

## **Inflation vs Median Income**

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EPPS 6356 Data Visualization Final Project

December 9th, 2022

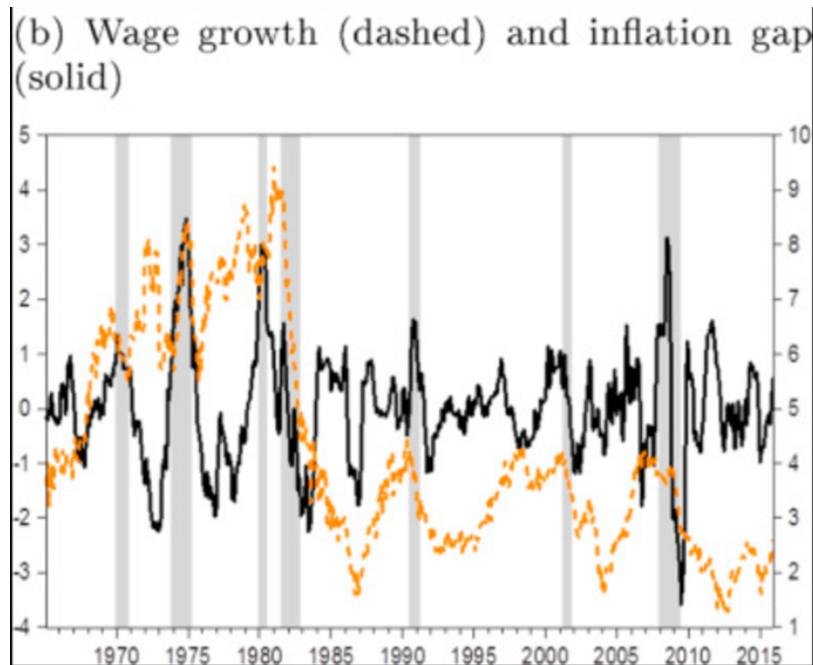
## **Abstract:**

This paper examines the relationship between median personal income per capita for each of the lower 48 states and national inflation rates from 1948 to 2021. R was utilized to visualize U.S. economic data obtained from the Federal Reserve Economic Data website (FRED). Our analysis showed a peak in inflation across the U.S. around the 1970s and 1980s, before broadly declining in the 1990s and deepening in 2021. Additionally, there was an observed increase in income inequality between states since the 1950s. We found that the variation in growth of real median personal income per capita between states decreased from 1960 to 2021.

## **Introduction:**

From the mid-1960s to early 1980s, wage growth in the U.S. remained higher than inflation during the same period (Donayre and Panovska 2018). However, after that time period the trend reversed and inflation overtook nominal income growth. Below is a graphic depiction of Donayre and Panovska paper showing the wage growth and the inflation gap, calculated as actual GDP less potential full-employment GDP, from 1965 to 2016. The shaded areas on the graphic below are the representation of the NBER-Dated recession (National Bureau of Economic Research - Business Cycle Dating Committee - the official recession scorekeeper) that defines the recession as a “significant decline in economic activity that is spread across the economy and that lasts more than a few months.” This paper was the closest we found related to our own

research on inflation vs. per capita income where Donayre and Panovska also used FRED data for their analysis.



(source: <https://www.sciencedirect.com.libproxy.utdallas.edu/science/article/pii/S0264999317305400>)

The average hourly wage grew from \$30.76 to \$32.36 from 2021 to 2022, an increase of 5.2%. However, when considering inflation, Americans experienced a 12-month pay cut of \$0.31 per hour (Wile 2022). High inflation rates are undermining American's purchasing power, and Americans are spending an estimated \$460.00 more in September 2022 than their usual monthly expenses for the same goods and services compared to 2020 numbers (Wile 2022).

Currently, as a cursory examination of data on the Consumer Price Index shows, there has been a drastic increase in the prices of shelter, food, and medical care over the past several decades, and an even sharper increase in recent months; hitting 8.3%

in August, not seasonally adjusted (U.S. Bureau of Labor Statistics 2022). In June of this year-2022, inflation hit a 40-year high of 9.1% (Associated Press 2022).

Consumers are feeling less capable of maintaining the same living standards as income growth falls behind inflation for the past several years, including 2022. This economic condition sparked in us the curiosity to look at the data in U.S. states and examine if each state in the nation is experiencing the same situation. The purpose of our project is to examine the differences in income and inflation between states.

Our research question therefore is: Have median incomes in each U.S. state kept up with the national inflation rate on a yearly basis? The goal for this data visualization project is to help the U.S. population be better informed about the economic circumstances of their state. By comparing median income growth for each state to the national inflation rate for the period of 1948 to 2021, we can visualize where in the United States income growth is rising faster or slower than price growth for each year.

We understand that there are several factors affecting the relationship between inflation rates and wage growth in different ways for each state. However, for this research we will not dive into all of the possible differences such as industrialization, political leanings, or others.

## **Literature Review:**

Integral to the discussion presented here is an understanding of the concepts of nominal prices and real value. Nominal price refers to the amount of currency a good or service is valued at in a given time period, while real value is a representation of the underlying value of a good by controlling for the change in purchasing power of the currency (Rutherford 2013).

Inflation is the growth in nominal prices of goods and services in an economy, or alternatively, the decrease in the real value of a currency. Income growth can be measured in terms of nominal prices or real wages.

A popular theory on potential contributors to inflation are the concepts of “cost-push or demand-pull”. Cost-push inflation occurs when the cumulative supply of goods and services declines because of the increase in the cost of production. The Demand-pull inflation occurs when the cumulative demand of households, business, government and foreign buyers increases (Hall 2022).

Donayre and Panovska (2018) considered the performance of wage growth, the effects of unemployment and inflation rates, and concluded that several situations affect wage growth such as labor market slack combined with periods of expansions with low inflation. They also found that the effect of inflationary shock on wage growth was small but statistically significant when the economy was expanding with a low inflation gap, but the effect of the inflation gap was insignificant during a mild recession.

Li and Born (2006) focused on the presidential elections and how it can affect the markets before and after the elections. One of our class colleagues asked us if we were

going to analyze our data for each U.S. state by looking if the state was Republican-controlled or Democrat-controlled. We chose the topic of our analysis to have a tighter focus on only economic factors, but to include a comment on this topic, we reviewed Li and Born's article and how the market behaves before and after presidential elections. They found Republicans are not as in favor of sparking inflationary demands compared to Democrats. They also recorded evidence that political uncertainty was noted by and priced into the equity market.

According to the Census Bureau, median incomes in 2021 have largely remained unchanged compared to 2020. Yet inflation rose by 4.7%, the highest since 1990. With many households feeling the effects of rising prices, it's probable that 2022 will be a high inflation year when the next report comes out. While the effects of inflation are clear, the severity is not. According to recent budget estimates from the Penn Wharton Budget Model, increases in earnings largely outpaced inflation for the middle class, and can be attributed to the increased job mobility many households experienced and the extended unemployment benefits from the Federal Government.

The survey data gives us a different story. According to the latest Gallup poll data, inflation is now causing financial hardship for 56% of Americans - up from 49% in January and 45% last November, with 74% of lower-income Americans saying that inflation was causing hardship for them in August (Qones 2022). While there may be a sampling bias, we know rising prices for inflation tends to hurt the lower class more, and for households that did not experience any change in job mobility.

## **Data Selection:**

When searching for data to accurately track inflation rates and wage growth in the United States over time, we were met with a variety of different possible datasets to use. Our options included many different federal and individual state government databases. After digging deeper into our options, we realized that using many different data sources from 50 states would cause difficulties in matching data collection methods, dates, and keeping consistent data quality. We decided it would be best to find one data source that could supply wage and inflation information for all states. We focused our search on Federal Reserve Economic Data (FRED), a database maintained by the Research division of the Federal Bank of St. Louis.

One of the struggles of the data collection was finding a measure that existed for all states and was not already adjusted for inflation, as it would disrupt our ability to compare inflation to income growth. The datasets we selected were five different measures of national inflation, per capita personal income (PCPI) for each state, and per capita personal income for the most populous metropolitan statistical area in 49 states (excluding New Jersey, as its most populous metro is shared with New York). All income data is annual, not seasonally adjusted, and in nominal dollars. Personal income data for most states began in 1929, except Alaska and Hawaii, which extended back to 1950, and Kentucky and Missouri, which only go back to 2010. We decided to use as many years of data as possible and accept the presence of the null values in the final product. Although we collected the data for metropolitan statistical areas, due to time constraints, we were not able to implement any visualizations that used it.

The inflation measures are: Consumer Price Index: Total All Items for the United States, Sticky Price Consumer Price Index less Food and Energy, Consumer Price Index for All Urban Consumers: All Items Less Food and Energy in U.S. City Average, Personal Consumption Expenditures: Chain-type Price Index, and Consumer Price Index for All Urban Consumers: All Items in U.S. City Average. Among these, the CPI for All Urban Consumers: All Items had the most data with the series beginning in 1948, and the data series with the least observations was the Sticky CPI Less Food and Energy for the U.S., beginning in 1968. All series stopped in 2021. Between the different inflation measures, the one chosen for the visualization was the CPI for all items, as we felt it better reflected what we could expect based on our understanding of inflation and the available data and covered a broader base than the data based on urban consumers. The original intended use for the CPI data for urban consumers was for a separate analysis conducted on the metropolitan areas, which was cut for time.

1948-01-01	1221	1783	1532	1816	1240
1949-01-01	1319	1738	1498	1800	1246
1950-01-01	1392	1868	1685	1947	1351
1951-01-01	1524	2020	1857	2166	1440
1952-01-01	1606	2075	1944	2303	1539
1953-01-01	1641	2160	1994	2345	1636
1954-01-01	1681	2190	1973	2323	1628
1955-01-01	1752	2310	2116	2478	1743
1956-01-01	1837	2432	2241	2597	1870
1957-01-01	1913	2542	2350	2683	1915
1958-01-01	1934	2608	2362	2705	1967
1959-01-01	2013	2750	2468	2847	2091
1960-01-01	2020	2847	2548	2931	2105
1961-01-01	2092	2936	2647	2986	2130
1962-01-01	2147	3055	2773	3110	2209
1963-01-01	2219	3160	2845	3211	2299
1964-01-01	2354	3351	2980	3383	2449
1965-01-01	2507	3531	3148	3531	2599
1966-01-01	2713	3768	3369	3784	2781
1967-01-01	2934	4044	3622	4001	3007
1968-01-01	3203	4435	3938	4334	3355
1969-01-01	3493	4619	4255	4676	3765
1970-01-01	3782	4920	4552	4965	4131
1971-01-01	4007	5234	4834	5209	4433
1972-01-01	4352	5603	5203	5652	4860
1973-01-01	4835	6022	5632	6123	5371
1974-01-01	5342	6533	6090	6731	5757
1975-01-01	5947	7066	6560	7320	6107
1976-01-01	6528	7510	7078	7975	6557
1977-01-01	7124	8158	7712	8681	7182
1978-01-01	8023	8949	8522	9661	8064
1979-01-01	8978	9831	9481	10758	8939
1980-01-01	9983	11001	10684	11945	10145
1981-01-01	11413	12277	11873	13158	11354
1982-01-01	12102	13327	13013	13793	11942
1983-01-01	12575	14286	14044	14582	12846
1984-01-01	13546	15749	15739	15895	13939
1985-01-01	14353	16815	16893	16795	14829
1986-01-01	14427	17915	18152	17588	15610
1987-01-01	14653	19064	19552	18482	16436
1988-01-01	15494	20827	21358	19605	17601
1989-01-01	16417	22461	22477	20561	19081
1990-01-01	17455	23990	23118	21485	19763
1991-01-01	17897	23868	23486	21857	20073

(This is a sample of per capita personal income for the states, showing data from 1948 to 1991.)

The data was collected by downloading it from the FRED website as a series of Excel files, then Excel was used to calculate the percent year-over-year change in the personal income data, and the files were converted to CSV and hosted in the coordinator's GitHub repository. All further data manipulation was performed in R, including dropping observations from the dataset and the calculation of additional variables.

The screenshot shows the RStudio interface. At the top, there is a toolbar with various icons. Below the toolbar is a tab bar containing several tabs: Untitled1\*, HIPCPI(notdone).R, msadf, myarrow, usdf, statesmapdf, NYPCPI, TXPCPI, MAPCPI, CAPCPI, df. The main area displays a data frame with columns: observation\_date, CPALTT01USM657N, CORESTICKM159SFRBATL, CPIFESL\_PCH, PCEPI\_PCH, CPIAUCSL\_PCH. The data consists of 68 rows of historical data from 2000 to 2014. Below the data frame, a message says "Showing 53 to 69 of 74 entries, 6 total columns". At the bottom, the R console shows the following text:

```
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> # state personal income data
> statedf <- read.csv("https://raw.githubusercontent.com/kyn dall-brown/homeworkcode/main/inflationdata/per-capita-personal-income-states.csv")
> |
```

(data “USDF” represents national inflation, sticky CPI, CPI for urban areas, and personal consumption expenditures in one data frame.)

The screenshot shows the RStudio interface with the 'msadf' data frame loaded. The data consists of 53 rows and 12 columns. The columns are labeled: observation\_date, HUN7601PCPI, ANCH202PCPI, PHOE004PCPI, LRSPCPI, LALBA906PCPI, DENV708PCPI, BRID909PCPI, PHIL942PCPI, JACK212PCPI, ATLA013PCPI, and UHON915. The data starts at 1969 and ends at 1984. The 'observation\_date' column contains dates like '1/1/1969' and '1/1/1984'. The other columns contain numerical values representing personal income per capita.

(“MSADF”- Metropolitan statistical area personal income per capita starts from 1969, we can see it accrued from first year)

The data has its limitations. The Per Capita Personal Income data for the states is published by the Regional Income Division of the U.S. Bureau of Economic Analysis (BEA). The series is calculated from two components, income and population; income includes wages, proprietors' income, dividends, interest, rent, and government benefits and is based on the residence of the person and not where the income was earned, while the population data is either provided by or derived from the Census. According to the BEA, for the years between each Census, the BEA estimated intercensal annual state population statistics based on the Census values, as the Census does not provide official intercensal data at the time of this publication. More importantly, the inflation data we used was the value for the entire U.S. and not by state. We selected this because we

struggled to find inflation data that was also for each state. The greatest limitation this imposed is that the regional variations in personal income less inflation may be less visually distinct, and some states with inflation rates far different from the national average will not appear properly in the animations. We still decided to proceed with the project because we felt that the resulting output would still be informative for our audience.

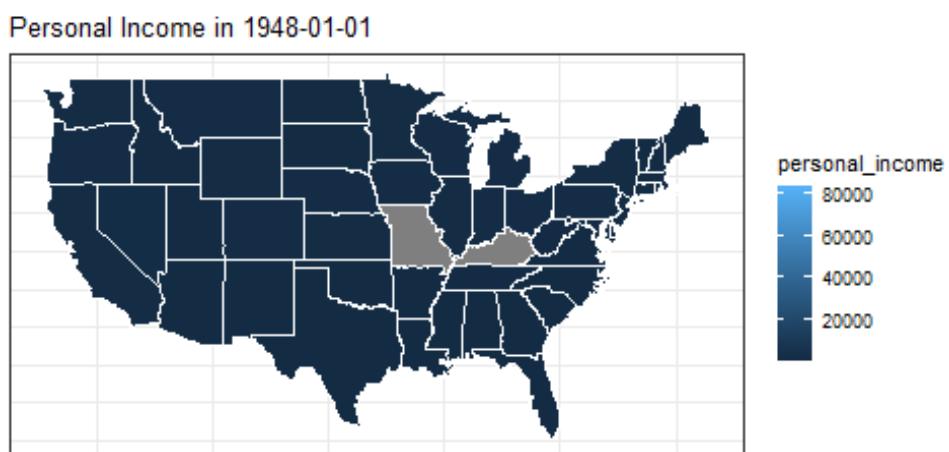
### **Data Methods:**

RStudio was used to create all visualizations in this report. The ggplot2 package was used to produce the plots, while the ganimate package and gifski package were used to animate them. The “lubridate” package was used to allow for easier managing of data that contains dates and times. The “transformr” package was used in conjunction with the “maps” and “mapdata” packages to work with animated spatial data by matching shapes between states, and ensuring that each pair of matched shapes contains the same number of paired anchor points to avoid rotation and inversion during animation. For the color palette of our visualizations, the “RColorBrewer” package was used.

We created three animated U.S. cartograms by showing each state with different colors; for the graph of personal income, we used a palette ranging from dark to light green, warm colors representing inflation outstripping personal income growth for each state and cool colors representing income growth outperforming inflation. The values and hues of the colors represented the difference, with the

darkest shades representing the greatest difference between inflation and income growth, and white representing being exactly equal. That means, the darker the color, the more extreme the difference. The colors of the states changed according to the year of observation.

Parts of the visualization process were challenging; we faced issues with some of the packages not working as intended and were forced to improvise. In particular, “ganimate” performed well when making line graphs of state income, but had issues when creating the cartogram of the U.S. The package was not accepting any functions to change the color scale of the plot, and would only accept the default blue scale or viridis. The resolution of the output was also lower than what we were looking for, the function was not accepting the argument to change the title of the legend, and the plot included large margins of white space. Pictured below is the output of the “ganimate” package when creating the cartogram for personal income in nominal dollars.



To circumvent this issue, we had to substitute “gganimate” for another package that could animate the graphs. We narrowed down the options to “gifski” and “ffmpeg”, but ultimately we used Gifski because it was easier to install and had more support in the R ecosystem. Gifski is an open-source library and free downloadable application for converting png files into gifs, using thousands of colors per frame. We originally used it to improve the output of the “gganimate” package, but used a function from “gifski” to animate the map instead. Gifski contains a function that accepts as an argument any function that produces images, so we created a function to iterate through a given range of years and produce the animated cartograms. The benefit of “gganimate” that we could not utilize was the process of tweening, where “gganimate” automatically creates in-between frames of the dataset between each year to blend the animation more seamlessly. But the benefit of Gifski was a truly high-quality animation in high-resolution that did not distort the colors of the maps and interfere with the readability of our visualizations.

There are many packages in R to help a researcher quickly and effectively create a basic map of the U.S., but often these packages have the downside of not allowing great control over the customization of the graphs. Not only did we want to stand out, but we pivoted away from “gganimate” and wanted to experiment with different packages for rendering the final gif. Below is the code that generated the maps of personal income against inflation, though the function was altered slightly to produce all three animations. The end of the function contains two arguments we alternated between, one to save each plot for each year into a new directory, and another to feed the frames into Gifski and animate them:

```

162 ##### set your working directory now!
163 setwd()
164 ani_map <- function() {
165   for (i in 1960:2021) {
166     g <- ggplot(data = animate_mapdf %>% filter(observation_date == i),
167       aes(x = long,
168           y = lat,
169           group = group)) +
170     geom_polygon(aes(fill = diff2),
171                   color = 'white',
172                   size = 0.25) +
173     theme_linedraw() +
174     #colors of Spectral palette n=11 colors
175     scale_fill_gradientn(colors = c("#5E4FA2", "#3288BD", "#66C2A5",
176                           "#ABDDA4", "#E6F598", "#FFFFFF",
177                           "#FEE08B", "#FDAE61", "#F46D43",
178                           "#D53E4F", "#9E0142"),
179     values = c(1.0, 11/12, 10/12, 9/12, 8/12,
180               7/12, 6/12, 5/12, 4/12, 3/12,
181               2/12, 1/12, 0),
182     breaks = c(105, 0, -105),
183     limits = c(-105, 105)) +
184     theme(plot.title=element_text(size=14,
185                                   hjust = 0.5, vjust = 2),
186       axis.title = element_blank(),
187       axis.ticks = element_blank(),
188       axis.text = element_blank(),
189       panel.grid = element_line(color = 'lightskyblue'),
190       legend.title = element_blank(),
191       legend.justification = c(0.8, 0.6),

```

```

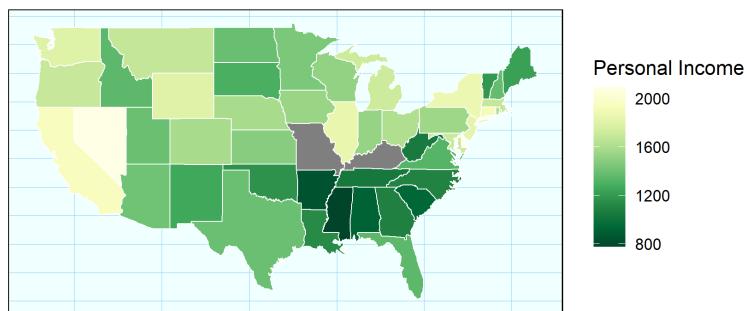
192       panel.background = element_rect(fill = 'azure',
193                                         color = 'white'),
194       plot.margin = unit(c(1,1,1,1), 'cm')) +
195     coord_fixed(1.3) +
196     ggtitle(paste0("Personal Income Growth Less Inflation in ", i, ", %"))
197     ggsave(paste0("frame", i, ".png"), device = 'png',
198             path = 'infl-vs-inc-2', width = 8,
199             height = 4.5, units = 'in')
200   #print(g)
201   # if (i == 2021) {
202   #   for (j in 1:20) {
203   #     print(g)
204   #   }
205   # }
206   #
207   }
208   }
209   # turning the still images into a gif! using gifsicle
210 save_gif(expr = ani_map(),
211           gif_file = "infl-vs-inc-2.gif",
212           width = 8*300, height = 4.5*300, res=300,
213           delay = 0.2, loop = TRUE, progress = FALSE)
214
215

```

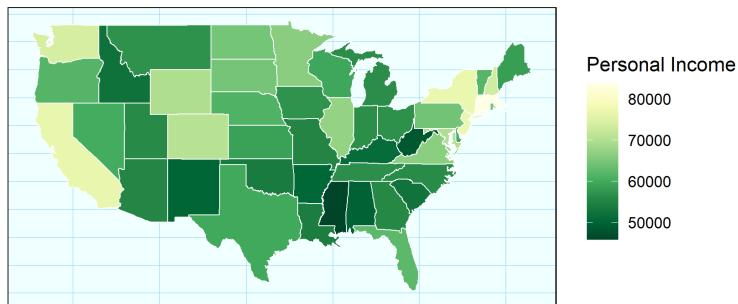
## Visual Analysis:

Below are two cartograms of personal income per capita for the contiguous 48 states in 1950 and 2021. Though the ranges of the data have changed, the focus of the analysis is on the change in color which represents each state's personal income per capita relative to the highest and lowest personal income per capita of that year.

Personal Income Per Capita in 1950



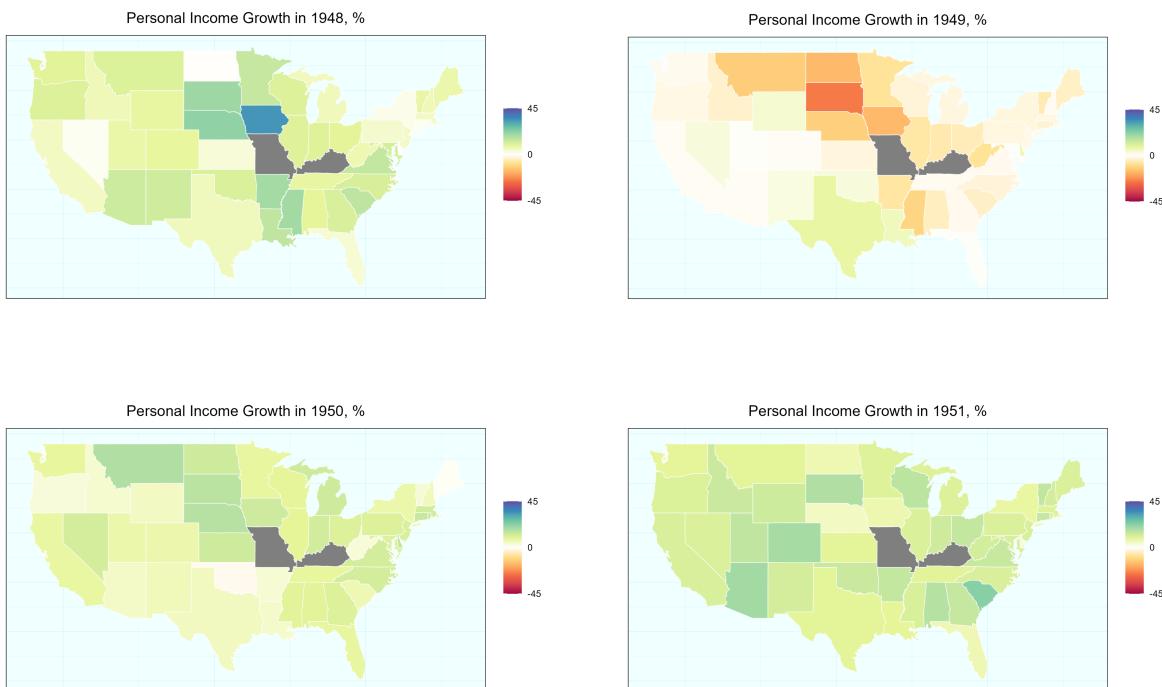
Personal Income Per Capita in 2021



In the 1950 graph, it has the same hotspots for high personal income that many people expect, like California, New York, and other states in the Northeast, but also shows Illinois and Michigan as areas of high personal income and most of middle America as a similar color of medium-dark green. But when we move on to examine the cartogram for 2021, we see the lightest colored states became brighter while the states in middle America became darker, and the decline of Illinois and Michigan

becomes apparent. The visualization shows that income inequality between the states has increased since 1950 and highlights how the decline of manufacturing jobs in the U.S. lowered the relative standard of living in the Rust Belt and Midwest.

Pictured below are a series of graphs for personal income growth in percent for the contiguous 48 states from 1948 to 2021. The orange and red hues represent a decline in income from the previous year, and the green and blues hues represent a positive annual growth. We noticed that there were large variations between states and between years for the period 1948 to 1951, but the variation between states was much lower in more recent years.



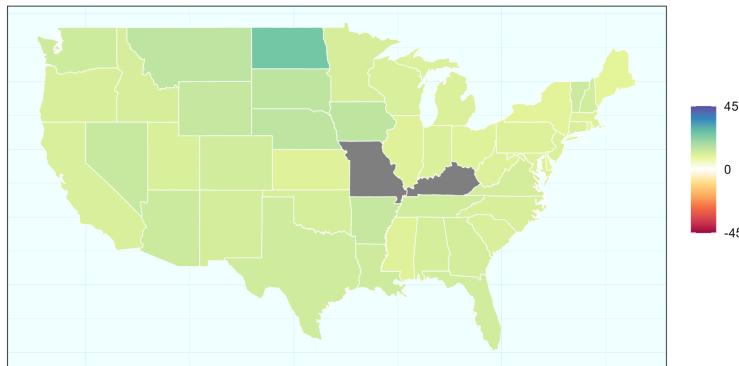
An interesting thing to note is the difference in personal income growth between Middle America and the coasts in the year 2016, the same year Donald Trump was

elected president. Worsening economic indicators are often included in election prediction models, and the timing of the downturn could have contributed to the

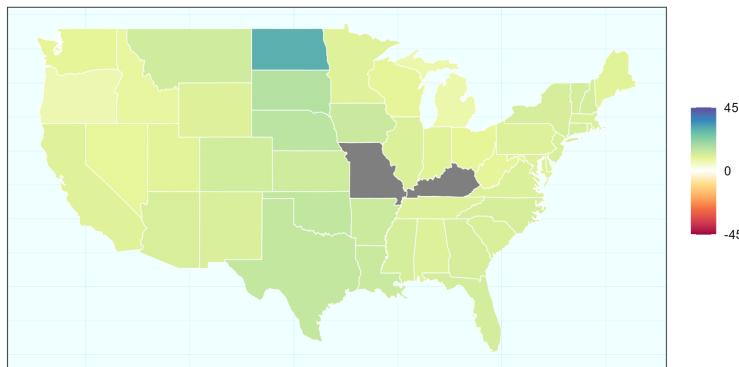


Below are the personal income growth graphs for 1978 and 1981, the peak years of the spike in inflation seen in the late 70's and early 80's. Without considering inflation, nominal per capita incomes rose during this time. This illustrates a concept known as the “wage-price spiral”, where elevated inflation causes workers to prioritize earning more wages and pressure is placed on institutions to increase the amounts of transfer payments, but the increased labor costs to businesses cause them to pass the increase on to consumers as higher prices.

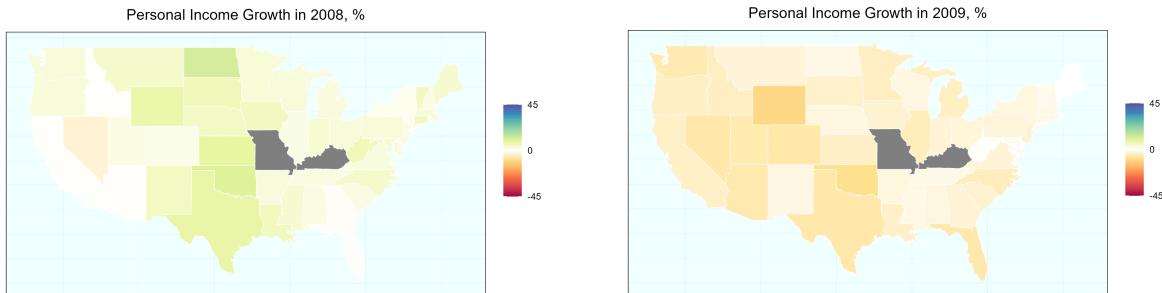
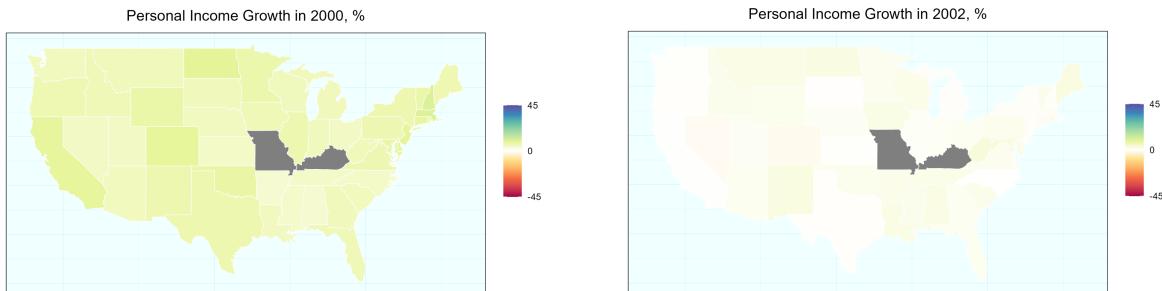
Personal Income Growth in 1978, %



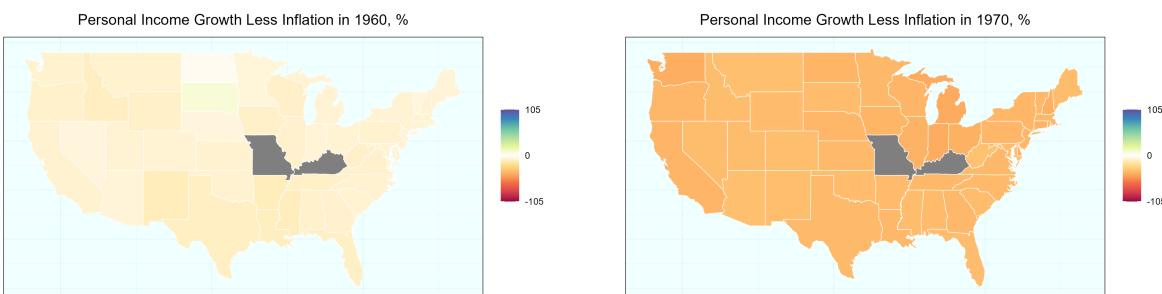
Personal Income Growth in 1981, %

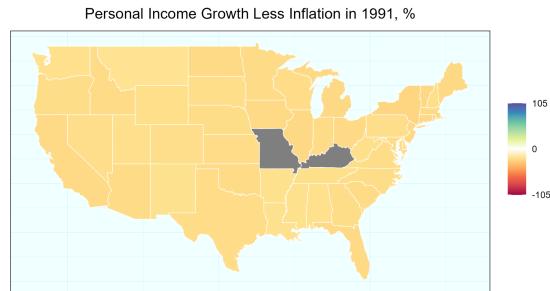
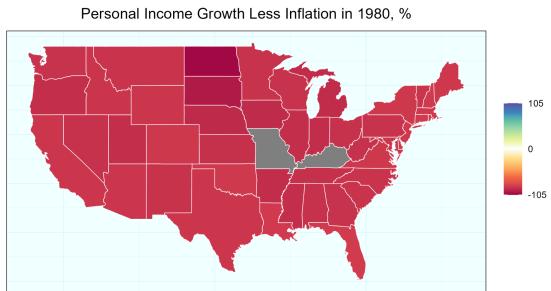


The animation also showed a sharp drop in personal income growth in the aftermath of 9/11 and the financial crisis of 2008. While only some states saw a contraction in personal income after 9/11, the declines were far larger in the Great Recession. We found this to be a useful visual for communicating the unusual severity of the Great Recession.



We created the final animation showing the difference between personal income per capita and inflation from 1960 to 2021 for a more complete picture. In almost every year, as expected, inflation outstripped the gains in personal income. The goal of the Federal Reserve is to maintain a 2% inflation target for the U.S. as a whole, but we did expect to find more regional diversity in the outcome than we did. Below are a selection of personal income and inflation graphs for each decade:





We can see the other side of the equation - the same late 70's to early 80's period that saw some above-trend gains in personal income also saw a dramatic increase in price growth that superseded income growth.

The animation frames pictured below also highlight the effects of the financial crisis in a different way, showing the heightened inflation in 2007 before the deceleration of inflation in 2008. Even after accounting for inflation, many states in the Midwest and South Central regions still saw a relative increase in their personal income, followed by the full extent of the crisis unfurling in 2009. Even though the map for 2009 looks similar to that of 2007, they are fundamentally different: in 2007, personal income growth and inflation were positive, while in 2009 personal income growth was already negative for most states before subtracting inflation.





Before we created the maps, we wanted to see how 50 states' per personal capita income have similar trends throughout years. We used ggplot2 in order to create animate line graph in which the x-axis labeled as income in dollars and y - axis is years from 1960. While we are putting up codes, there were also differences in year within states: some states recorded their income from the 1940s while other states' data started in the 1960s. The code below shows how you can select states in alphabetical order and we selected 9 states in order to see if they have a similar trend in increase of income capita. "Statemapdf" is a dataset with 50 states income per capita measures in which we also had trouble in first creating a heatmap because the labels for each state were not formal statename. We had to change its column names with states names in which after that, it was each to create a further process. (This is an example of income growth by state from 1948~2021.)

```

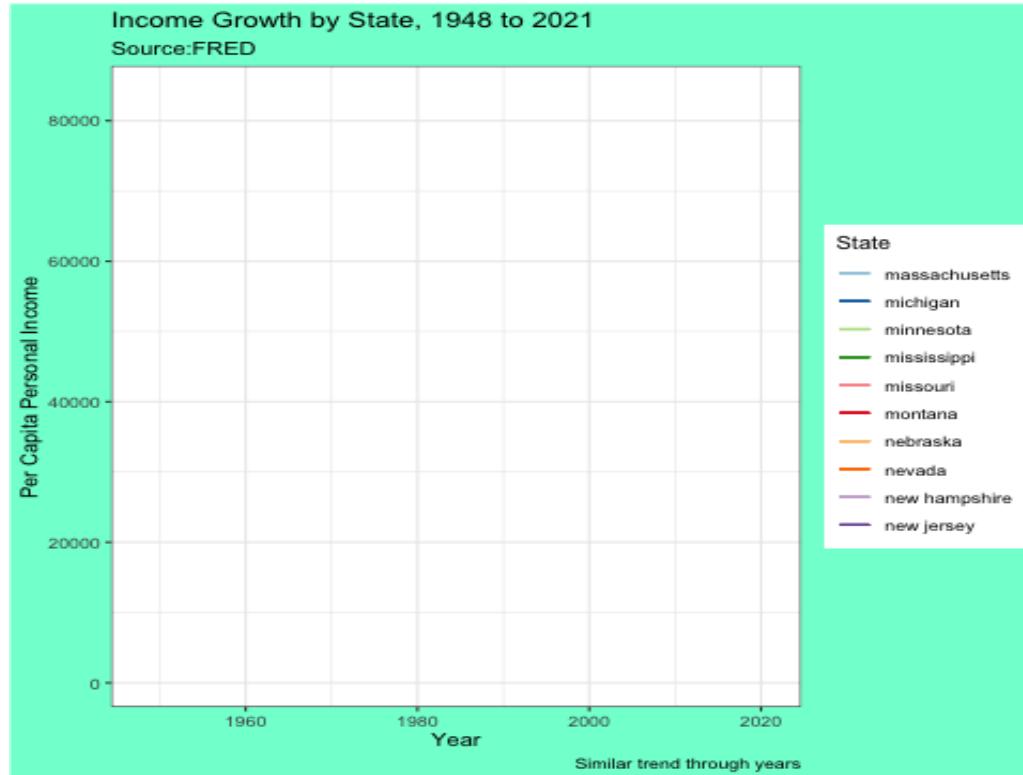
# bind them onto the bottom of statesmapdf
statesmapdf <- rbind(statesmapdf, tempdf)
}

p = ggplot()
for (i in 31:40) { # 1:10 plots the first 10 states
  p = p + geom_line(data = subset(statesmapdf,
    state_name == tolower(state.name)[i],
    select = c("observation_date",
    "state_name",
    "personal_income")),
  aes(x = observation_date,
    y = personal_income,
    color = state_name))
}
p <- p + scale_color_brewer(name="State",
  palette = "Paired") +
  xlab("Year") +
  ylab("Per Capita Personal Income") +
  ggtitle("Income Growth by State, 1948 to 2021") + theme_bw() +
  transition_reveal(observation_date) +
  labs(subtitle = "Source:FRED", caption = "Similar trend through years") +
  theme(plot.background = element_rect(fill = "lightcyan"))
p

#fonts
# install.packages("extrafont")
library(extrafont)

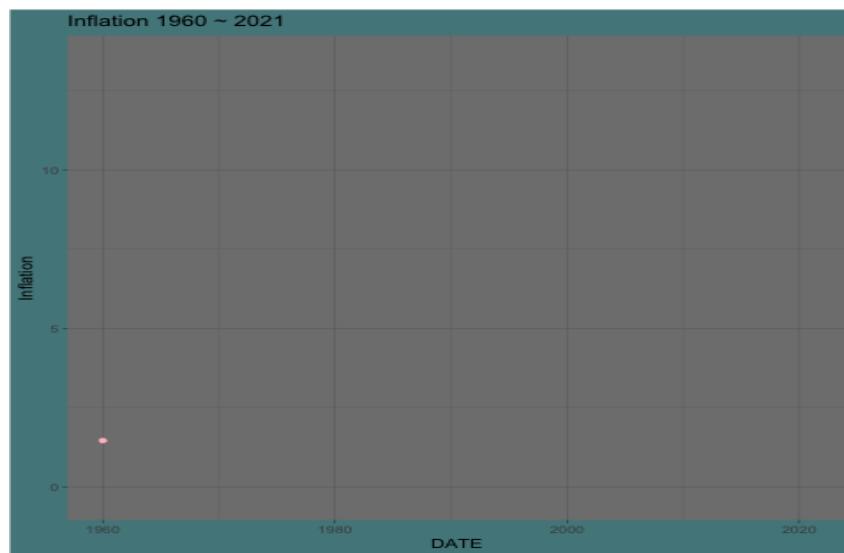
# Import all the .ttf files from your system
# You will only need to run this once, but it will take a few minutes to finish
font_import()

```





As we see in the above animated line graph, they were steady until they hit the year of 1980, and it shows a high increase of income. Also New Jersey was the top state within 9 states however, in the year of early 2000, Massachusetts started to outperform in which results, Massachusetts has the highest capita income.



As we compared these all 50 states, usually Northeast states turn out to have the highest personal incomes. One thing that we also noticed is that in North Dakota near the year of the late 2000s, North Dakota had outperformed New Jersey, New York, Pennsylvania and Rhode Island. There was also a downfall in per capita personal income in the late 2000s due to the 2008 financial crisis.

The graph pictured above shows inflation from 1960 through 2021, the y-axis represents the rate of inflation growth and the x-axis shows its year. There was a big peak at the year of 1980 and the growth of inflation after 1980 was similar to the start of 1960. Also looking at the year of 2008 financial crisis, its inflation growth in 2008 had decreased compared to previous years and after the year of 2008 early 2010, it started to show constant increase and decrease which by that means high frequency shows how national financial structures are not well stabilized.

## **Conclusion:**

As the nation's inflation rate continues to rise, the lagging personal income growth rates continue to be a major issue in American citizen's lives. To investigate this phenomenon, we set out to visualize the historical difference between the median income and inflation rate. We asked the question: Has personal income kept up with the national inflation rate? In order to answer our question, we went through various federal data sources to find a valid and reliable database. The Federal Reserve Economic Data website was a valuable resource that provided us with financial time series data for all 50 states regarding personal income and inflation rate.

In RStudio, we prepared the data through various intensive data cleaning techniques. After this, we were able to create high quality GIF animations of the U.S. Map that tracked the nation's inflation issue from the 1950s to the present day. Through these visualizations, we were able to see many interesting patterns that have transpired throughout the past seven decades. National inflation rate seemed to hit a peak in the 1980's. Income growth has shown to steadily increase since the 1950s. Income inequality between states has increased since the 1950s, as the highest personal incomes have concentrated to a few states. Personal income growth seemed to be greater in the late 70's and early 80's, then seems to broadly decline in the 90's. Real personal income seemed to be declining in the 70's and early 80's, despite nominal income being higher. However, around 2012, inflationary pressures seem to recede, as real wages decreased at a slower rate.

Through this research project, we have learned that median personal income has not kept up with the national inflation rate. To bridge the gap in our research and further expand on this project, more research should be done to examine other economic variables and how they might have influenced the spikes in inflation and personal income. The effects of inflation can also be further disambiguated in testing the impact of different inflation measures on income. Given that the category of food and energy have some of the most volatile price changes, the impact of Sticky CPI could have a different impact on wage growth. It would be interesting to examine different historical events that have occurred since the 1950s and relate their consequences to patterns we examined in our data.

In addition, an interesting expansion on our visualizations would be to graph the growth in personal income based on census regions instead of the individual states. This visualization could have shown different patterns on a smaller scale. For future implications on how the gap between personal income and inflation rates behaves, our research project serves as a great starting point to examine historical occurrences and provides a way to predict how the economy might react in the future to rising inflation rates.

### **Synergy Report:**

Ana Zysko performed research for the literature review, provided coding advice, and contributed to the Introduction, Literature Review, and References sections in the final paper. She worked on the proposal presentation, proposal paper, final presentation and final paper.

Michelle Kim created the animations for the line graphs of personal income growth for twenty states and change in inflation rate in the U.S., and contributed to the Data Selection and Visual Analysis portions of the final paper. She worked on the proposal paper, proposal presentation, final presentation, and final paper.

Leslie Malave contributed to the Abstract, Introduction, and the majority of the Conclusion section of the final paper. She worked on the proposal paper, proposal presentation, final presentation, and final paper.

Theophilus Chia contributed to the Conclusion section of the final paper. He worked on the proposal paper, proposal presentation, final presentation, and final paper.

Kyndall Brown was the coordinator of the group and contributed to the Introduction, Literature Review, Data Selection, Data Methods, Visual Analysis and Synergy Report sections of the final paper. They collected the data from the Federal Reserve Economic Data website and created the animation and still frames involving the map of the United States, including the cartograms depicting personal income per capita, growth in personal income per capita, and growth in personal income per capita less inflation. Kyndall worked on the proposal paper, proposal presentation, final presentation, and final paper.

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