

AVERAGE WEEKLY EARNINGS ANALYSIS

TEAM 8 PROJECT FINAL REPORT

1. SRINANDHINI
2. ROCHANA RAMANATHAN
3. KARUNAKAR CHERUKUPALLY
4. AJAYRAM K A
5. YAO ZHONG

Introduction

A worker's decision regarding their education and profession has a significant impact on their career [1]. Additionally, a worker's choice of residence has a significant impact on many professions. When experiencing the rapid growth of economy and technology, we are also witnessing great fluctuations in the job market: What is hot and trending this year may sink to the bottom in the next year. Location also makes a significant impact, as the right job at the right place brings more food to the table than the top job in an empty city.

Institute for Work & Health report [8] claims that worker's compensation claim rates experienced a sharp decline during the 2008–2009 recession. And according to a study by the IZA Institute of Labor Economics [6], the Covid 19 pandemic's increased unemployment rate has coincided with declines in labor force participation, hours worked, and wages. Such events bring a lot of uncertainty into the job market as well, and some industries are prone to shocks than the others. As upcoming data analysts and data scientists, we are curious to find out the dynamics of the job market in Canada to be prepared for the future.

In this exploratory analysis, we look at some of the differences in typical weekly earnings across provinces and industries in Canada because datasets like this offer a glimpse into the economic landscape of a region or sector, shedding light on income disparities, job market dynamics, and the overall financial well-being of individuals and households.

Dataset

This project makes use of the dataset “Average Weekly Earnings (including Overtime)” which is available at Average Weekly Earnings (including overtime), Alberta - Open Government [3] website.

This information is well-structured and available in CSV format. The dataset comprises 80190 rows and the following 7 columns:

1. Reference_Date,
2. Geography
3. Estimate
4. Industry
5. Average_Weekly_Earnings
6. MOM_Percent_Change

7. YOY_Percent_Change

The "Reference_Date" column is presented as a "month-year" and spans the period from "Jan-01 to Jun.-23." Geography refers to 10 Canadian provinces as well as the entire country. There are 28 industries listed under the "Industry" column, all of which fall under the North American Industry Classification (NAICS) code and exclude businesses that cannot be categorized under NAICS. NAICS is an industry classification system developed by the statistical agencies of Canada, Mexico, and the United States [5]. Total weekly earnings are divided by the total number of employees to arrive at average weekly earnings. Alberta – open government [4] authorizes the usage of the dataset and contains the license to use the data.

One issue with this data is that for nearly 13k rows, the "Average weekly earnings" data is missing. We described how we deal with this issue in our data wrangling process.

Guiding questions

To better understand the dataset, we have chosen to answer the following guiding questions.

1. What is the trend of earnings over the years?

[Yao was responsible for above questions]

2. How have the rankings of weekly earnings changed for each industry from 2001 to 2023?

[Rochana was responsible for above questions]

3. How the High paying Industry and Low paying Industry performed in term of salary in Canada?

[Rochana and Ajay were responsible for above question]

4. Which provinces have grown the fastest over the years?

5. Which industries have contributed to the total earnings for Alberta?

[Karunakar was responsible for above two questions]

6. Are earnings prone to economic shock?

7. How have the top performing industries performed during economic crisis?

[Srinandhini was responsible for above two questions]

Data Exploration:

Data wrangling:

	Reference_Date	Geography	Estimate	Industry	Average_Weekly_Earnings	MOM_Percent_Change	YOY_Percent_Change
0	2001/01	Alberta	Average weekly earnings including overtime for...	Accommodation and food services [72]	\$274.66	NaN	NaN
1	2001/02	Alberta	Average weekly earnings including overtime for...	Accommodation and food services [72]	\$264.74	-3.6	NaN
2	2001/03	Alberta	Average weekly earnings including overtime for...	Accommodation and food services [72]	\$261.44	-1.2	NaN
3	2001/04	Alberta	Average weekly earnings including overtime for...	Accommodation and food services [72]	\$261.13	-0.1	NaN
4	2001/05	Alberta	Average weekly earnings including overtime for...	Accommodation and food services [72]	\$255.66	-2.1	NaN

Table 1: Before Data wrangling

Step 1: We divided the "Reference_Date" column into "Month" and "Year" columns. This allows us to use the year data from the "Year" column and the month data from the "Month" column directly. The "Reference_Date" column was removed after splitting because it was no longer necessary.

Step 2: Remove the '\$' sign from "Average_Weekly_Earnings"(AWE) since we want to perform numerical calculations on this column and need it to be in numerical format without any symbols.

Step 3: At the end of each industry name in the industry column are numbers enclosed in []. We do not need these numbers and brackets because we are only interested in industry names themselves.

Step 4: Now that we are only dealing with NA values, our approach is as follows:

- We eliminate every row where the AWE data is missing for every month over the course of a year.
- We substitute missing data with the mean of the remaining months of the year for years where AWE data is missing for fewer than or equal to 4 months.

We now have the dataset in the format that is necessary, and we will use it to continue answering the guiding questions.

	Geography	Industry	Average_Weekly_Earnings	Month	Year
0	Alberta	Accommodation and food services	274.66	01	2001
1	Alberta	Accommodation and food services	264.74	02	2001
2	Alberta	Accommodation and food services	261.44	03	2001
3	Alberta	Accommodation and food services	261.13	04	2001
4	Alberta	Accommodation and food services	255.66	05	2001

Table 2: After data wrangling

Guiding question 1: What is the trend of earnings over the years?

The average weekly earnings have been steadily increasing among all provinces. Figure 1.1 and Figure 1.2 show that all provinces have all almost doubled their weekly earnings number over 22 years. The top 3 provinces with highest weekly earnings in 2023 are Alberta, Ontario and British Columbia, which fits the general impression. The weekly earnings number grows at a different speed in each province, and some are growing faster than the other. The difference between the highest and lowest weekly earning has increased from \$204 in 2001(Ontario – Prince Edward Island), to \$305 in 2023(Alberta – Prince Edward Island).

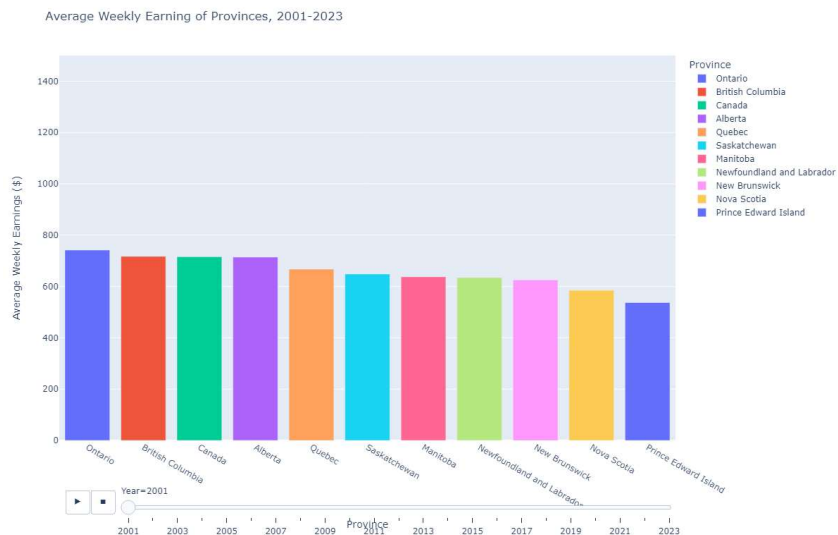


Figure 1.1: Average Weekly Earnings of Provinces, 2001

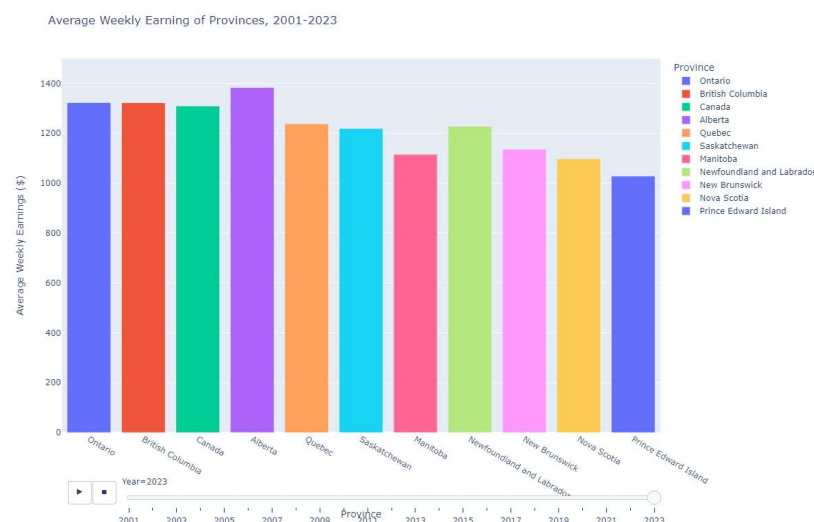


Figure 1.2: Average Weekly Earnings of Provinces, 2023

Figure 1.3 and Figure 1.4 display the change of average weekly earnings for each NAICS defined industry from 2001 to 2023. The Mining, Quarrying, Oil, Natural Gas Extraction industry, and the Utilities industry have always been the top 2 industries over the years and have exceeded the numbers of other industries far and beyond. This could be explained by the abundant natural resource reserve of Canada, which makes these two industries the backbone of Canadian economy. Meanwhile, Accommodation and Food Services, Arts, Entertainment and Recreation and Retail Trade have been the under-performing industries over the years.

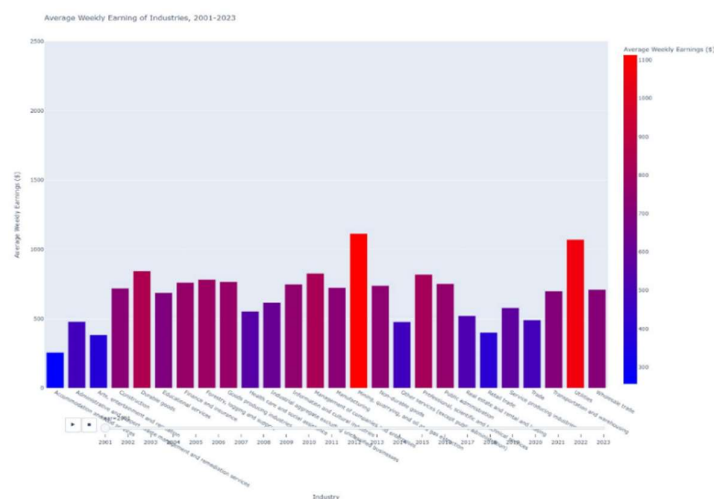


Figure 1.3: Average Weekly Earnings of Industries, 2001

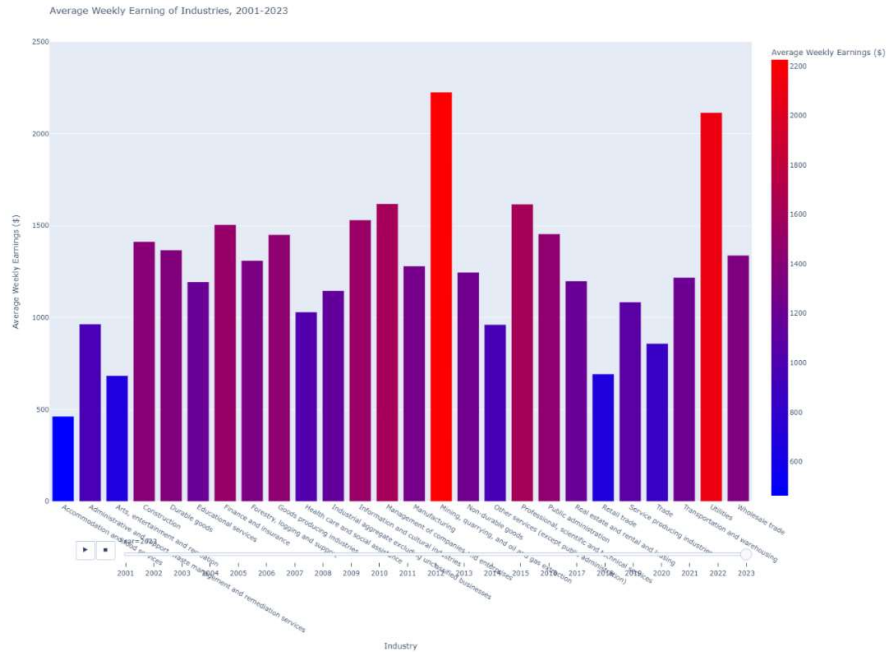


Figure 1.4: Average Weekly Earnings of Industries, 2023

We pick 3 representative industries from high, med, and low tier in terms of weekly earnings. Figure 1.5 displays an upward trend of average weekly earnings despite fluctuations in certain periods. High paying industries in general often have high fluctuations in earnings.

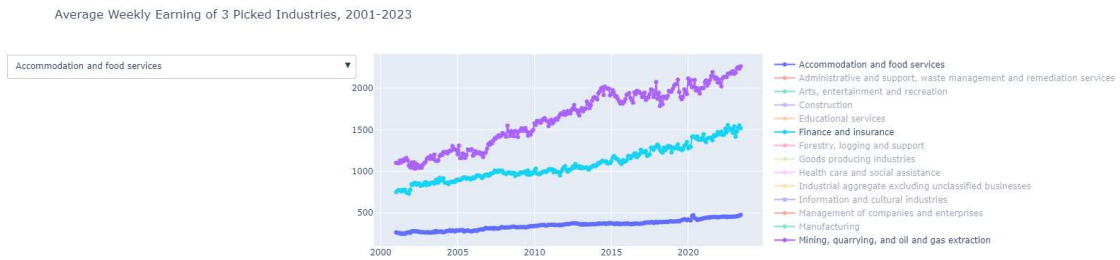


Figure 1.5: Average Weekly Earnings Trends of High, Medium, Low Paying Industries, 2001-2023

Guiding question 2: How have weekly earnings rankings shifted across industries in Canada from 2001 to 2023?

Our analysis delves into sector-specific performance, employing a visual chart to trace the evolution of various industries across Canadian provinces over the years. In this chart, each bar corresponds to a specific province, and the colour of the bar signifies the industry that offered the highest weekly earnings for that year.

The output was obtained by grouping the data by 'Geography,' 'Year,' and 'Industry,' and then computing the mean of 'Average_Weekly_Earnings' using the **mean()** function. The industry with the highest average weekly earnings for each province in each year was determined by finding the index of the maximum value using **idxmax()**.

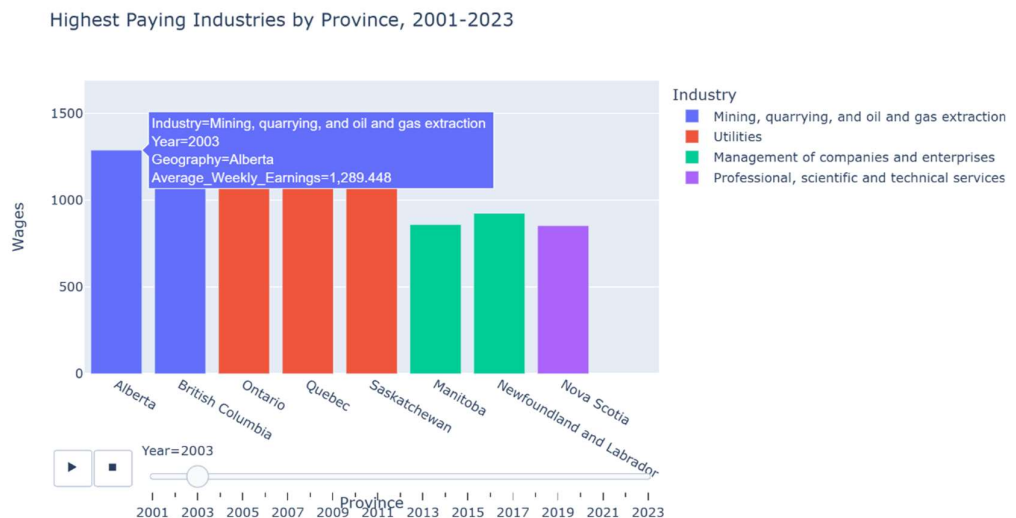


Figure 2.1 - Highest Paying Industry by Province – 2003

In Figure 2.1, the "Mining, Quarrying, and Oil and Gas Extraction" industry is ranked as the highest-paying sector in many provinces, followed by "Utilities". These industries hold significant importance due to their high average weekly earnings in various provinces, with "Management of Companies and Enterprises" and "Finance and Insurance" also featuring prominently, with the highest average weekly earnings reaching \$1,274.62 in the year 2003.

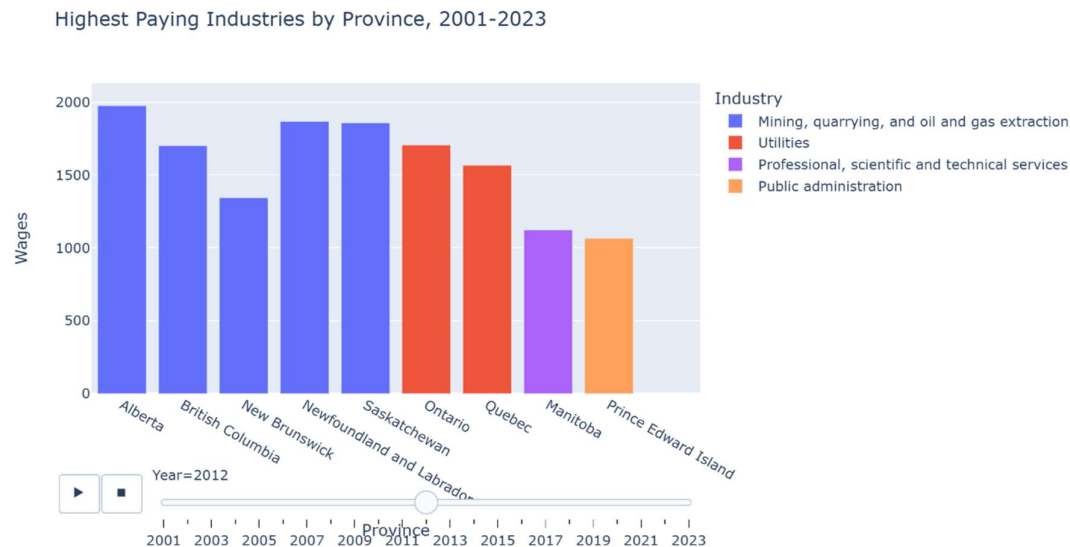


Figure 2.2- Highest Paying Industry by Province – 2012

In Figure 2.2, we observe that in the year 2012, the "Mining, Quarrying, and Oil and Gas Extraction" industry and "Utilities" maintained their rankings from 2003, while industries like "Professional, scientific, and technical services" and "Public administration" surpassed "Management of companies" and "Finance and insurance," indicating fluctuations in their positions

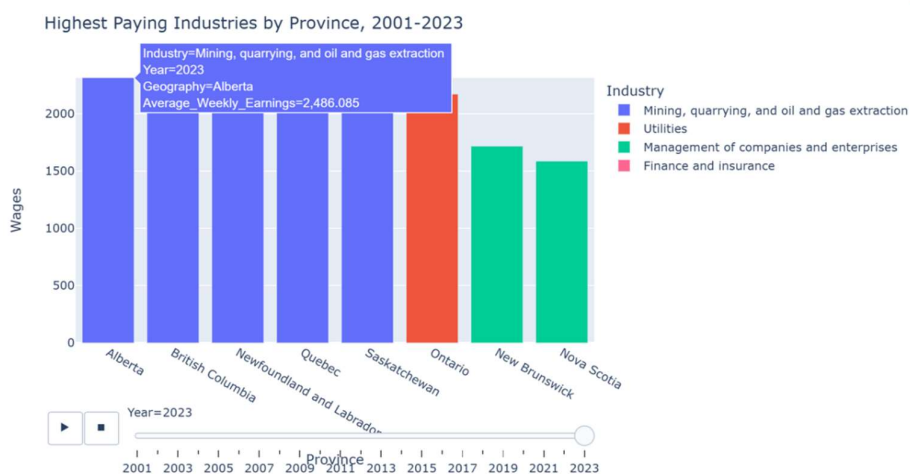


Figure 2.3 - Highest Paying Industry by Province – 2023

Moving on to Figure 2.3, in 2023, a similar trend is evident, where the rankings of "Mining, Quarrying, and Oil and Gas Extraction" and "Utilities" remained consistent, while other industries showed no clear patterns in their rankings.

From the graphs of "Highest paying Industries 2001 -2023", it is evident that,

- Over the years, "Mining, Oil, and Gas Extraction" and "Utilities" consistently maintain their positions as the top-earning industries, showcasing their pivotal roles in driving economic prosperity, especially in provinces like Alberta and British Columbia.
- Additionally, other sectors like "Management of Companies," "Scientific and Technical Services," "Finance and Insurance," and "Cultural Industries" occasionally lead in various provinces but exhibit fluctuations over time.
- This analysis offers a comprehensive perspective on the changing landscape of high-wage sectors in Canada from 2001 to 2023.

In terms of Low waged Industry, we've examined the five lowest-paying industries in Canada from the year 2001 – 2023.

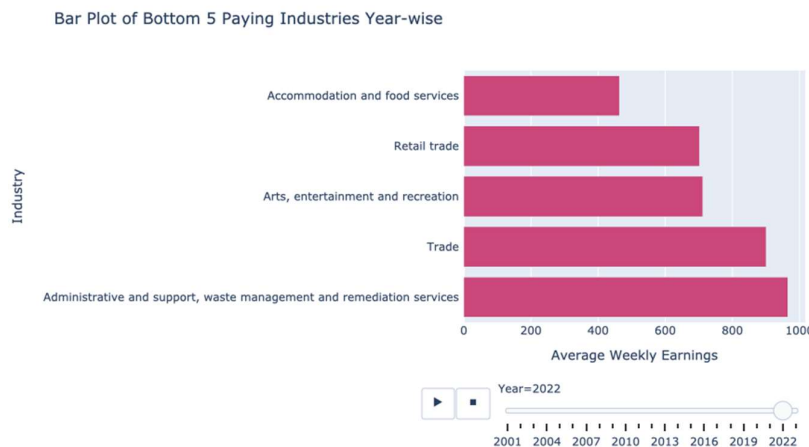


Figure 2.4 – Bar Plot of Bottom Paying Industries Year - wise

The fig 2.4 indicates in 2022, the industries offering the lowest wages were Accommodation and Food Services, Retail Trade, Arts, Entertainment, and Recreation, Trade, and Administrative and Support, Waste Management, and Remediation Services. We've ranked them based on their wage levels, with the lowest-paying ones at the top.

Guiding Question 3: How the High paying Industry and Low paying Industry performed in term of salary Canada?

We conducted a comparison between the industries with the highest and lowest wages in both 2001 and 2022. Surprisingly, these industries remained consistent. The highest-paying sectors were found to be in Mining, Quarrying, and Oil and Gas Extraction, while the lowest-paying sectors were still within Accommodation and Food Services.

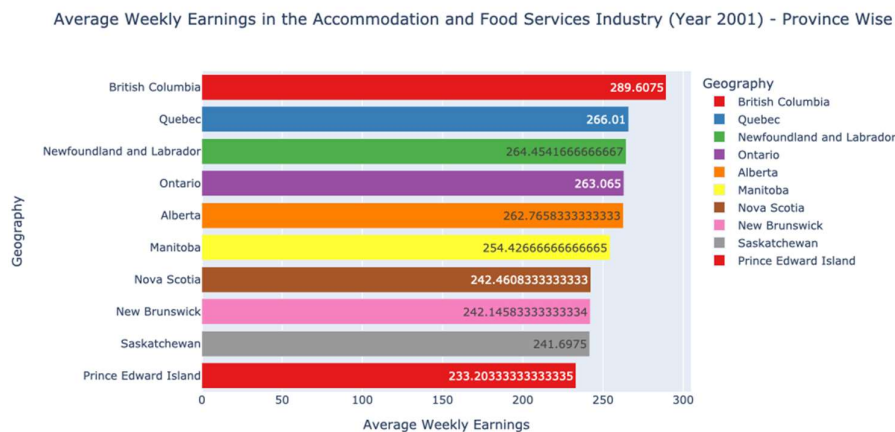


Figure 3.1: Average weekly earnings in Accommodation and Food services for year 2001

Regarding Accommodation and Food Services in 2001, British Columbia paid the highest weekly wage of \$290 CAD, while Prince Edward Island paid the lowest at \$234 CAD per week as per the Figure 3.1

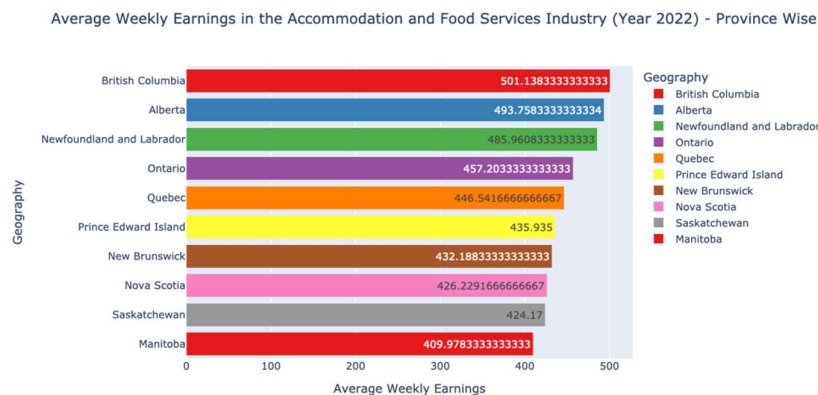


Figure 3.2: Average weekly earnings in Accommodation and Food services for year 2022

The Figure 3.2 depicts that in 2022, British Columbia had the highest weekly wage at approximately \$502 CAD, with Manitoba paying the lowest wage in the same sector.

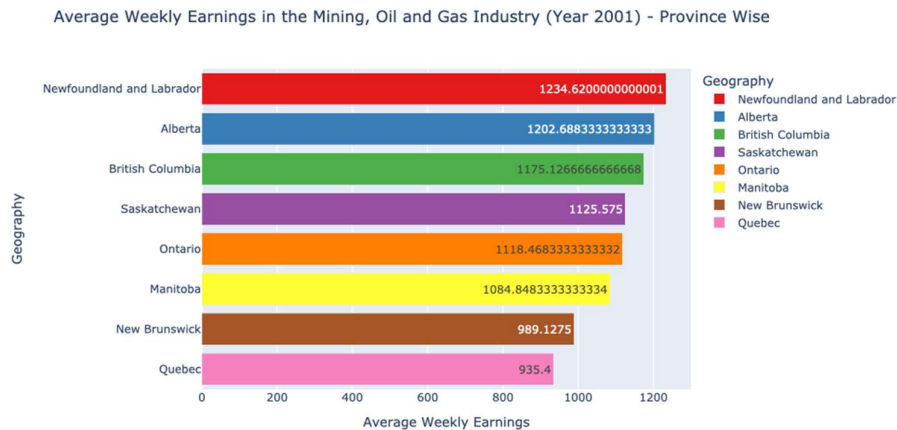


Figure 3.3: Average Weekly earnings in Mining, Oil and Gas Industry for year 2001

In 2001, the figure 3.3 indicates that the highest weekly wage was \$1,235 CAD in Newfoundland and Labrador, and the lowest was \$936 CAD in Quebec.

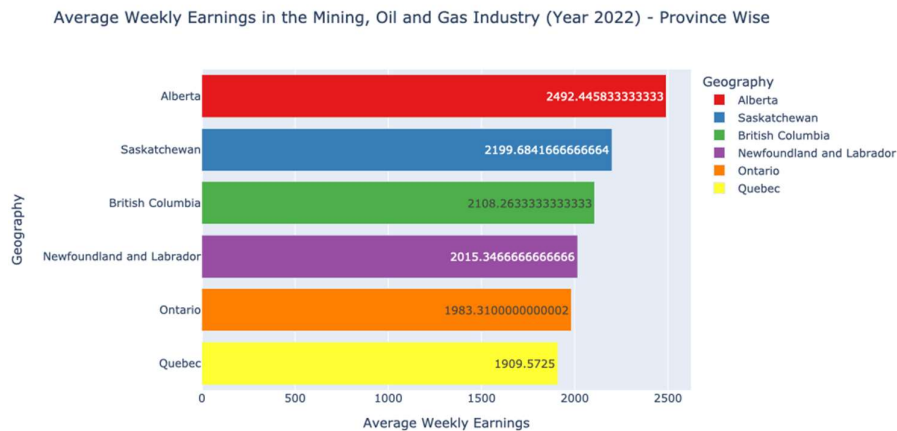


Figure 3.4: Average Weekly earnings in TMining, Oil and Gas Industry for year 2022

In 2022, the graph shows that Alberta offered the highest wage at \$2,493 CAD per week, while Quebec once again had the lowest at \$1,910 CAD per week.

Guiding Question 4: Which provinces have grown the fastest over the years?

AWE of all provinces 2001-2023

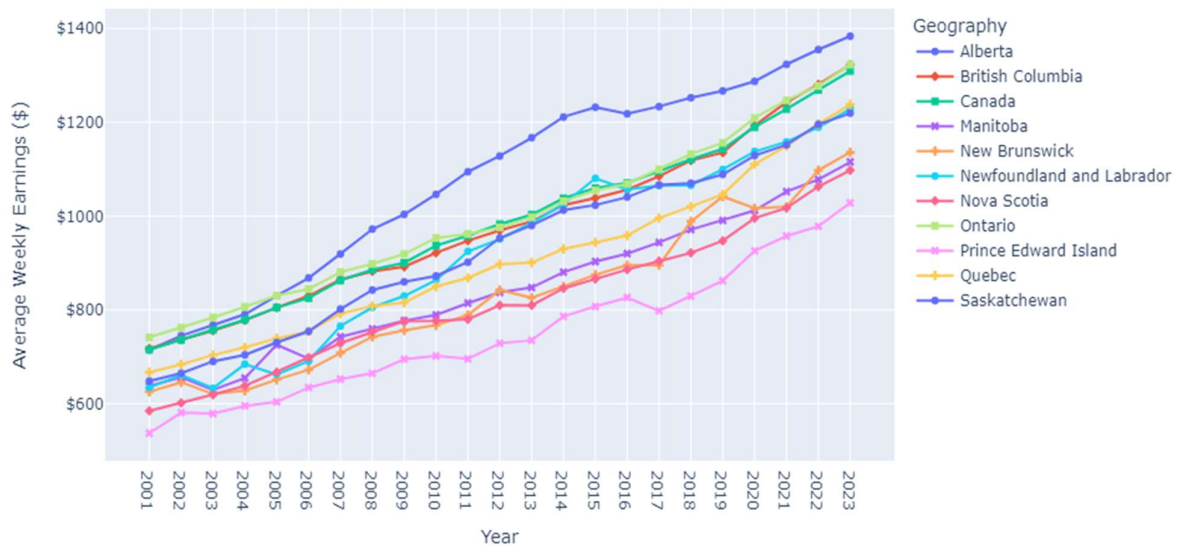


Figure 4.1: Average Weekly Earnings of all provinces 2001-2023

When we look at the average weekly earnings of all provinces over the past two decades, a few key observations stand out:

- **Alberta's Strong Performance:** Alberta consistently maintained average weekly earnings above the national average, making it one of the highest-paying provinces in Canada. While Alberta soars at the top and Prince Edward Island remains at the bottom.
- **Competing with Ontario:** Around 2005-2006, Alberta's wages began to outpace Ontario's, marking a significant shift in economic dynamics.
- **British Columbia and Ontario's stability:** British Columbia and Ontario show a consistent pattern of being relatively close to the country's average weekly earnings. This suggests a certain level of economic stability and equilibrium in these provinces, with earnings in line with the national average.
- **Long-Term Wage Superiority:** Despite economic challenges like the 2009 crash and the 2020 COVID-19 shutdown, Albertans have consistently earned more than residents of other provinces, a trend spanning decades.

Guiding Question 5: Which industries have contributed to the total earnings for Alberta?

Let's explore how Alberta's industries stack up against the national average:

Top Industries Alberta v/s Canada 2001-2023

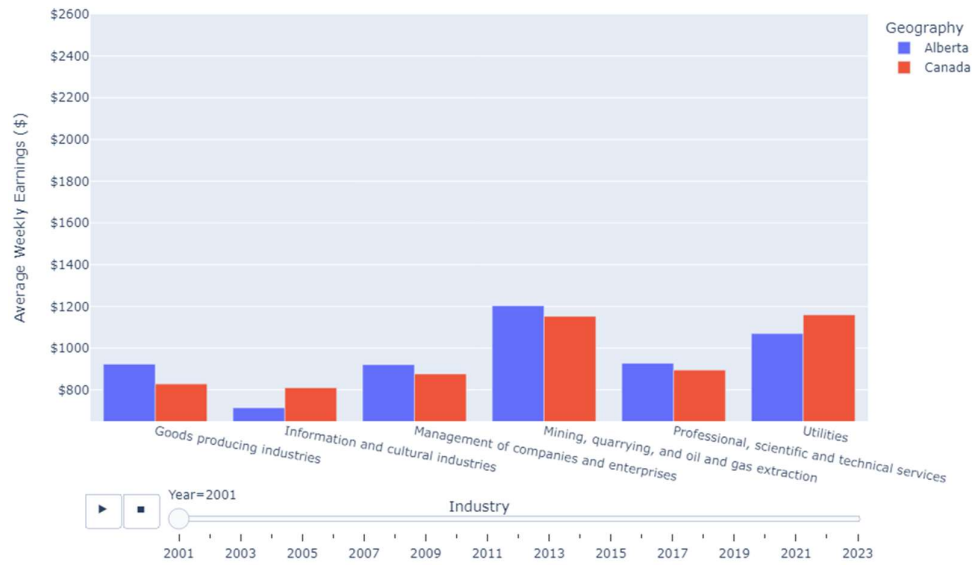


Figure 5.1: Comparison of top industries of Alberta with Canada – 2001

Top Industries Alberta v/s Canada 2001-2023

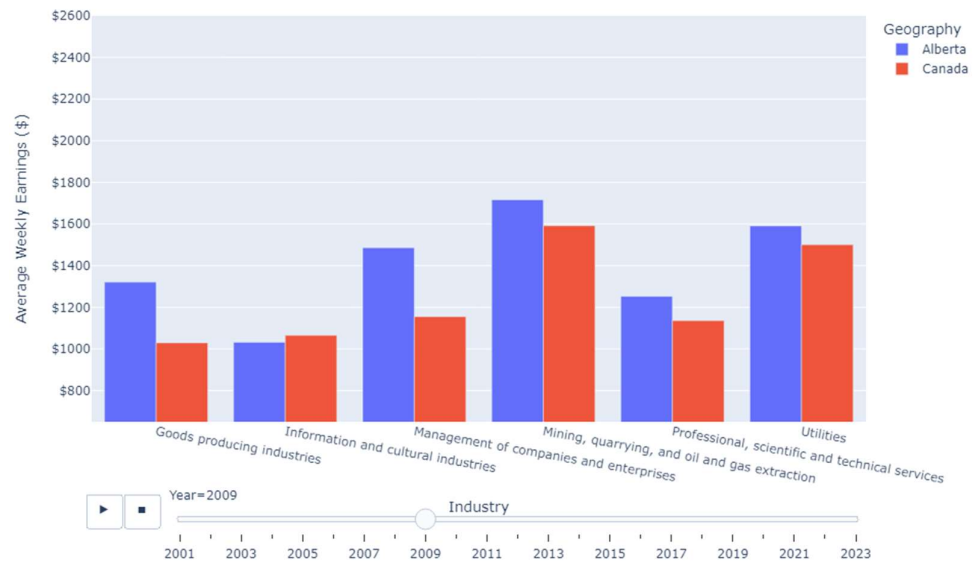


Figure 5.2: Comparison of top industries of Alberta with Canada – 2009

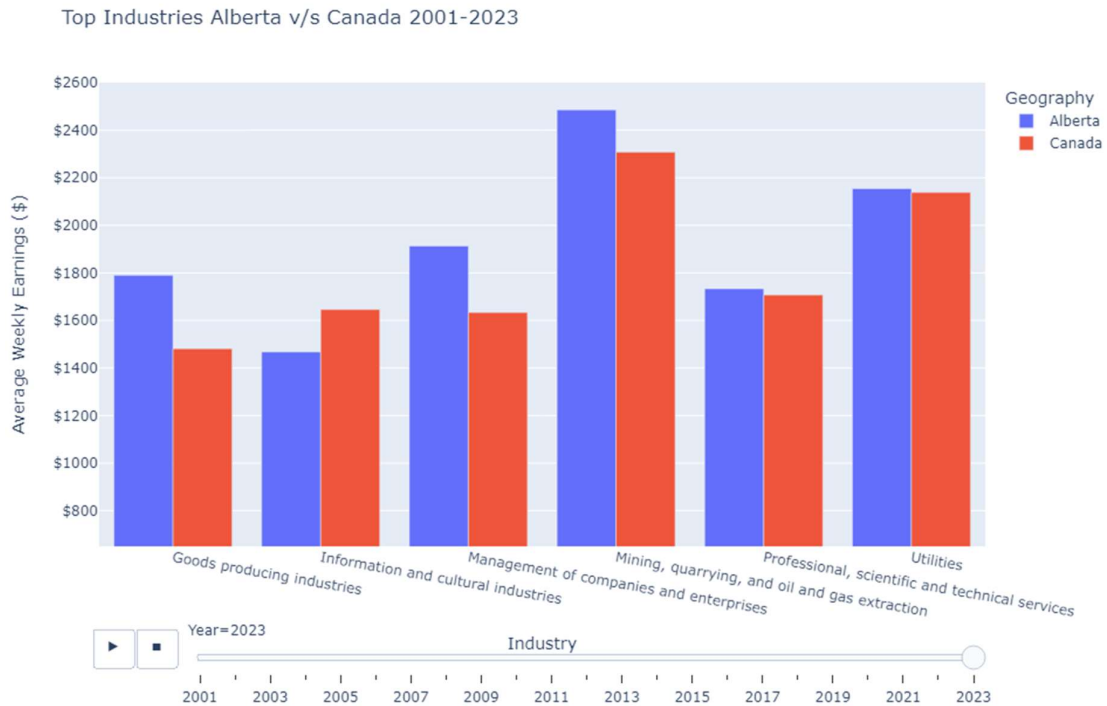


Figure 5.3: Comparison of top industries of Alberta with Canada - 2023

Several noteworthy observations emerge when we examine the three graphs [5.1, 5.2 & 5.3] above:

- **Goods Producing Industries:** Throughout the period, goods-producing industries in Alberta consistently offered higher wages than the rest of the country.
- **Dominance of Mining and Oil & Gas:** The 'Mining, quarrying, and oil and gas extraction' industry has been a cornerstone of Alberta's economy, consistently dominating this sector with higher earnings compared to the national average.
- **Overall Industry Performance:** Apart from mining and oil & gas, other industries in Alberta have performed on par with the national average, showcasing a well-rounded economic landscape.
- **Utilities Sector:** Interestingly, the utilities sector in Alberta initially paid less than the rest of the country. However, by 2023, Alberta's utilities industry had surpassed the national average in terms of earnings.

Guiding Question 6: Are earnings prone to economic shocks?

This guiding question centers on an examination of the impact of economic shocks on earnings, including overtime wages, within the timeframe spanning 2001 to 2023. Two major economic crises have been identified as pivotal within this period:

- The 2008 Financial Crisis.
- The 2019 Pandemic [COVID outbreak]

These economic occurrences are regarded as economic shocks. The research entails conducting visualizations to emphasize the performance during these specified periods and, subsequently, drawing inferences based on the observed data.

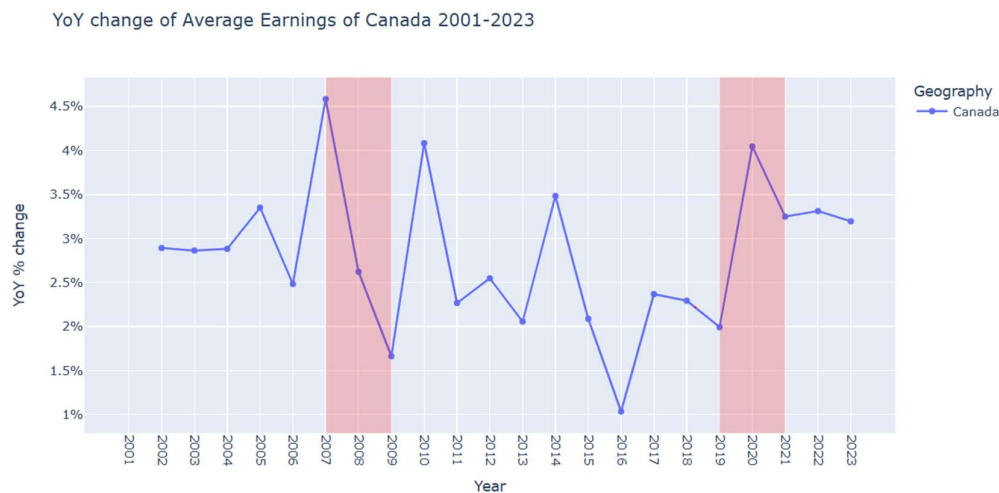


Figure 6.1: Year on Year change of Average Earnings of Canada 2001-2023

Figure 6.1 illustrates the year-on-year percentage change in average earnings across Canada. Within this figure, the highlighted red regions correspond to the duration of economic crises. Specifically, from 2007 to 2009, it represents the impact of the 2008 financial crisis. Notably, this period reflects a surge in average wages from 2006 to 2007, followed by a sharp decline, which persisted until 2009. After 2009, a sudden raise is evident, marking the recovery phase from the financial crisis. Transitioning to the more recent COVID-19 crisis, the graph indicates an increase from 2019 to 2020. However, as the COVID-19 restrictions extended well into the subsequent year, there was a decline in average earnings observed in 2021. A comparative analysis of these two crises reveals that the 2008 financial crisis exerted a more pronounced

impact on the nation's earnings when contrasted with the COVID-19 crisis, which Canada managed relatively effectively.

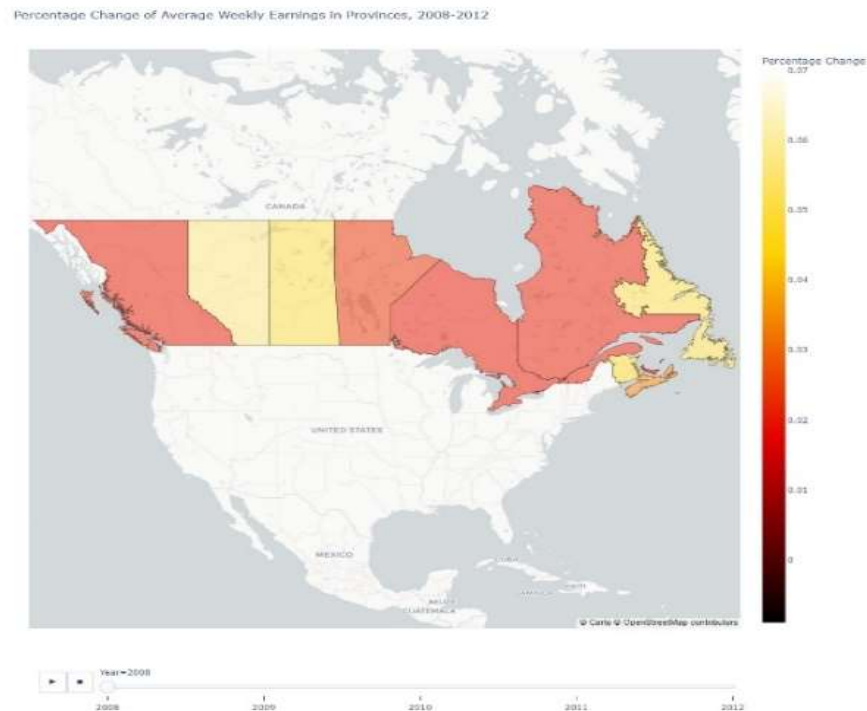


Figure 6.2 Percentage change of average weekly earnings across provinces for the year 2008

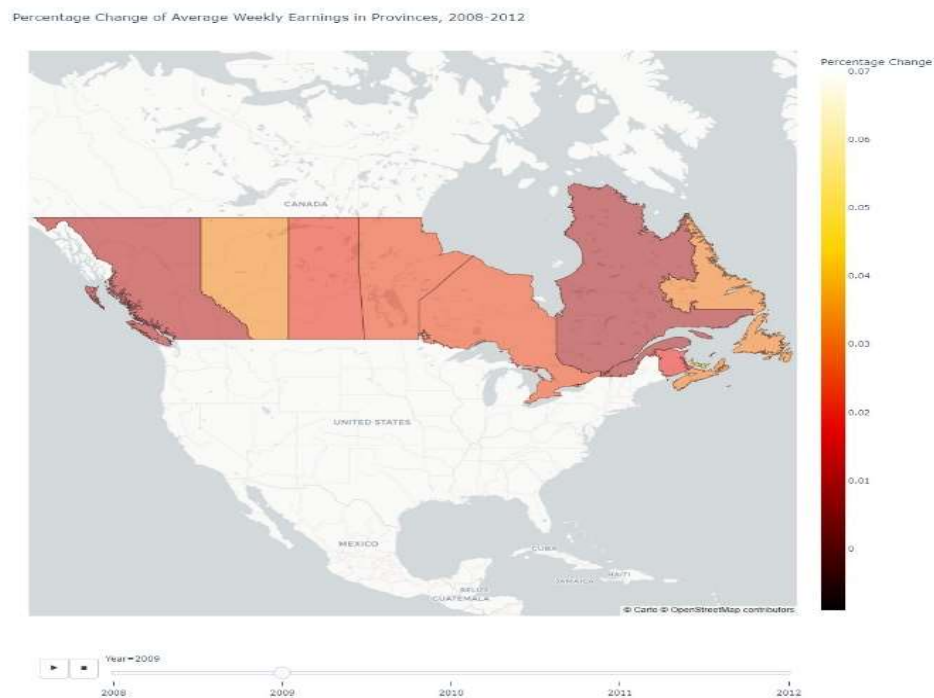


Figure 6.3 Percentage change of average weekly earnings across provinces for the year 2009.

Due to substantial decline during the 2008 financial crisis, a more detailed examination was conducted across the provinces, as depicted in Figures 6.2 and 6.3. Figure 6.2 illustrates a relatively modest decrease, primarily limited to specific provinces. In contrast, Figure 6.3 reveals a substantial drop in the percentage change of average earnings across all provinces. This graphical representation is dynamic, with values changing over the years in sequence. Notably, post-2009, there is a marked increase in the percentage change, represented by the prevalence of yellow shades across the provinces, denoting recovery phase.

Guiding Question 7: How have the top performing industries performed during economic crisis?

The identification of the top-performing industries in Canada was derived from a comprehensive industry-wise analysis made. These sectors, deemed as the premier performers, encompassed Mining, Quarrying, and Oil and Gas Extraction, Utilities, Management of Companies and Enterprises, and Professional, Scientific, and Technical Services. The visualisation made for the earnings made from these top industries during the economic shocks.



Figure 7.1: Year on Year change of Average weekly earnings of top industries – 2008 Financial crisis

Figure 7.1 presents the year-on-year percentage change in earnings derived from the highest-performing industries during the 2008 financial crisis. This graphical representation illuminates a trend where, in the period from 2007 to 2008, even the top industries experienced a decline.

However, it is noteworthy that these industries rebounded markedly, nearly to the same extent as their prior dip.

Fascinatingly, the mining sector, which held the position of the topmost industry, remained consistently in a downturn until 2009. Subsequently, there was a great upswing, elevating mining to an exceptional position. Meanwhile, other top-performing industries found themselves trailing behind mining, experiencing a longer recovery.

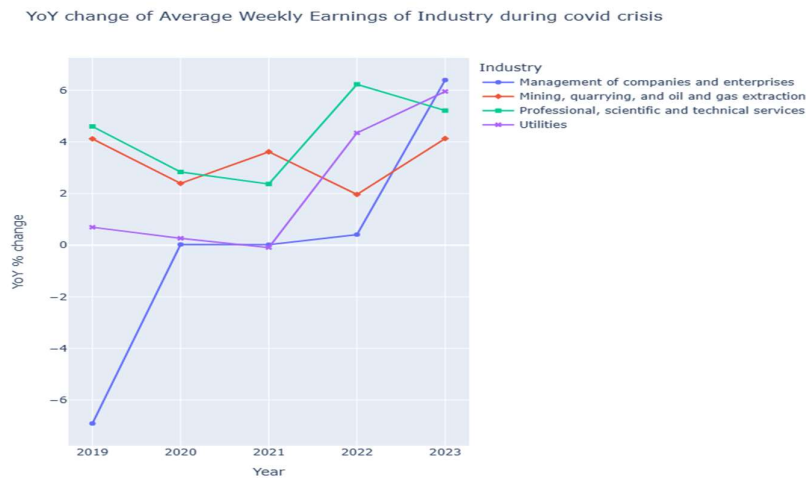


Figure 7.2: Year on Year change of average weekly earnings of top industries – 2019 Pandemic

Figure 7.2 presents the year-on-year percentage change in earnings derived from the highest-performing industries during the 2019 Pandemic. This graphical representation illuminates a trend where, in the period from 2019 to 2020, even the top industries experienced a decline. Conversely, the sector of Management of Companies and Enterprises exhibited a notable shift from the negative quadrant to the positive segment of the graph. Following 2020, both the Utilities sector and the Professional, Scientific, and Technical Services sector demonstrated a decline, whereas the remaining industries experienced an upward trajectory. This phenomenon can be attributed to the fact that the lockdown measures had a comparatively more substantial impact on these specific sectors than on the other top-performing industries.

CONCLUSION

When considering Canada as a whole, the average weekly earnings have displayed a consistent upward trajectory over the period under scrutiny.

Specific provinces and industries have demonstrated varying rates of growth. Upon delving into the provincial analysis, Alberta emerges as a high-wage province in Canada, boasting a diverse economic landscape characterized by significant contributions from various industries. The province's unique economic profile is occupied by the presence of the mining and oil & gas sector, which continues to play a vital role in its economic strength.

Industry wise, the "Mining, Oil, and Gas Extraction" and "Utilities" sectors have consistently maintained their positions as the leading contributors to economic prosperity. This is especially true for provinces like Alberta and British Columbia. Additionally, other industries such as "Management of Companies," "Scientific and Technical Services," "Finance and Insurance," and "Cultural Industries" have intermittently held the top spot in different provinces, with trends that have displayed variations over time.

During economic crisis, there have been fluctuations, often followed by recovery phases. The 2008 financial crisis left a lasting impact. However, it is reassuring to observe that even the top-performing industries, though challenged during economic downturns, have managed to rebound, resulting in an overall consistent growth trajectory.

The analysis can be further enhanced by developing a time series prediction model to forecast the future average earnings of industries throughout Canada in the coming years which helps in better informed decision-making.

REFERENCES:

- [1] Lauren Bauer, Audrey Breitwieser, Ryan Nunn and Jay Shambaugh(2018). *Where Work Pays: How Does Where You Live Matter for Your Earnings?* [online] The Hamilton Project. Available at: <https://www.brookings.edu/articles/where-work-pays-how-does-where-you-live-matter-for-your-earnings/>
- [2] AvaTrade. (n.d.). Income and Wages as an Economic Indicator | Fridberg Direct. [online] Available at: <https://www.avatrade.ca/education/economic-indicators/fundamental-indicators/income-and-wages>.
- [3] Average Weekly Earnings (including overtime), Alberta - Open Government. (n.d.). <https://open.alberta.ca/opendata/average-weekly-earnings-including-overtime-alberta#detailed>.
- [4] open.alberta.ca. (n.d.). *Open Government*. [online] Available at: <https://open.alberta.ca/licence>.
- [5] Government of Canada, Statistics Canada. “North American Industry Classification System (NAICS) Canada 2017 Version 3.0,” August 17, 2018. <https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=1181553>.
- [6] “The Short-Term Economic Consequences of COVID-19: Occupation Tasks and Mental Health in Canada.” Accessed October 18, 2023. <https://www.iza.org/publications/dp/13254/the-short-term-economic-consequences-of-covid-19-occupation-tasks-and-mental-health-in-canada>.
- [7] S. (2023, October 11). *Minimum Wage by Province* | Retail Council of Canada. Retail Council of Canada. <https://www.retailcouncil.org/resources/quick-facts/minimum-wage-by-province/>
- [8] Mustard, Cameron A, Andrea Chambers, Christopher McLeod, Amber Bielecky, and Peter M Smith. “Comparison of Data Sources for the Surveillance of Work Injury.” *Occupational and Environmental Medicine* 69, no. 5 (May 2012): 317–24. <https://doi.org/10.1136/oemed-2011-100222>.
- [9] Stephen Gordon [2017]. Recession of 2008–09 in Canada from <https://www.thecanadianencyclopedia.ca/en/article/recession-of-200809-in-canada>. Accessed 1 Oct. 2023.)