sections have established the importance of more localized growth patterns, this section is restricted to evaluate geographical variations at the county-level due to data availability. We hope to expand this analysis to a more localized level in the future. Additionally, this section will profile two global changes that have gained major importance in the short-term with ramifications for Wyoming: the rise of remote work and the acceleration of decarbonization. Wyoming faces some negative consequences of these trends, especially decarbonization, but could benefit greatly from each in the future. The analysis in this section will show these patterns in detail and discuss how a growth strategy might capitalize on each.

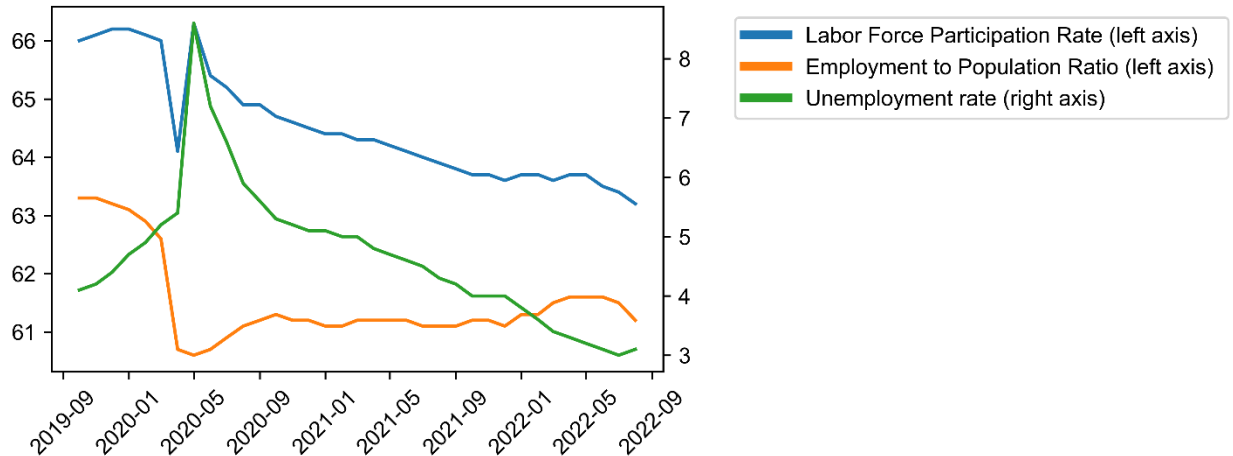
How has Wyoming's economy recovered since the start of the pandemic?

Since the economic downturn of March 2020, the economy of Wyoming has recovered slowly and is still significantly below key pre-pandemic labor market indicators. The COVID-19 pandemic led to an economic shutdown across the country, which prompted an increase in the unemployment rate in Wyoming from 5.4% in April 2020 to 8.6% in May of that year. This was the highest unemployment rate in the state since the commodities bust of 1987 (Bureau of Labor Statistics 2022) and meant that about 10,000 people lost their job between April and May. The economy of Wyoming has not managed to recover all these jobs as of the latest available data in 2022.¹⁷ Although the state-level unemployment rate has continuously declined since a spike at the start of the pandemic and is now well below pre-pandemic levels, which is a more rapid decline than in the U.S. overall,¹⁸ the employment rate (employment as a share of the population) has not converged back to the pre-pandemic level (Figure 64). The decline in unemployment in Wyoming is not just due to a recovery in employment since the initial months of the pandemic, but it is also linked to a steady decline in Wyoming's labor force participation rate. In simple terms, the unemployment rate is not only falling because jobs have been recovered but also because people are dropping out of the labor force by no longer looking for work. Wyoming's labor force participation rate shows a curious pattern where the rate dropped from a pre-pandemic rate of 66% to a low of 64% in July of 2020, then recovered briefly before beginning a steady decline over more than two years to a level that is now below the level of July 2020. Wyoming is unlike the U.S. overall, where the employment rate returned to its pre-pandemic level in mid-2022 and where the labor force participation rate has seen a largely steady increase, not decrease, over this period. We will return to this observation to identify potential causes of the difference in this section.

¹⁷ In August of 2022, 7,060 people less were employed in Wyoming than in March of 2020, accounting for seasonality effects (BLS Local Area Unemployment Statistics)

¹⁸ U.S. Bureau of Labor Statistics, Unemployment Rate [UNRATE], retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/UNRATE>, October 18, 2022.

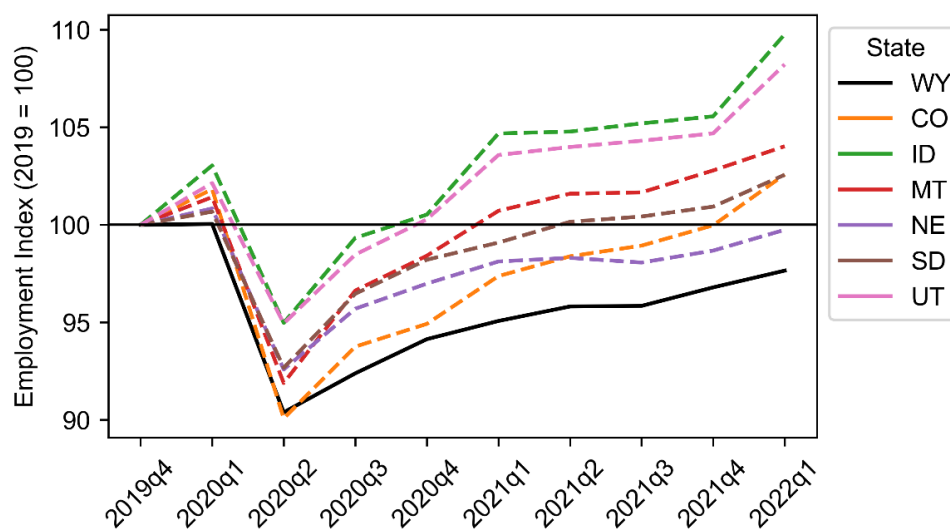
Figure 64: Key Labor Market Indicators in the Short-Run

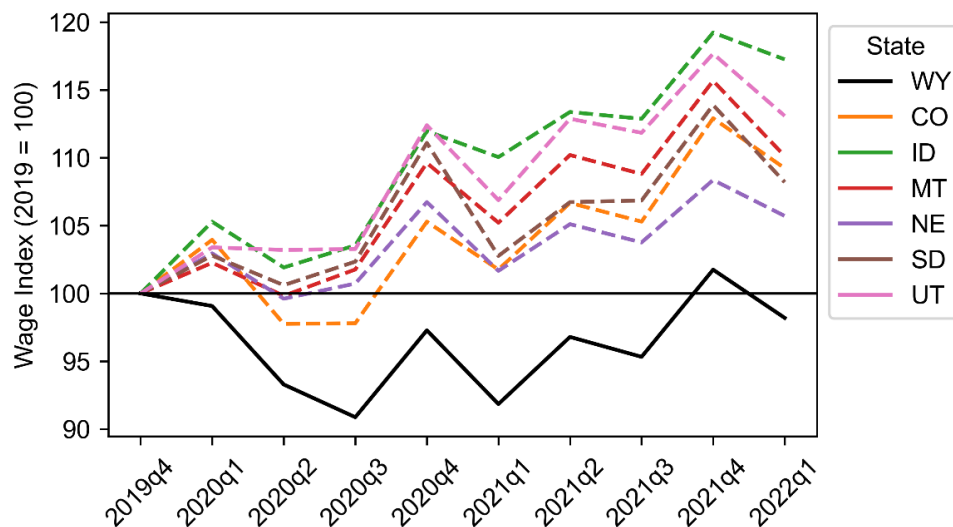


Source: Local Area Unemployment Statistics (BLS)

The recovery of Wyoming's economy has been significantly slower than that of its peers. Figure 65 shows the path of this recovery in terms of both employment and wage levels indexed to 100 prior to the pandemic. Wyoming's employment recovery follows a similar trend to that of neighboring states, but its initial negative shock was much more severe than in the rest of the region (except for Colorado), and it has not yet reached pre-pandemic levels while all others have (left panel). When looking at total real wages in Wyoming, the difference between Wyoming and its peers is more pronounced (right panel). All neighboring states had recovered total wages by the end of 2020, but Wyoming did not achieve this until Q4 2021. The gap in total real wages between Wyoming and its neighbors is larger than that of the employment gap with neighbors, which suggests that Wyoming lost disproportionately more high-paying jobs than its peers without being able to recover them.

Figure 65: Recovery in Employment and Real Wages for Wyoming and Neighbors

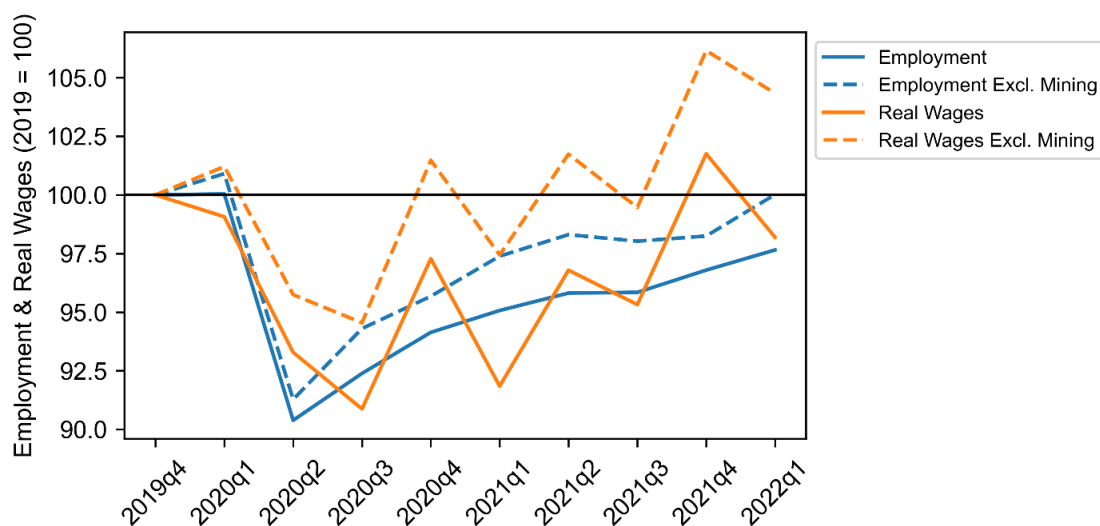




Note: In both graphs the quarterly values are indexed to the respective quarter of 2019.
Source: Quarterly Census of Employment and Wages

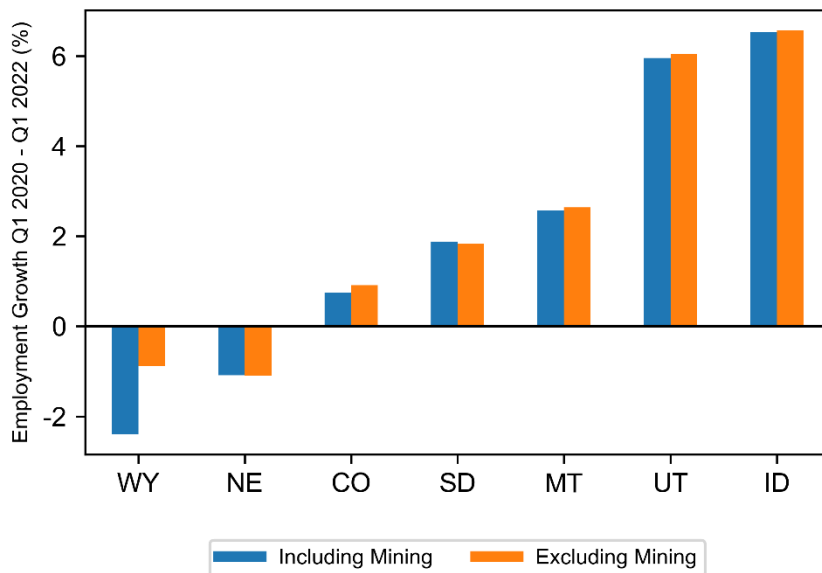
The comparatively slow recovery of Wyoming's economy is mainly driven by its mining sector. In fact, outside the mining sector, Wyoming has reached pre-pandemic employment levels and surpassed pre-pandemic total real wages much earlier (Figure 66). This shows that the rest of Wyoming's economy has regained its strength faster than the mining sector. Wyoming's gap in economic recovery in comparison to its neighbors also significantly decreases when mining is excluded from employment and total wages (Figure 67). Wyoming's non-mining recovery remains weaker than other states, but closer to that of Nebraska, when the direct impacts of the mining industry are included. As mining is a principal tradable industry in Wyoming, the negative decline it has experienced also has negative knock-on effects in other industries' growth.

Figure 66: Employment and Wage Recovery over Time, Including and Excluding Mining

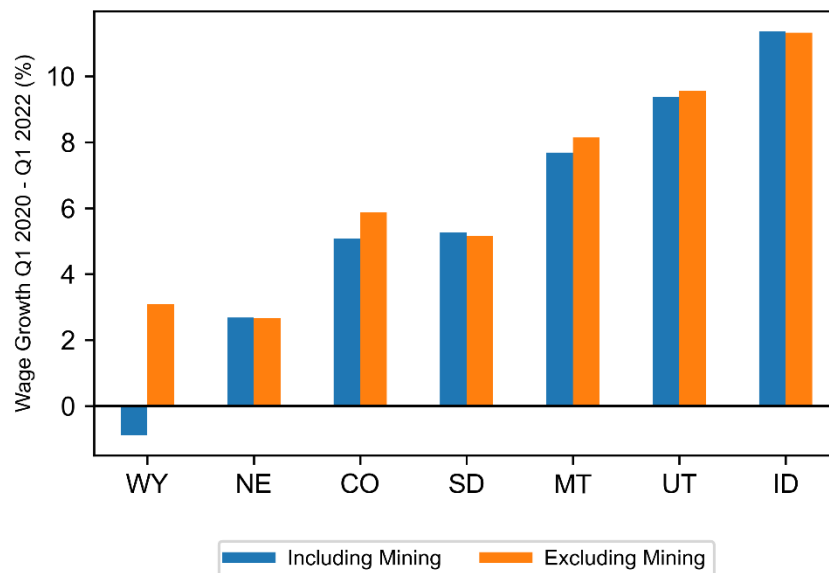


Note: Quarterly employment and wage values are indexed to the respective quarter in 2019.
Source: Quarterly Census for Employment and Wages

Figure 67: Employment and Wage Recovery across States, Including and Excluding Mining



Source: Quarterly Census of Employment and Wages

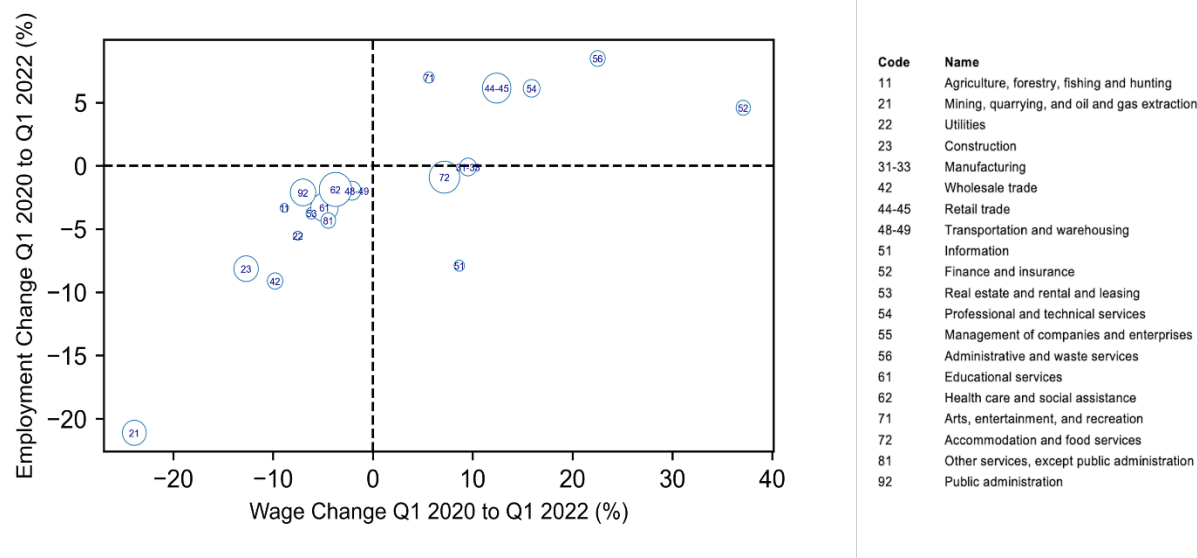


Source: Quarterly Census of Employment and Wages

Growth challenges in the mining sector did not emerge uniquely after the pandemic, as discussed in the medium-term section, but trends have overall continued in the short-term. There are differences in the growth path of different minerals in the short-term as well, but in aggregate mining reliance, combined with declining demand for several minerals, is at the center of why Wyoming's COVID-19 recovery is weaker. This is further captured in Figure 68, which shows employment and wage changes over the short-term across industries in Wyoming.

The mining industry (NAICS21) has experienced more than 20% loss of jobs and total wages. This is highly related to the decline of the construction industry (NAICS23) by around 10% on both dimensions and possibly related to the decline in wholesale trade (NAICS42). Meanwhile, there are several sectors that have led the economic recovery. These include professional and business services, retail trade, and the leisure and hospitality industries.

Figure 68: Employment and Wage Changes of Industries in Wyoming over the Pandemic



Source: Quarterly Census of Employment and Wages

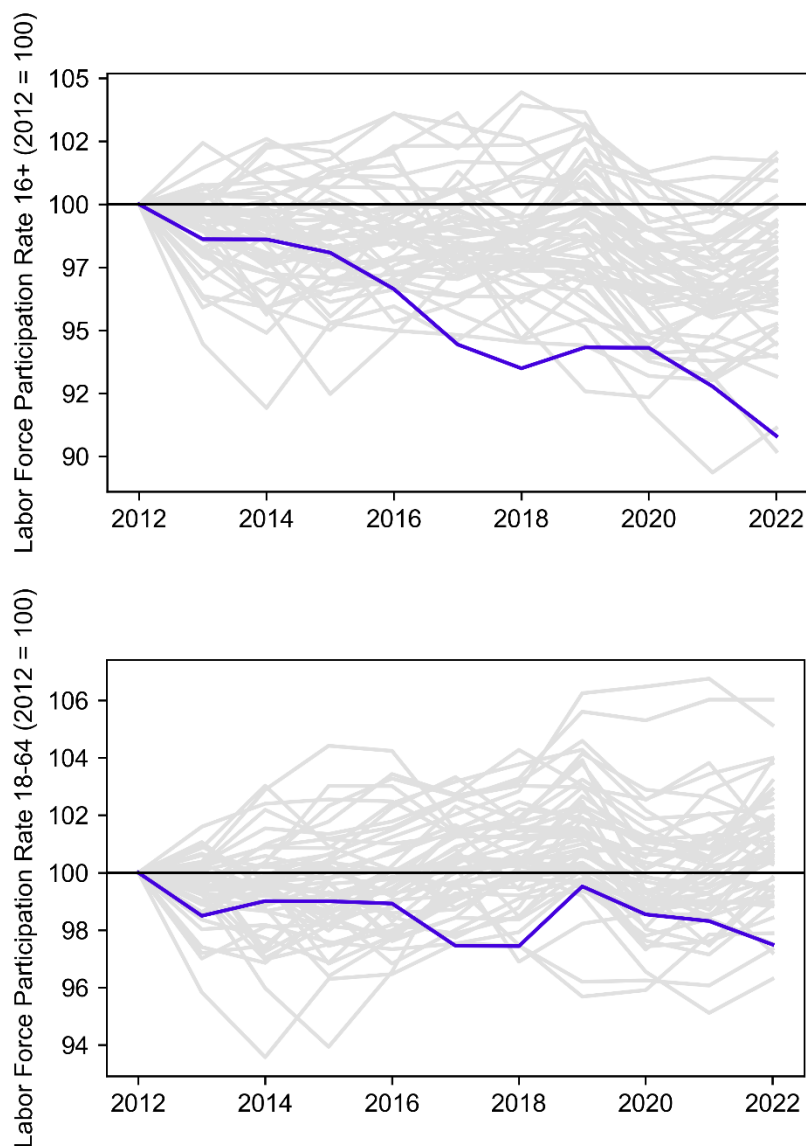
High-paying industries such as finance and insurance (NAICS52) and professional and technical services (NAICS54) have grown in terms of real wages and employment since the start of the pandemic. Even though these industries are relatively small in employment (reflected by the small size of the bubble in the figure), they are typically tradable industries that can also generate downstream growth in other industries. This may also apply to the information industry (NAICS51) which has grown in terms of real wages but decreased in employment.¹⁹ The leisure and hospitality industries (NAICS71 & NAICS72) have also grown in terms of wages and recovered their pre-pandemic employment levels or surpassed them in the case of arts, entertainment, and recreation. Important contributors to the economic recovery of Wyoming have also been the growth in retail trade (NAICS44-45) and manufacturing (NAICS31-33). Retail trade tends to be non-tradable at the state-level (except when customers are out-of-state tourists) but can be tradable at the local level. Manufacturing, on the other hand, tends to be tradeable at the state and even international levels.

With the industry-drivers of job losses and job gains in mind, we return to the curious pattern of declining labor force participation in Wyoming. Figure 69 (top panel) shows that this is not a short-term development but instead a continuation of a medium-term trend. Wyoming has seen its labor force participation rate decline over more than the past eight years. Much of the decline

¹⁹ The information industry (NAICS51) in Wyoming consists largely of wired telecommunication carriers, followed by newspaper publishers and broadcasting & content providers.

can be attributed to people aging out of the labor force and retiring. Between 2012 and 2022, Wyoming had the largest growth of all U.S. states in people not being in the labor force due to retirement (Current Population Survey). When analyzing the trajectory of the labor force participation of people of working age (defined here as 18 to 64 years), Wyoming is much more in line with the trend of other U.S. states (Figure 69, bottom panel). This implies that the declining labor force participation is not in itself a significant problem, though it may have implications on state expenditure needs for an aging population. However, the struggles of the mining sector on aggregate and over the medium term to expand jobs and tradeable income remain problematic.

Figure 69: LFP Rate Change over Time in Wyoming and Other States – Age 16+ (top) and Working-age (18-64) (bottom)

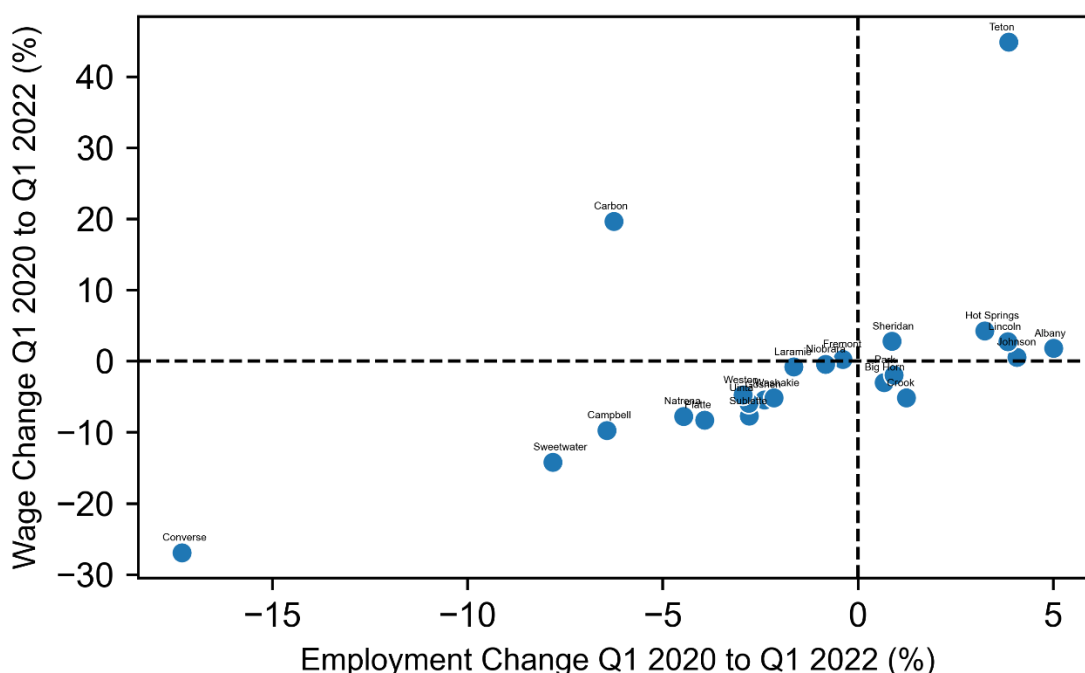


Note: Wyoming is highlighted in blue, all other U.S. states in grey.
Source Current Population Survey

County-level variation in the short-term recovery

The overall weak economic recovery of growth, jobs, and wages in the short-term has varied substantially across the State of Wyoming. Not surprisingly based on the industry drivers discussed above, parts of the state with resource-intensive counties have struggled more than others. As Figure 70 shows, Converse, Sweetwater, and Campbell counties are furthest below their pre-pandemic levels in terms of employment and real wages. All three of them mining-intensive at the county level and two of them have been “collapsing” in the medium-term. While these are the counties under the greatest stress in the short-run, most other counties are within the -5% to +5% range in terms of employment and real wages. A positive outlier is Teton County which grew 3.9% in employment in the short-term and at the same time increased its real total wages by an astonishing 44.9%. Such a significant wage growth paired with comparatively smaller employment growth could be driven by high-income individuals moving to Teton County. Another notable outlier is the development of Carbon County, which has grown in real wages while still being 5.5% below its pre-pandemic employment levels.²⁰ Within each county, there are surely differences in local performance, which cannot yet be captured with available data.

Figure 70: County-Level Employment and Total Real Wage Growth in the Short-Run



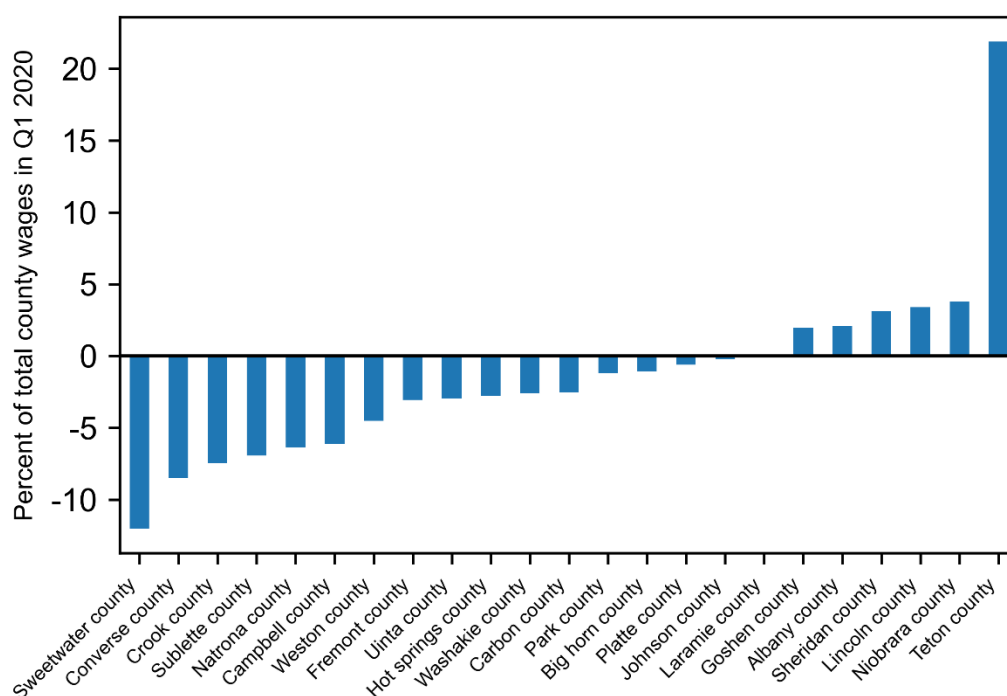
Source: Quarterly Census of Employment and Wages

In most of Wyoming's counties, growth in a set of narrowly defined tradable industries was not able to compensate for the loss in the mining sector. This is captured in Figure 71, which shows total wage growth between Q1 2020 and Q1 2022 of a set of narrowly defined tradable sectors

²⁰ We cannot explain the drivers of wage growth in Carbon County yet, due to data suppression issues in the QCEW which we are using for this part of the analysis.

pooled together for this analysis.²¹ One way of interpreting this variable we have constructed is as an indicator of whether highly tradeable industries outside of mining are offsetting declines in mining. Based on this narrow list of tradable industries, we only see full compensation for lost total wages in mining by the other industries in 6 of 23 counties. There is a strong relationship, but not a perfect one, between how counties performed on this measure and their overall growth in jobs and total wages. The loss of tradable income appears to be important for the total number of jobs in counties such as Converse, Sweetwater, Campbell, and Natrona, while the growth in tradeable income is important for Teton, Albany, Sheridan, and Lincoln counties. However, there are also a few counties that have lost tradable income but appear to be growing in wages and jobs, like Hot Springs, or that gained tradable income but appear to be losing wages and jobs, like Niobrara. Both examples are counties with exceptionally small populations that might make them more idiosyncratic in comparison to more general trends.

Figure 71: Total Wage Growth in Narrowly Defined Tradable Industries, Q1 2020 to Q1 2022

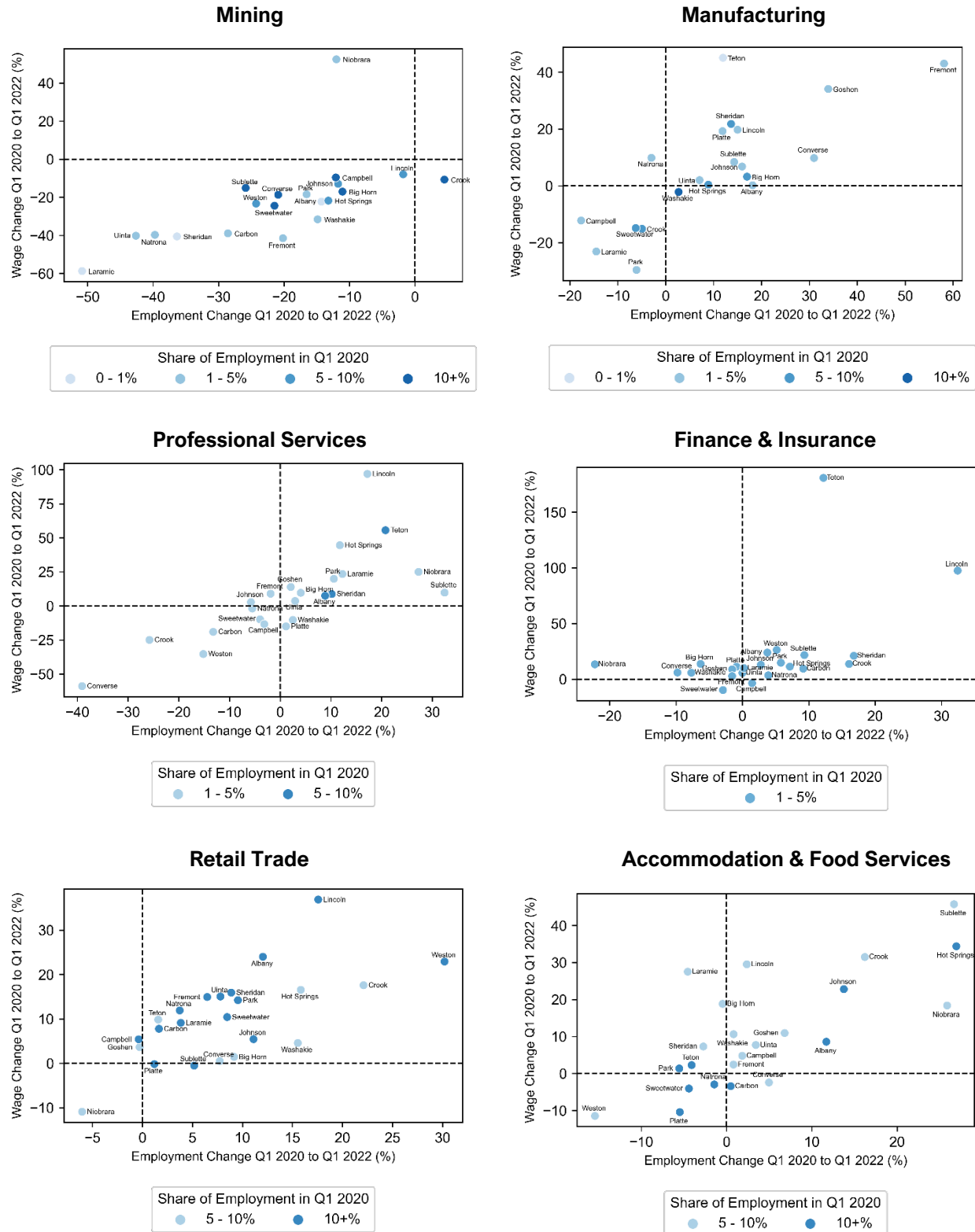


Source: Quarterly Census of Employment and Wages

We can explore further how the drivers of recovery, albeit slow, in Wyoming play out across different counties. Figure 72 shows employment and real wage growth within key industries in the short-term across all counties. Each graph also captures how concentrated the county is in the industry in terms of its employment share. We discuss overall patterns of the performance of these industries across counties here but exploring the exact position of individual counties would be important for understanding their specific short-term growth dynamics.

²¹ This includes, in addition to Mining, Professional Services, Finance and Insurance, Information, Manufacturing, Wholesale Trade, and Transportation and Warehousing.

Figure 72: Short-Term Employment and Wage Growth across Key Industries



Source: Quarterly Census of Employment and Wages

Total wage and job losses in mining were common across nearly all counties. Crook County was unique in that it expanded mining jobs even as the total mining wage bill declined, and tiny Niobrara is again an outlier here. By comparison, manufacturing grew across most counties in both total wages and employment, but the share of jobs in manufacturing tends to be very small across counties. Sheridan and Big Horn Counties have been seeing manufacturing growth with slightly higher shares of jobs in manufacturing. This was important to the stronger recovery of these counties (see Figure 71). A similar overall picture appears for professional services. Like with manufacturing, professional services grew in total wages and employment in most counties. Also, like manufacturing, these represent a small share of jobs (larger in Teton, Albany, and Sheridan counties) but may be important sources of tradable income. Most counties similarly saw growth in finance and insurance, while Teton and Lincoln counties were outliers with very large growth, perhaps reflecting companies or employees relocating from outside these counties.²²

Accommodation and food service, which was not included in our narrow definition of tradable industries but may be highly tradable if customers are from out of state or from outside the county, likewise grew across most counties. This industry notably provides a higher share of jobs across counties, so growth in this industry is very promising for many parts of the state. Growth here likely reflects relatively strong tourism growth and perhaps opportunity for greater tourism growth in the future. Finally, retail trade showed the highest tendency to grow across nearly all counties and this industry also represented a large share of jobs for many counties. This industry, while growing, will not tend to be a strong source of tradable income. Outside of retail targeted for tourism, it will tend to be subject to the level of aggregate demand that local economies can support based on what they sell outside. The strong growth in this industry across Wyoming in this period may be related to one factor that is worth understanding better. COVID-19 relief measures provided by the federal government increased the purchasing power of individuals during the pandemic and this may have boosted demand for retail in an ultimately artificial and short-term way.

The short-term growth patterns discussed to this point — at both the state and county levels — are merely an overview. These patterns capture the broad features of what appears as a weak recovery from COVID-19 in Wyoming. However, the drivers of these short-term patterns are not all directly related to the pandemic but rather follow from more medium-term trends, just as the medium-term trends relate to longer-term growth processes. Nevertheless, industries that are growing and industries that are downsizing capture how these medium-term drivers have been affected from accelerating changes in the national and global economy. Two ongoing changes stand out in importance and are discussed in the remainder of this section. One change is the rise of remote work across the United States and other beyond that was brought on by the pandemic. The next subsection explores evidence of how remote work is playing out in Wyoming and what opportunities that remote work might create for future growth and new jobs. Another change is the general intensification of decarbonization efforts in the U.S. and globally. Decarbonization has, of course, translated into lower demand for many of Wyoming's fossil fuel resources. But decarbonization may also create new growth opportunities in Wyoming. We provide and discuss a framework for understanding these opportunities to close this section.

²² The growth in the finance and insurance industry in both Lincoln County and Teton County is largely due to growth in the industry "Securities, Commodity Contracts, & Other Financial Investments & Related Activities" (NAICS 523).

Exploring Remote Work in Wyoming

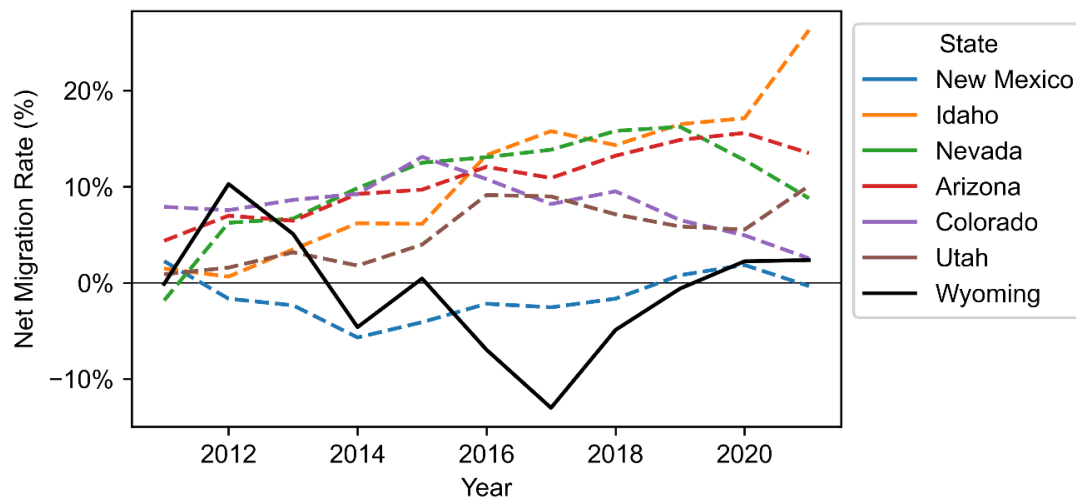
The forced shift to work from home because of COVID-19 showed many companies that they can continue operating while a share of their employees works remotely. Data shows that remote work is a trend that, is, at least in part, here to stay (Barrero et al., 2021). Technology adoption has allowed many types of work relationships to be possible in remote circumstances that were not before. For many higher-skill occupations, workers have come to expect the option to work remotely much more than before the pandemic. The emergence of remote work has many different implications, and these are still taking shape across Wyoming.

One implication of remote work is that people no longer need to live in areas with high costs of living to access jobs in expensive metropolitan areas, which means that individuals can move to more rural areas and generally increase their real take-home pay and enjoy the benefits of more space. This was a common hypothesis of how remote work would play out that was to some extent true throughout the pandemic, but with time it has also become clear that most remote work continues to be done by people who continue to live in dense metropolitan areas. Still, this type of remote work can benefit Wyoming. A different dynamic, that has more mixed impacts, is that people in teleworkable occupations that were previously employed by firms in Wyoming can now more easily be poached from outside firms who pay higher wages. These individuals may continue to live in Wyoming, and their wages will contribute to local demand, but this could harm local employers. A third channel of remote work could operate within the state. Employers in one part of the state are now more able to hire from labor markets in other parts of the state, which can be helpful when a business in one labor market is looking for certain skills that are hard to find but available in another local labor market. Since many jobs can be only partially done remotely — needing some in-person presence — this could be another positive development for businesses and workers in the state.

The extent to which these channels of remote work are expanding in Wyoming cannot yet be fully observed, but we can begin to see some signals of what is happening and where there may be more potential. Since the start of the pandemic, Wyoming has seen a net positive migration inflow into the state, though at a low level in comparison to other Mountain West states (Figure 73). This is not necessarily a fundamental break from the past as the net migration rate was on an upward trend since 2018. However, it is a positive signal when taken alongside the weak economic recovery from COVID-19. Among the comparator states, Idaho and Utah stand out in their significant increase in the net migration rate in 2021. At this point we are unable to differentiate if in-migrants are working remotely, but it is possible that this may be the case for some individuals moving into Wyoming and elsewhere in the region.

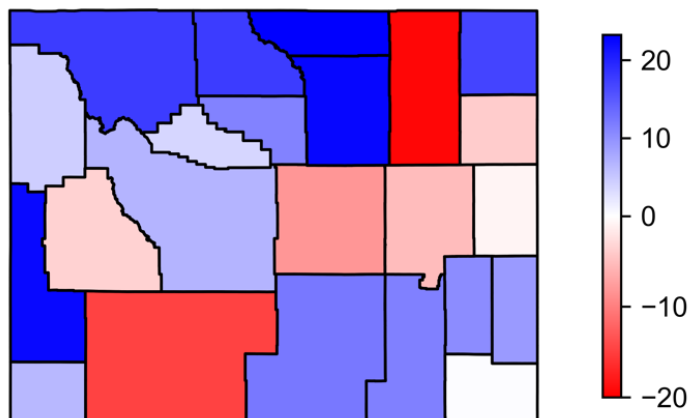
Not surprisingly, there are significant differences in net migration across the state, which we can observe at the county-level. Resource-dependent counties are experiencing negative net migration, while the rest of the state has seen positive inflows of migrants (Figure 74). Lincoln, Sheridan and Johnson counties had the highest net migration rate in 2021, but most counties were positive. It is surprising that one county that has seen stronger growth over time — Laramie County — has seen essentially zero net migration as people moving in and people moving out balanced in 2021.

Figure 73: Short-Run Migration into Wyoming and its Mountain West Peers



Source: U.S. Census Bureau

Figure 74: County-Level Net Migration Rate (%) within Wyoming in 2021

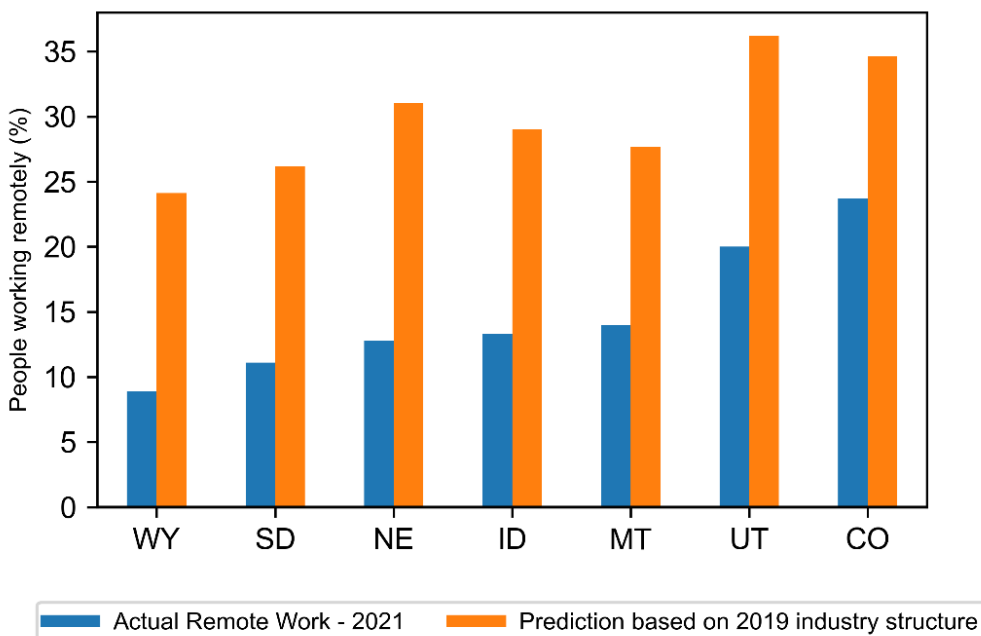


Source: U.S. Census Bureau

There is direct information on the prevalence of remote work captured in responses to the American Community Survey. These survey responses suggest that Wyoming has the lowest prevalence of remote work, at less than 10%, among neighboring states (Figure 75). Utah leads the peer group with 20% of the employed population working remotely, while the other states are between 11% and 15% by these self-reported estimates. However, some of this difference can be attributed to differences in the occupational composition of Wyoming versus other states. Occupations differ in the extent to which they can be done remotely. For example, most — though not all — jobs in the mining industry cannot be done remotely. Using the teleworkability scores from Dingel & Neiman (2020), we can approximate the share of jobs in a state that theoretically could be done remotely. As Figure 75 shows, Wyoming's predicted share of teleworkable jobs

(based on its pre-pandemic occupational structure) is lower than other states as well, but Wyoming stands out more in its low remote work in practice than in the prediction.

Figure 75: Remote Work and Predicted Remote Work in Wyoming and Neighboring States



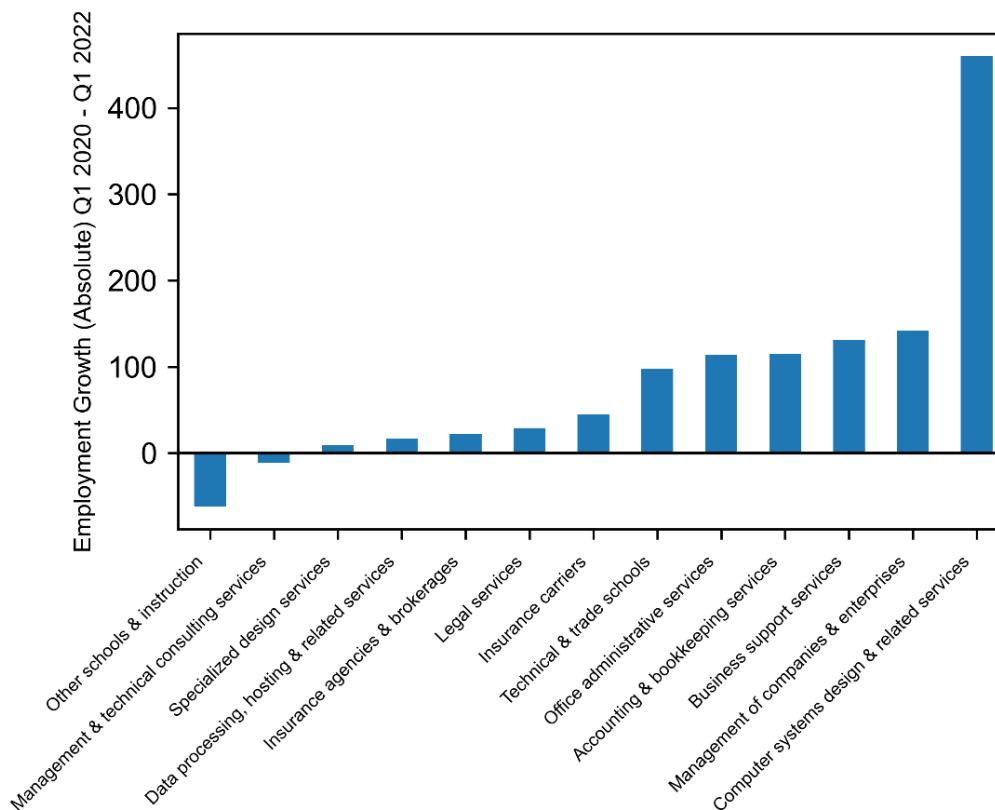
Source: American Community Survey and Dingel & Neiman (2020)

It is important to note that we cannot distinguish here whether people who report working remotely are doing so for employers within the state or outside the state, nor can we tell how many of these individuals have chosen to move to Wyoming and work for an outside employer when remote work became an option. Whether individuals have moved into the state in this way or have long-lived in the state but been able to find a remote job where the employer is based out of the state, these represent tradable sources of income, which could be strategically important for growth in Wyoming. Further work may allow for these types of remote work to be distinguished better.

Overall, Wyoming has seen limited short-term growth in highly teleworkable industries,²³ but some promising signs emerge. As Figure 76 shows, short-term employment growth depicted in absolute numbers is relatively low in highly teleworkable industries. However, within the computer systems design industry more than 400 new jobs were created between Q1 2020 and Q1 2022. In relative terms, this industry's employment grew by 55% compared to the pre-pandemic baseline, which is very promising. Even though this goes in line with the earlier finding of relatively low remote work adoption in Wyoming overall, it shows that some teleworkable industries are growing, and the information technology sector seems to be increasing.

²³ For this analysis, we define industries as highly teleworkable when the share of teleworkable occupations in that industry is larger than 70% based on the Dingel & Neiman (2020) and further work by the Growth Lab.

Figure 76: Employment Growth in Highly Teleworkable Industries between 2020 and 2022

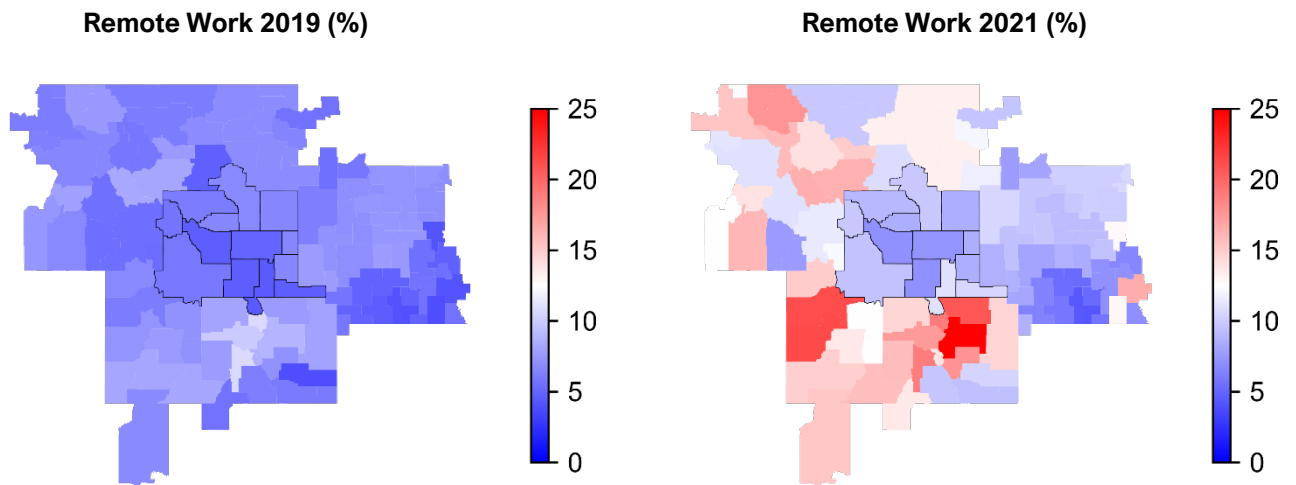


Source: Quarterly Census of Employment and Wages

We can also observe the share of self-reported remote workers by at the commuting zone level by using data from the American Community Survey²⁴. Figure 77 shows the results for 2019 and for 2021. Before the pandemic, very few people were working remotely across the region and variation across commuting zones was very limited. Remote work grew enormously in many places by 2021, creating significant variation across commuting zones. The commuting zones of Wyoming range between a minimum estimate from the survey of 7.1% in Rawlins and a maximum of 10.9% in Laramie. The commuting zones with the highest share of remote workers are in Colorado — with Denver (28%) and Fort Collins (21%) — and in Utah — with Provo (21%) and Salt Lake City (21%). All these commuting zones include larger urban agglomerations and, in general, more urbanized areas have seen a larger rise of remote work. Ramani & Bloom (2021) have shown that many people who have moved away from urban centers likely due to new remote work possibilities, have moved to suburbs of those cities as hybrid working arrangements require them to stay reasonably close. As at the state-level, the expected amount of remote work can be assessed using information on the occupational structures of commuting zones. The results of such an analysis are shown in Figure 78, which suggest that the commuting zones of Cheyenne and Laramie are below the level of remote work that would be expected for them.

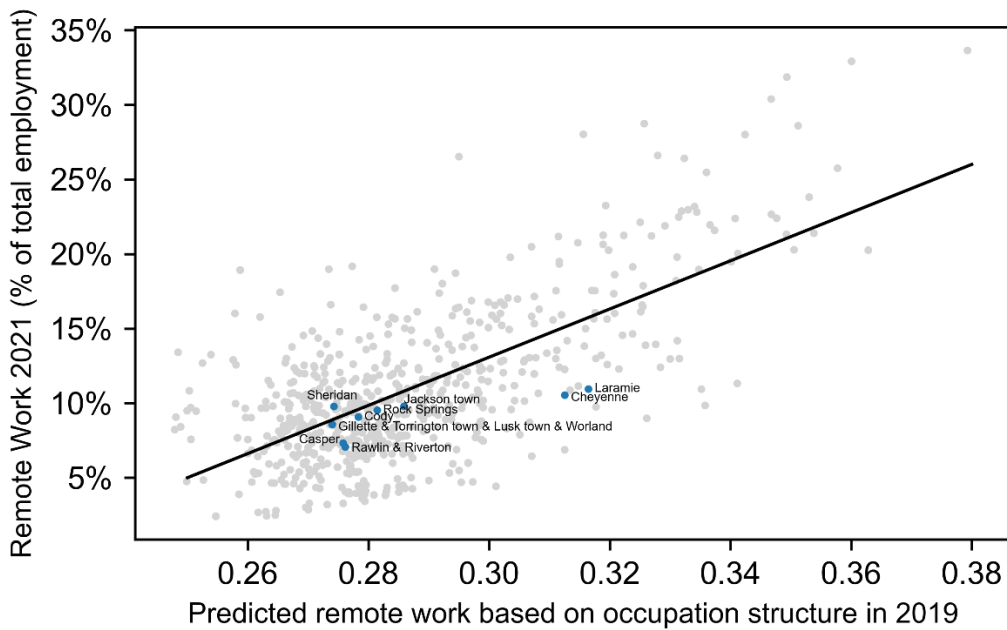
²⁴ The American Community Survey reports data at the level of public use microdata areas. We transformed this data to the commuting zone level using the crosswalk from Autor & Dorn (2013).

Figure 77: Remote Work across Commuting Zones (% of total employed)



Source: American Community Survey

Figure 78: Predicted vs. Actual Remote Work by Commuting Zones



Note: Regression line allows for a sense of if commuting zones are above or below expectation.
Source: American Community Survey and Dingel & Neiman (2020)

Based on this analysis, occupational structures from 2019 explain 45% of the variation of remote work patterns in 2021 across commuting zones. Since Cheyenne and Laramie are well below the linear fit, this signals a larger potential for remote work than is currently expressed in those places. With the current data available, it is not yet possible to analyze in what industries in Cheyenne and Laramie remote work is not taking place as predicted. However, the prediction of remote work in

those places is higher than in other areas of Wyoming due to a larger presence of professional, scientific, and technical services as well as educational services. Given that the predicted remote working scores are based on pre-pandemic occupational structures, their prediction does not fully capture the amount of opportunity for people to move into a commuting zone to work remotely for an employer outside of the commuting zone. This may be a greater underdeveloped opportunity than the untapped remote work potential reflected here, not just for Cheyenne and Laramie but also for other parts of the state.

Decarbonization as a Challenge and Opportunity in Wyoming

Global decarbonization has reduced demand and will continue to reduce demand for Wyoming's fossil fuel resources overall. Meanwhile, decarbonization may also open substantial new opportunities for Wyoming. Some of these opportunities are becoming clear already while others are uncertain and may emerge in the future either naturally or through the support of public policy.

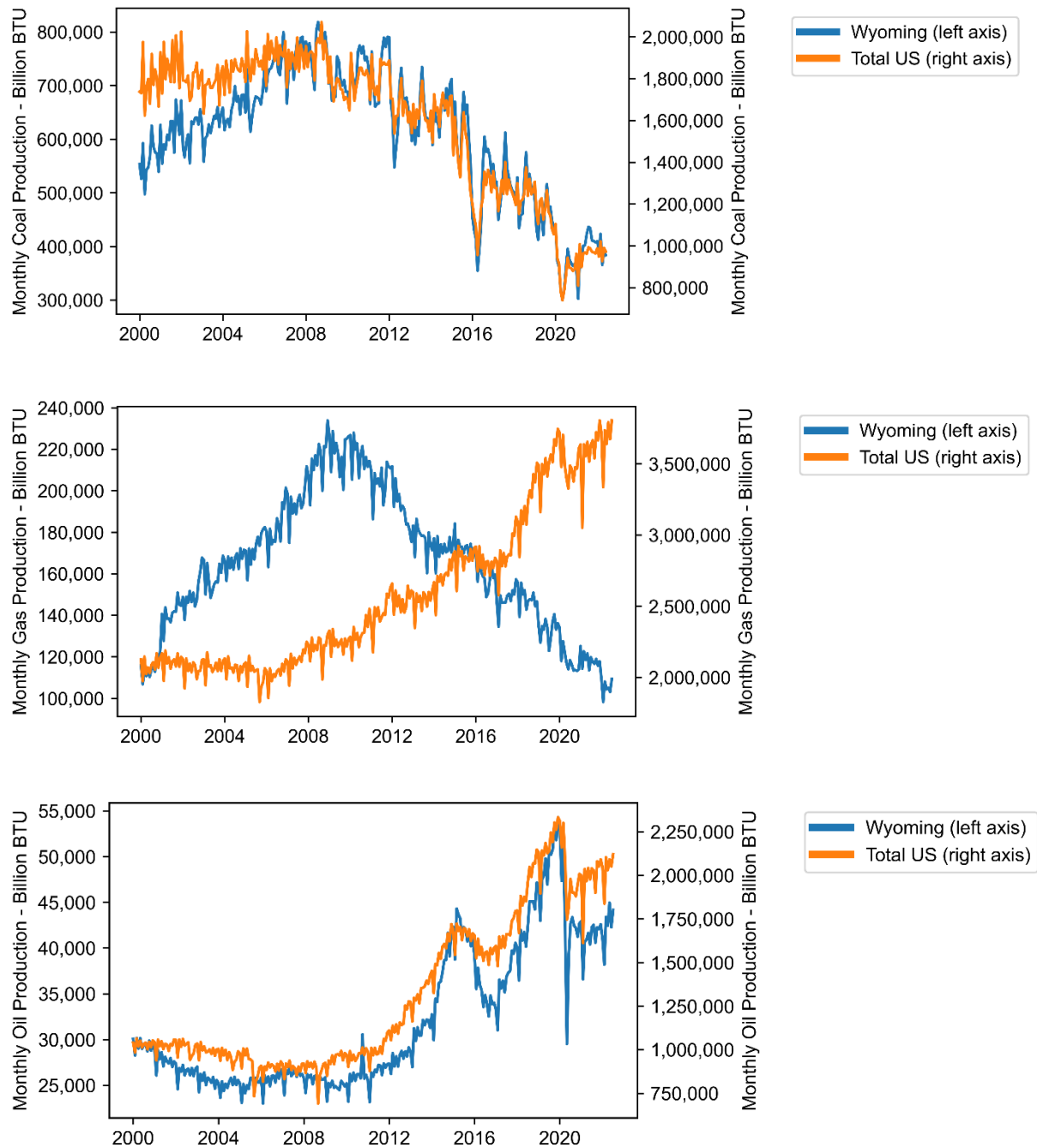
Wyoming has faced a significant loss in tradable income and employment from declines in fossil fuel production and exports to other states over the medium-term, but the short-term picture is more complicated. This is captured in the three graphs in Figure 79, which show production in Wyoming and the U.S. in total for coal, natural gas, and oil.

- Coal production in Wyoming has closely followed a decline that has affected the whole of U.S. production since 2008, though Wyoming coal was growing while total U.S. coal production was constant in the years before. Wyoming produces the most coal of any U.S. state, with a 41% of the national share in 2021. There has been a slight uptick in coal production in the short-term following a sharp drop at the start of the pandemic, but coal production has not recovered to its pre-pandemic level and sits at about half of its 2008 peak production level.
- Wyoming's natural gas production has also declined by about half from its 2008 peak after growing in the years before. In this case, however, the trend for Wyoming is strikingly different than that of the U.S. Whereas coal has been hit by a problem of declining demand, natural gas has seen growing demand, yet Wyoming's gas production does not appear price competitive as hydraulic fracturing has revolutionized the industry. Natural gas shows no turnaround in production in the short-term for Wyoming (declining) or the U.S. overall (rising) as medium-term trends continue.
- Oil production has seen more frequent rises and falls over the medium-term, and Wyoming's oil production largely tracks that of the U.S. overall. Production has grown since 2008. Like with coal, the onset of the pandemic brought on a sharp drop in oil production, which has been followed by a gradual recovery of production that has not reached pre-pandemic levels. Many analyses project the demand for oil to remain stable at least in the next five years, while prices are always unpredictable, but demand will eventually decline to reach carbon emission targets (International Energy Agency, 2021).

Figure 80 captures an overall pattern of job losses in the mining sector over the short-term from Q1 2020 to Q1 2022, but with differences across sub-industries. Large job losses were felt in crude petroleum extraction, drilling, and especially support activities for oil and gas. Coal mining jobs also continued to decline, but still represent a large share of overall mining jobs. As of Q1 2022, the production of oil, gas and coal remains a key part of Wyoming's economy, constituting 9% of statewide private sector employment. It also plays a very large role in state government

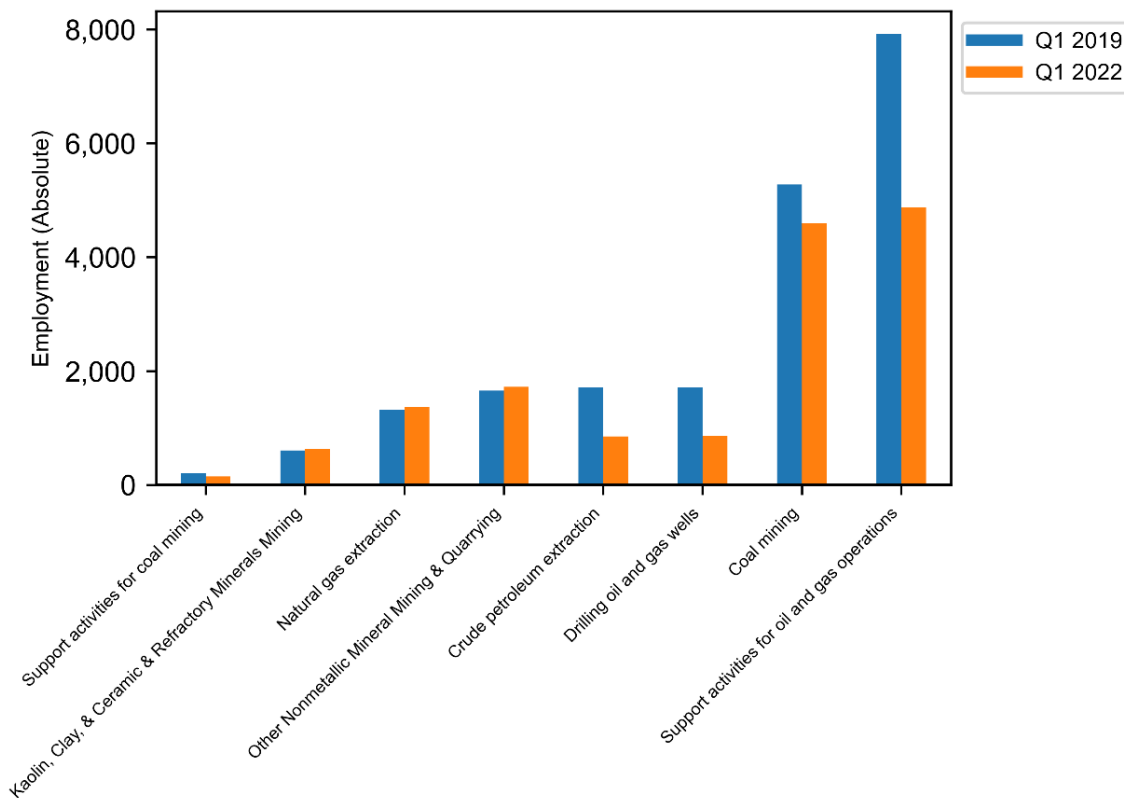
revenues, as discussed earlier. While fossil fuels suffer projected decline, mining of some other minerals that are not sources of carbon dioxide, such as trona, are expanded slightly in Wyoming in the short-term and many firms are now expanding such that they will need more workers in the future.

Figure 79: Fossil Fuel Resource Production: Coal, Gas & Oil – Wyoming and U.S. Total



Source: U.S. Energy Information Administration

Figure 80: Wyoming's Employment in the Mining Sector in 2019 & 2021



Source: Quarterly Census for Employment and Wages

Decarbonization represents a negative shock to important parts of Wyoming's economy, especially in mining-intensive regions, but there also may be significant opportunities for Wyoming to benefit from the ongoing change. Global decarbonization is changing the nature of demand, both for energy generation itself and for many products that are critical to the "green economy". We provide a framework for understanding potential opportunities for Wyoming to grow tradable income growth and see direct job growth via decarbonization. The following section explores the following opportunities:

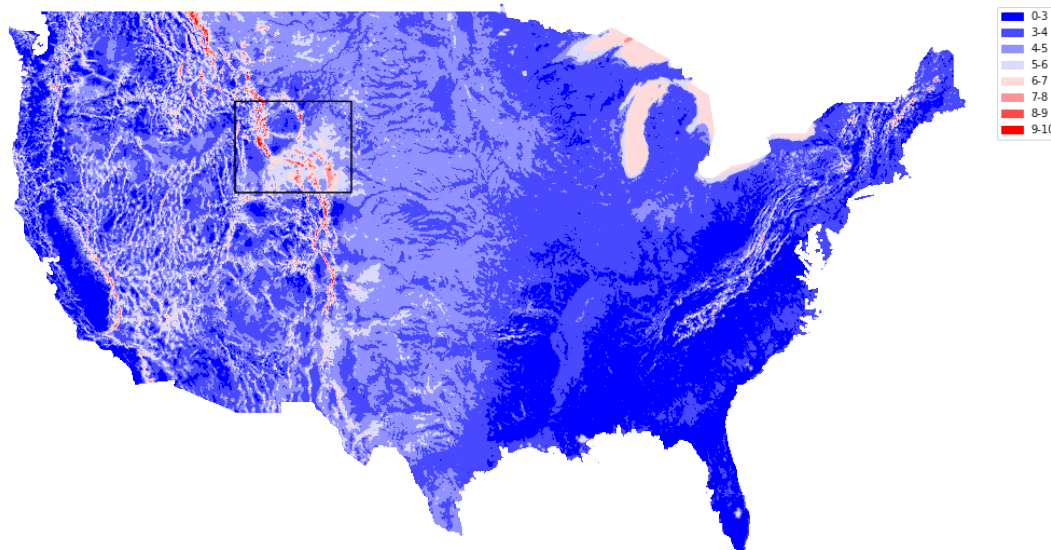
- Generation (and export) of energy that is increasing in demand
- Production of products and services that are needed for the "green economy"
- Mining of critical materials that are needed for the "green economy"
- Leveraging productive capabilities for innovation in the "green economy"
- Monetizing carbon sinks

Generation (and export) of energy that is increasing in demand

Wyoming has potential to produce more wind energy that it currently does, which could facilitate additional green growth opportunities. Wyoming has some of the fastest wind speeds in the U.S.

and a very large potential for wind energy (Figure 81). With a cumulative installed capacity of 3.178 GW, Wyoming currently has the 14th largest wind energy capacity of all U.S. states, and this capacity has doubled within the last two years (American Clean Power, 2021). The planned Chokecherry and Sierra Madre wind farms, which will be the largest in the country when completed, will double the current capacity by adding a projected 3 GW in capacity and an additional 2.4 GW has already been approved by local and state authorities (Khalaf, 2022). Wind energy production can become an important source of tradable income as transmission lines connecting it to the markets of California, Nevada and Arizona are already being constructed. An impact analysis of the University of Wyoming indicated that an additional construction of 4 GW would be expected to lead to over 6,000 construction phase jobs and 1,000 operation and maintenance phase jobs, with an impact of \$772 million in the first phase and annually \$140 million in the second phase (Khalaf, 2022). According to the analysis, this scenario would also lead to annual tax revenues of \$60 million. One of the largest obstacles to realize these benefits is the permitting process especially in cases where federal land is involved (Khalaf, 2022).

Figure 81: Mean Annual Wind Speed at 10m above Surface Level



Source: National Renewable Energy Laboratory

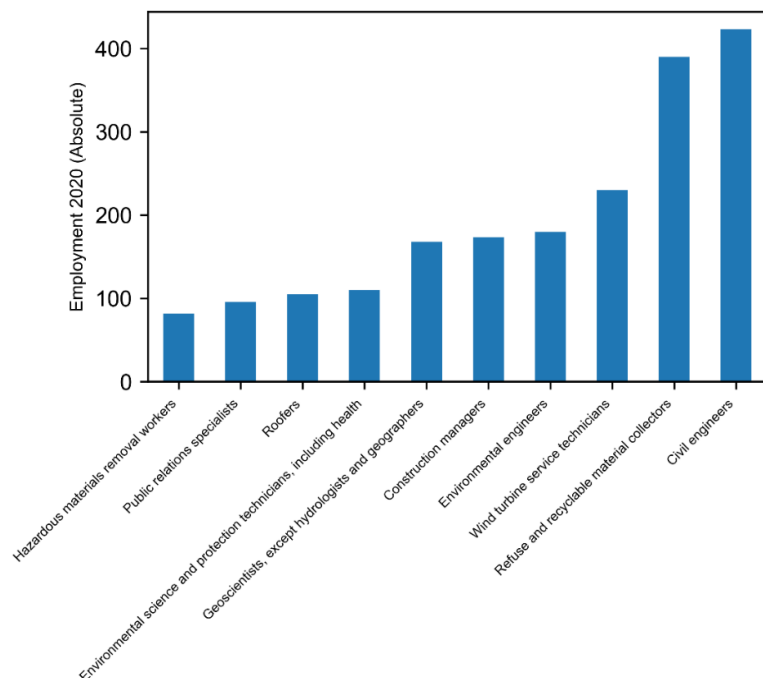
Wyoming's existing infrastructure also makes it a promising location for other energy generation technologies that have not yet scaled commercially to the extent of wind, but which may become commercially competitive soon. This is the case for small-scale nuclear generation and the production of hydrogen (which can be a source of energy). There are cost advantages to building new small-scale nuclear capacity at or near existing or decommissioned generation sites because of existing transmission infrastructure as well as an existing workforce with related skills and experience. This was a motivating factor for the company TerraPower to choose Kemmerer, Wyoming as a first location for proposed advanced nuclear reactor. Nuclear generation may not only generate income and jobs but also catalyze upstream demand for products and services used by the facilities. Hydrogen, meanwhile, is a potential energy opportunity in many parts of the world where electricity can be supplied cheaply to power the production process. Cost structures for various production approaches are not yet commercially proven and demand for hydrogen as a source of energy is also not yet established, but many large-scale investment projects are

seeking to develop the industry. Wyoming participates in a collaboration with the states of Colorado, New Mexico, and Utah for the development of a Western Interstate Hydrogen Hub (WISHH). These may help Wyoming to leverage existing knowledge and geographical advantages to develop another new stream of energy, and potentially tax revenue, in the future. As various generation technologies evolve, the U.S.

Production of products and services that are needed for the “green economy”

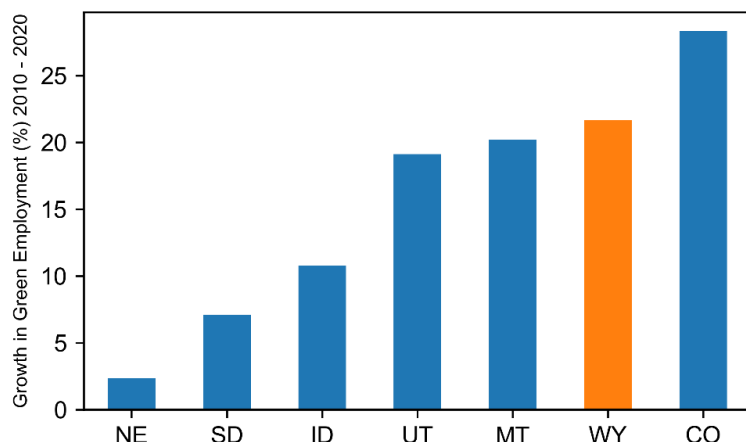
Wyoming's workforce appears to hold numerous skills that relate to “green goods and services” that are expected to increase in demand. We conducted an analysis of employment in “green occupations” in Wyoming and neighboring states, where these occupations are defined as those where the impact of the green economy will likely either result in an increase in employment demand or generate new occupations and worker requirements that are closely related (see Appendix for methodology). Wyoming has a noteworthy presence in such occupations. Wyoming had the second largest share of green employment of its peers in 2020, at 1% of total employment (following Colorado). Some occupations that currently map to the mining industry in Wyoming have skills that are transferable to green industries (e.g., civil engineers, construction managers, environmental engineers, and geoscientists). The top ten such occupations in Wyoming are shown in Figure 82. These occupations with green skills grew by 22% from 2010 and 2020, and thus also had the second highest growth rate among the states, behind Colorado (Figure 83). Most of this growth came from wind turbine service technicians, refuse and recyclable material collectors, and geoscientists.

Figure 82: Top 10 Occupations by Green Employment in Wyoming, 2020



Source: Own calculations based on Occupational Employment and Wage Statistics

Figure 83: Growth in Green Employment, 2010-2020



Source: Own calculations based on Occupational Employment and Wage Statistics

Mining of critical materials that are needed for the “green economy”

Wyoming also has potential to supply certain critical mineral inputs to decarbonize the economy. Demand for certain critical minerals and rare earth materials is expected to grow strongly. For example, lithium demand is expected to increase by 585% until 2050 (International Energy Agency 2017). The U.S. Geological Survey has a list of 50 mineral commodities that are critical to the economy and national security. Wyoming has reservoirs of 27 of these 50 mineral commodities (see Table 4 in Appendix). However, it is not clear how economically viable it is to mine these minerals in Wyoming. To understand which critical minerals Wyoming's deposits are substantial and where it might be economically feasible to mine them, the state must engage in geological mapping and consequent economic modeling of extraction costs. Wyoming may earn a premium for some of these minerals by mining them in the U.S. (for example, the Inflation Reduction Act includes an additional tax incentive for inputs to semiconductors sourced from the U.S. or a partner country with a free trade agreement (Section 13401)). Exploiting the potential in this area may include significant environmental risks and land ownership discussions, so strong institutional structures are needed to balance tradeoffs. Since Wyoming has a long history of mining and oil and gas extraction, it may have an institutional advantage versus other places.

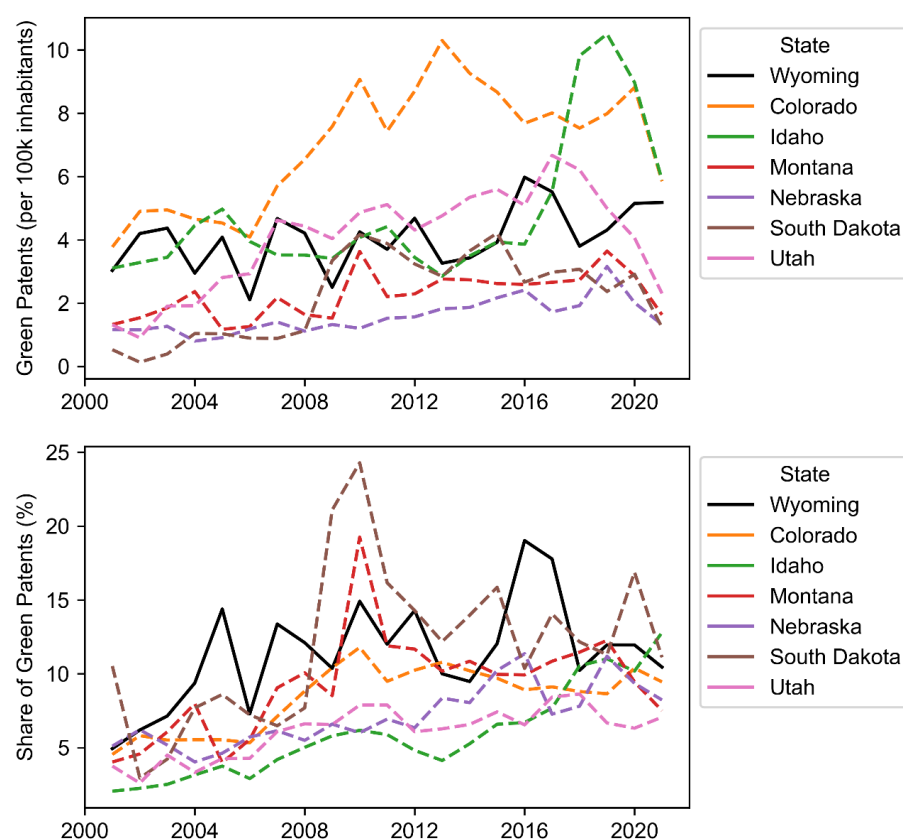
Leveraging productive capabilities for innovation in the “green economy”

For the world to eventually reach net zero carbon emissions, it will require new goods, services, and production processes, which will require a knowledge base that is not fully developed. Wyoming may have many specialized types of knowledge that can position it to participate in this innovation process in important ways. We analyzed the patent applications at the state level in the “climate change mitigation technologies” category as reported by the U.S. Patent and Trademark Office, which we henceforth call “green patents.” As the top graph of Figure 84 shows, Wyoming lags only Idaho and Colorado regarding green patents per 100,000 inhabitants. The bottom figure shows that there is a strong focus in this area within Wyoming's research community, as consistently more than 10% of patent applications have been for “green patents.” Within those “green patent” applications in Wyoming, many are for renewable energy sources, industrial and mineral processing technologies, adaptation technologies, and greenhouse gas capture (Figure

85). These indicate an existing knowledge base in Wyoming for green technologies that may evolve and expand in the future.²⁵

Wyoming's green patents suggest that it might also have significant green production capabilities in sophisticated products and services. Wyoming may be in a position leverage its green production capabilities to expand its advanced manufacturing industry. Sophisticated manufacturing associated with components for wind turbines, which currently is done in Wyoming, for instance, may crowd in other manufacturing opportunities as well. Places are often able to jump from one advanced manufacturing sector to another (Diodato et al., 2018). Advanced manufacturing in the United States often requires the co-location of research and development with on-the-ground fabrication as ongoing interaction between basic research and commercial applications is often important for refining technologies and scaling. In the context of global decarbonization, there is a growing focus through federal policy to incentivize widespread experimentation of new technologies with full knowledge that many may not succeed and scale. This is the nature of uncertain technologies, where investment in many technologies is needed to ensure sufficient resources for some uncertain yet transformative technologies to mature.

Figure 84: "Green Patents" by Origin of Invention



Source: U.S. Patent and Trademark Office

²⁵ Though the total number of these patents is small (around 20-25 green patents in recent years), it is noteworthy that Wyoming produces this many green patents given its small agglomerations in comparison to other states. There may be advantages in being small in this case in terms of targeted State services to these innovators.

Figure 85: Topic Area of Green Patents in Wyoming, 2001-2022

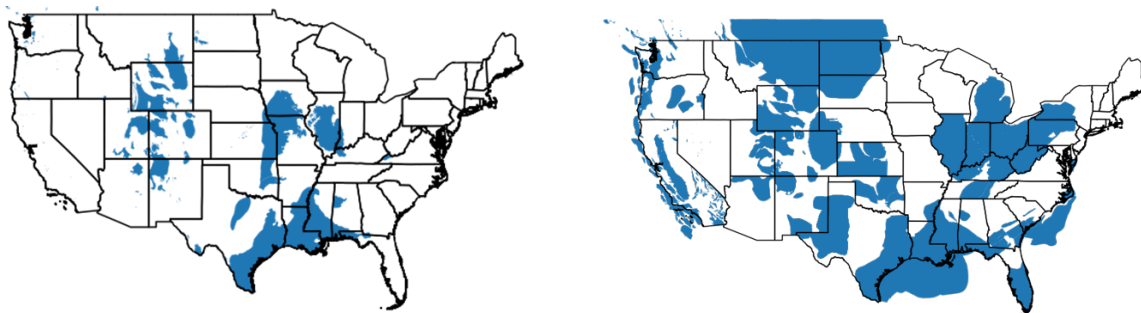


Source: U.S. Patent and Trademark Office

Monetizing carbon sinks

Monetizing carbon sinks could be one more important growth opportunity for Wyoming if a market for carbon dioxide storage develops as part of a global net-zero carbon economy. Wyoming has many geological formations that can store carbon dioxide. The Department of Energy has mapped its saline formations and unmineable coal deposits, which are indications that formations may be able to store carbon dioxide (Figure 86). Wyoming could potentially store upward of 1,900 billion metric tons of carbon dioxide which is 50 times the global emissions from 2021 (International Energy Agency, 2022). Another sign of this potential is also the announcement of the expected direct air capture (DAC) facility, "Project Bison" in late 2022. With an envisioned capacity of five megatons per year. This could become the first scalable DAC project in the United States. Wyoming's regulatory and operating environment for carbon storage was cited as one of the reasons for this project (Businesswire, 2022). With years of experience in exploring carbon capture and underground storage (CCUS), Wyoming has advantages in knowledge and public goods to support this technology. Wyoming is one of the few places in the United States that has multiple types of underground storage capacity and existing connecting pipelines.²⁶

Figure 86: Unmineable Coal Reserves (left) & Saline Formations (right) across the U.S.



Source: U.S. Department of Energy

²⁶ See, for example, p.18 of Abramson, McFarlane, et al., [An Atlas of Direct Air Capture: Opportunities for Negative Emissions in the United States](#) (Carbon Solutions LLC & Great Plains Institute, March 2023).

Short-Term Growth in Summary

In the short-term, Wyoming has experienced what could appear to be a slow and partial economic recovery from the acute impacts of the pandemic. The shock to jobs and incomes in Wyoming was larger than in neighboring states and recovery has been weaker. Currently, Wyoming has returned to low unemployment levels, but the employment rate has not recovered to its pre-pandemic level. However, Wyoming's economic weakness over the last two years appears to be driven more by medium-term trends than by pandemic impacts. Job losses have been most clear in the mining industry and economic weakness has been most pronounced in mining-intensive counties, just as in the medium-term. The economy outside of mining looks more like comparator states in terms of recovery. Production trends are positive in coal and oil in the very recent term, but production has not recovered to pre-pandemic levels. Counties that have sufficient sources of tradable income to offset the decline of mining have fared better. The same could be assumed for cities and towns, but more granular data will be needed to study local economies in detail over short time horizons. Strengths vary by county, but there are trends of growth in tradeable (or partially tradeable) industries of manufacturing, professional services, finance and insurance, and accommodation and food service. Retail trade, a non-tradable, has grown across the state, which may be the result of federal COVID-19 stimulus programs.

The pandemic era has introduced new realities that have affected Wyoming, creating both challenges and opportunities. The rise of remote work could impact Wyoming's labor market and growth in several ways, but most channels would be expected to be positive through allowing workers to live in the remote state but connect with employers from outside the state. Early indications are that Wyoming may be benefiting from remote work, since net migration has been positive even amidst economic weakness. Yet, this opportunity looks underdeveloped. Self-reported remote work in Wyoming is lower than expectation when controlling for occupational structure at the state level and across the state, particularly for Cheyenne and Laramie. Strategies for capitalizing more on remote work may be important for Wyoming's growth, including in more rural areas with weaker local job markets.

Demand for traditional energy sources has shown significant volatility, but recent trends make clear that global decarbonization is accelerating overall. Changing demand has had negative consequences on jobs, income sources, and tax revenues in Wyoming. These impacts have been the proximate cause of Wyoming's weak overall growth over more than a decade, including in the short-term. This has been compounded by little diversification in tradable income to buffer these losses, due in part to a lack of large agglomerations to support more diverse economic activity. However, global decarbonization need not be a purely negative force for Wyoming's economy. There are several areas of opportunity for Wyomingites to benefit from the changing global demand that goes along with decarbonization. Wyoming has opportunities for large-scale energy generation in line with shifting demand; emerging capabilities to produce goods and services needed in a decarbonizing national and global economy; potentially viable critical mineral resources; knowledge assets to support valuable innovation; and unique advantages for carbon sequestration and storage. Many of these opportunities are uncertain, and thus government and other stakeholders must aim to enable new opportunities while managing the risks that come with uncertain technologies. Ultimately, the shift in global energy demand should create growth opportunities across the state, and policymakers may need to manage the challenges of that growth, including increased housing demand and infrastructure needs, such as arterial roads, sewage, and electricity, which may be needed to accommodate population shifts across the state.

5. Understanding Pathways to Prosperity

Armed with this perspective on Wyoming's growth over the long-, medium-, and short-term, we can make a clearer assessment of the central growth problem facing the state and its residents. We find that the current composition of Wyoming's economic activities cannot sustain a high quality of life across all parts of the state. Part of this problem can be understood at the state level in terms of the state's overall economic structure, but it is more importantly a problem of local economic resilience across the state as towns and cities have lost key sources of local tradable income, which is critical to sustaining local growth and viability.

Wyoming's long history of constrained population agglomeration and reliance on energy exports have led to its present-day economic concentration. This reliance is narrow and vulnerable. National and global decarbonization have already shrunk Wyoming's chief source of tradable income and tax revenue and threaten to continue doing so. The current growth trajectory poses serious risks of an untenable economic future. We find, however, that it is essential not to overgeneralize this problem. Differences are substantial across the state in medium- and short-term growth performance and pathways to prosperity will also differ substantially across the state. Thus, the Pathways to Prosperity Project, which this report informs, will focus enabling statewide, regional, and local strategies and actions to strengthen growth moving forward.

Some economies across the state are experiencing noteworthy growth that could be accelerated, yet they are bumping up against new constraints as they develop resilient tradeable industries that build on their historic and emerging strengths. This is the case in many of the state's larger population centers. While these communities weathered the bust and pandemic reasonably well, their growth is not yet large enough to put Wyoming's economic diversity on comparable footing with peer states. This could be accomplished both by scaling up existing industries and taking advantage of untapped opportunities in digital industries, the new energy economy, and other options that will be explored in detail in the next stages of the Pathways to Prosperity Project. Many of Wyoming's growing cities are facing challenges that follow from their size as businesses that are looking to enter or expand struggle to secure the workforce that they need or lack confidence that they will be able to hire sufficient workers. Though significant efforts and expenses are being undertaken to develop labor pools through education and training, this remains an immediate challenge of many firms. It is suggestive that issues of housing expansion and other constraints that impact the growth of labor markets are important to understand to enable the continued growth of growing agglomerations.

At the same time, many parts of the state lost jobs, income, and population over the course of the recent bust, and may urgently need to add new sources of tradable income to prevent deeper local economic damage. Many smaller communities across the state have experienced decades of population decline that follow from lost engines of tradable income to sustain local economies. As these communities have lost population, challenges intensify in maintaining and improving the infrastructure and public services, which creates new challenges for jumpstarting new engines of growth that could reverse the population outflow. These places often face a different but also pressing problem of workforce availability and, counterintuitively, can also face severe housing challenges for individuals that do try to move there. Many such economies will need to accomplish a "big push" that enables new private growth opportunities while also reversing long-term population decline. Place-specific strategies and localized constraints will matter immensely. In

many cases, public and private capabilities will be narrow given very low population, and strategies will need to link the comparative advantages across geographies. Sometimes this will mean building on complementary assets across multiple small communities with connectivity to one another and sometimes this may come through small labor markets better connecting to larger agglomerations that are growing.

State-level policies and systems must enable growth under these various circumstances. Through its expenditures and through its programs, state-level agencies and legislation can enable growth as well as help ensure that growth that occurs in some parts of the state increases resources and tools to address challenges that affect other parts of the state. Ultimately, stronger growth in the states more urban areas can create demand for more tradable opportunities for more rural regions, but this will not happen automatically. Ultimately, addressing the disconnected economic geography of the state is likely to be important for Wyoming, as numerous individual small towns may not have many viable diversification opportunities when considered in isolation.

Pathways for industries to grow

Subsequent work within the Pathways to Prosperity Project will aim to identify industry growth opportunities in high granularity and match these to local economic capabilities. This data-intensive work will build on opportunities that are qualitatively evident across the state. This includes areas of growth that are already gaining momentum in some parts of the state in manufacturing, transportation and logistics, and an increasing range of tradeable services. Other areas of historic strength in Wyoming can also support more growth. As mentioned earlier in this report, natural resources, agriculture, and tourism-related activities tend to survive in more remote places. It is noteworthy that these areas of the economy are evolving within the national and global economy, which will create new opportunities that are often place-specific. Both existing and emerging strengths across these sectors are important.

Changing demand for natural resources will favor many resources across Wyoming, but state and local actions may be needed to make these resources available for development and to ensure that their development benefits local economies. Agriculture and tourism are also areas undergoing significant change. While Wyoming has historically had concentration in cattle and other livestock together with geographically concentrated crop agriculture, technologies (for example in water management) and market access (for example in direct-to-consumer models) are creating new opportunities. Additionally, Wyoming's immense ranch and farmland has always been a tool used for both conservation and energy uses, and opportunities are expanding through new technologies, business models, and markets to continue this tradition. Wyoming also has both historic and new tourism advantages. Traffic to national parks has long-dominated Wyoming's tourism industry, but there are signals of growing opportunities in outdoor recreation and other tourism in more parts of the state. This includes assets for cultural tourism, food-related tourism, as well as sports and events. This diversity — and complementary — of strengths across geography suggests that some opportunities may only be realized through regional strategies.

Pathways for places to grow

Given the findings of this report, it is essential that the Pathways to Prosperity Project continues to study local and regional economic and partner with local stakeholders to develop strategies and actions. This is especially true for parts of the state that are losing population over time. Since

many of the data sources used in this report are not able to capture economic realities for small population counties, towns, and cities, many of their economic conditions are not well captured by this report. Meanwhile, discussions with county and city officials in Hot Springs, Washakie, Goshen, Carbon, and Lincoln counties, as well as with tribal government leaders on the Wind River Reservation, have emphasized that every local economy has unique historical dimensions and distinct challenges and opportunities. While some issues resonate widely — for example, workforce size and housing supply issues — other issues vary significantly — for example, water availability, transport connectivity, and local capacity to meet local needs within the state’s fiscal system. In coordination with state and local officials, the Pathways to Prosperity Project will develop problem-based workstreams that aim to address both state and local constraints to enable widespread growth opportunities.

Pathways for building lasting capabilities

This report underscores how economic conditions are dynamic over any time horizon. Therefore, enabling pathways to prosperity must be dynamic as well. This is true in any context, but perhaps especially so when a state economy is as vulnerable as Wyoming’s and where local differences in economic capabilities are as varied. For this reason, the Pathways to Prosperity Project ultimately aims to strengthen public capabilities across the state to continuously understand economic challenges and effectively overcome them. The project will work to expand these capabilities through enabling processes of learning-by-doing focused on key constraints and opportunities. Some such constraints and opportunities may be relevant at the state-level, while others will require more local actions. In both cases, lasting capabilities will require combining state and local knowledge, authority, and effort. If successful, such capabilities will long outlast the project itself and enable resilience to a wide variety of future challenges.

Appendix

Table 1: Industries with Proclivities to Appear in Remote Places

Remoteness Coefficient	NAICS Code	NAICS Industry Name
-1.00	424510	Grain and Field Bean Merchant Wholesalers
-0.81	213112	Support Activities for Oil and Gas Operations
-0.66	211111	Crude Petroleum and Natural Gas Extraction - crude petroleum extraction
-0.46	213111	Drilling Oil and Gas Wells
-0.46	721110	Hotels (except Casino Hotels) and Motels
-0.42	713290	Other Gambling Industries
-0.40	212221	Gold Ore Mining
-0.37	115112	Soil Preparation, Planting, and Cultivating
-0.34	311611	Animal (except Poultry) Slaughtering
-0.33	423820	Farm and Garden Machinery and Equipment Merchant Wholesalers
-0.33	486110	Pipeline Transportation of Crude Oil
-0.31	213114	Support Activities for Metal Mining
-0.30	481111	Scheduled Passenger Air Transportation
-0.28	211112	Natural Gas Liquid Extraction
-0.21	424520	Livestock Merchant Wholesalers
-0.20	424710	Petroleum Bulk Stations and Terminals
-0.20	311313	Beet Sugar Manufacturing
-0.17	333111	Farm Machinery and Equipment Manufacturing
-0.16	212291	Uranium-Radium-Vanadium Ore Mining
-0.15	212234	Copper Ore and Nickel Ore Mining
-0.15	212299	All Other Metal Ore Mining
-0.09	325193	Ethyl Alcohol Manufacturing
-0.07	212231	Lead Ore and Zinc Ore Mining
-0.07	212222	Silver Ore Mining
-0.07	212391	Potash, Soda, and Borate Mineral Mining
-0.06	481219	Other Nonscheduled Air Transportation
-0.05	487990	Scenic and Sightseeing Transportation, Other
-0.03	713210	Casinos (except Casino Hotels)
-0.03	424910	Farm Supplies Merchant Wholesalers
-0.03	115113	Crop Harvesting, Primarily by Machine
-0.02	481112	Scheduled Freight Air Transportation
-0.02	484230	Specialized Freight (except Used Goods) Trucking, Long-Distance
-0.01	333132	Oil and Gas Field Machinery and Equipment Manufacturing
-0.01	332992	Small Arms Ammunition Manufacturing

Table 2: Ten Example Industries with Proclivities to Appear in Central Places

Remoteness Coefficient	NAICS Code	NAICS Industry Name
0.07	311710	Seafood Product Preparation and Packaging
0.26	333242	Semiconductor Machinery Manufacturing
0.62	561599	All Other Travel Arrangement and Reservation Services
0.69	522292	Real Estate Credit
0.70	523120	Securities Brokerage
0.70	334515	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
0.73	327212	Other Pressed and Blown Glass and Glassware Manufacturing
0.84	334416	Capacitor, Resistor, Coil, Transformer, and Other Inductor Manufacturing
1.10	332216	Saw Blade and Hand Tool Manufacturing
1.30	332119	Metal Crown, Closure, and Other Metal Stamping (except Automotive)

Green Jobs - Methodology

There is no standardized method for measuring “green jobs” in the literature. However, many recent contributions (Peters, 2014; Vona et al., 2018) have used the O*NET classification of green occupations based on their skills. The O*NET list includes 205 occupations that have at least one green skill. This results in a relatively broad list of occupations. Vona et al. (2018) expand on the O*NET approach by calculating the share of tasks associated with an occupation that are green tasks (called “greenness”). This allows for a finer distinction between green and non-green jobs than the O*NET classification. We further restrict the list from Vona et al. (2018) to occupations at the six-digit SOC level which have at least 30% of their overall skills being green skills. The restriction to the six-digit SOC level is done because employment data is only available at that level. Otherwise, the more detailed green occupations would be used to indicate that an occupation at a more aggregated level is also green, which would introduce bias. After applying these conditions, we end up with a list of 20 occupations (see Table 3). This is the narrow definition of green jobs that we use for our analysis.

Table 3: Green Occupations

SOC Code	Title	Greenness
17-2081	Environmental Engineers	1
17-3025	Environmental Engineering Technologists and Technicians	1
19-4042	Environmental Science and Protection Technicians, Including Health	1
47-2231	Solar Photovoltaic Installers	1
49-9081	Wind Turbine Service Technicians	1
53-7081	Refuse and Recyclable Material Collectors	1
47-4041	Hazardous Materials Removal Workers	0.91
19-1013	Soil and Plant Scientists	0.63
19-2021	Atmospheric and Space Scientists	0.5
19-2042	Geoscientists, Except Hydrologists and Geographers	0.48
17-2051	Civil Engineers	0.47
17-1011	Architects, Except Landscape and Naval	0.37
19-3051	Urban and Regional Planners	0.37
17-2161	Nuclear Engineers	0.35
19-5012	Occupational Health and Safety Technicians	0.35
13-2051	Financial and Investment Analysts	0.33
13-2054	Financial Risk Specialists	0.33
17-2011	Aerospace Engineers	0.33
51-8011	Nuclear Power Reactor Operators	0.33
47-2181	Roofers	0.3

Table 4: Critical Minerals with Existing Reserves in Wyoming

Mineral	Main Use Cases	US net importance reliance (% of total consumption)
Aluminum	Almost all sectors of the economy	44%
Antimony	Lead-acid batteries and flame retardants	84%
Arsenic	Semi-conductors	100%
Barite	Used in hydrocarbon production.	75%
Beryllium	Used as an alloying agent in aerospace and defense applications	16%
Bismuth	Used in medical and atomic research	90%
Chromium	Most important applications in in stainless steel and nonferrous alloys	84%
Cobalt	Rechargeable batteries and superalloys	76%
Germanium	Fiber optic communication networks, infrared night vision systems and polymerization catalysts	50%
Iridium	Inputs for catalysts in the petrochemical industry	100%
Lithium	Rechargeable batteries	25%
Manganese	Steelmaking and batteries	100%
Nickel	Stainless steel	48%
Niobium	Steel and superalloys	100%
Palladium	Inputs for catalysts in the petrochemical industry	37%
Platinum	Catalytic converters	70.0%
Rhodium	Catalytic converters	100%
Ruthenium	Used as catalysts	100%
Scandium	Aluminum-scandium alloys and solid oxide fuel cells	100%
Tantalum	Electronic components	100%
Tellurium	Solar cells	95%
Tin	Protective coatings and alloys for steel	78%
Titanium	White pigment or metal alloys	90%
Tungsten	Wear-resistant metals	50%
Vanadium	Alloying agent for iron and titanium alloys used in jet engines and high-speed airframes	100%
Zinc	Metal products, rubber and medicines	76%
Zirconium	Refractories, foundry sands and ceramic opacification	50%

Source: U.S. Geological Survey

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