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DIDA 370 Final Paper

Due: 5/8/2024

"*The 2008 Recession*" was categorized by tension in international financial markets, a loss of over 8.7 million jobs in the United States, and a depletion of 19 trillion dollars across US households (Weinberg)[3]. The escalation of the recession began in 2004 when banks and investors started giving out mortgage-backed securities, or MBSs. Because the increase in profits from these mortgages was profound, banks and investors relaxed the regulations on who could obtain an MBS. As a result, many people could not make their mortgage payments, and banks and investors lost a significant amount of money. This issue came to a head in December of 2007, which resulted in the United States entering the 2008 recession (Duggan)[2].

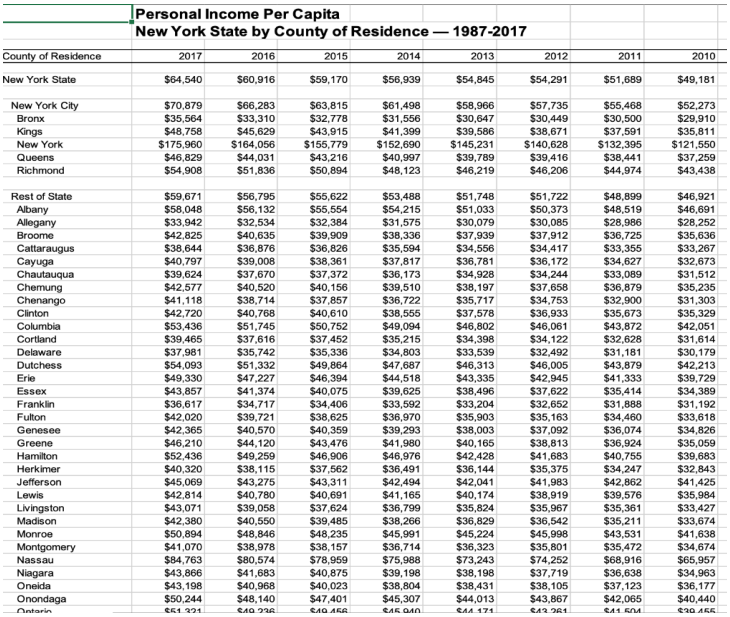
A consequence of the recession was a substantial decrease in the average income per capita in New York State (NYS). Compared to the average income per capita in New York State in 1988 and 2017, that of 2008 was atypical. Contrasting these three years allows for the analysis of how the Income Per Capita of NYS changed from 1988, 2008, and 2017.

Recent studies show that large, economic abnormalities affect marginalized communities the most. For example, the unemployment rate, caused by the 2008 recession, was greatest for African Americans and Hispanics (Logan and Weller)[1]. Many factors contribute to personal income, two of which may be race and population density. The economy of New York State was greatly affected by the 2008 recession and the economy's crash, however, demographic factors

like population density and race have recently proven to have a greater effect on the personal income of an individual living in New York State.

The dataset, "*C-14-Personal-Income-NYS-by-Cty-Residence*", taken from the SUNY Rockefeller Institute of Government website, was the primary dataset used in this analysis. The dataset was altered to remove dollar signs, commas, unneeded spaces, and text boxes, add a geometry column, and convert numeric strings to integers. See Figures 1 and 2 below;

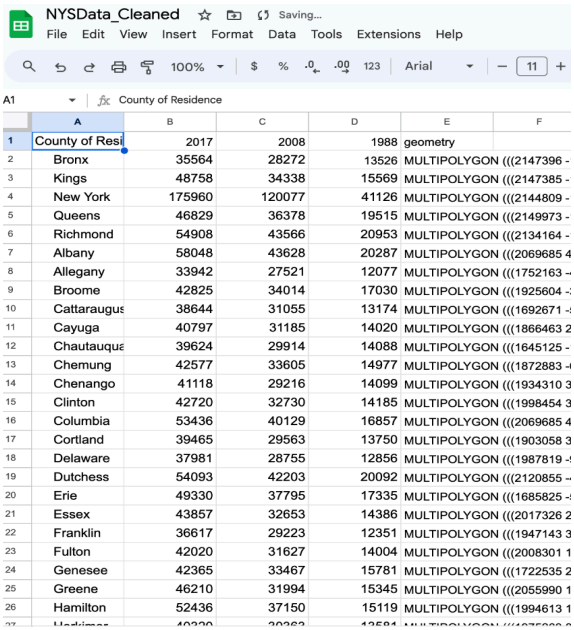
Figure 1: A Sample of the Primary Dataset, Prior to Cleaning



Personal Income Per Capita
New York State by County of Residence — 1987-2017

County of Residence	2017	2016	2015	2014	2013	2012	2011	2010
New York State	$64,540	$60,916	$59,170	$56,939	$54,845	$54,291	$51,689	$49,181
New York City	$70,879	$66,283	$63,815	$61,498	$58,966	$57,735	$55,468	$52,273
Bronx	$35,564	$33,310	$32,778	$31,556	$30,647	$30,449	$30,500	$29,910
Kings	$48,758	$45,629	$43,915	$41,399	$39,586	$38,671	$37,591	$35,811
New York	$175,960	$164,056	$155,779	$152,690	$145,231	$140,628	$132,395	$121,550
Queens	$46,829	$44,031	$43,216	$40,997	$39,789	$39,416	$38,441	$37,259
Richmond	$54,908	$51,836	$50,894	$48,123	$46,219	$46,206	$44,974	$43,438
Rest of State	$59,671	$56,795	$55,622	$53,488	$51,748	$51,722	$48,899	$46,921
Albany	$58,048	$56,132	$55,554	$54,215	$51,033	$50,373	$48,519	$46,691
Allegany	$33,942	$32,534	$32,384	$31,575	$30,079	$30,085	$28,986	$28,252
Broome	$42,825	$40,635	$39,909	$38,336	$37,939	$37,912	$36,725	$35,636
Cattaraugus	$38,644	$36,876	$36,826	$35,594	$34,556	$34,417	$33,355	$33,267
Cayuga	$40,797	$39,008	$38,361	$37,817	$36,781	$36,172	$34,627	$32,673
Chautauqua	$39,624	$37,670	$37,372	$36,173	$34,928	$34,244	$33,089	$31,512
Chemung	$42,577	$40,520	$40,156	$39,510	$38,197	$37,658	$36,879	$35,235
Chenango	$41,118	$38,714	$37,857	$36,722	$35,717	$34,753	$32,900	$31,303
Clinton	$42,720	$40,768	$40,610	$38,555	$37,578	$36,933	$35,673	$35,329
Columbia	$53,436	$51,745	$50,752	$49,094	$46,802	$46,061	$43,872	$42,051
Cortland	$39,465	$37,616	$37,452	$35,215	$34,398	$34,122	$32,628	$31,614
Delaware	$37,981	$35,742	$35,336	$34,803	$33,539	$32,492	$31,181	$30,179
Dutchess	$54,093	$51,332	$49,864	$47,687	$46,313	$46,005	$43,879	$42,213
Erie	$49,330	$47,227	$46,394	$44,518	$43,335	$42,945	$41,333	$39,729
Essex	$43,857	$41,374	$40,075	$39,625	$38,496	$37,622	$35,414	$34,389
Franklin	$36,617	$34,717	$34,406	$33,592	$33,204	$32,652	$31,888	$31,192
Fulton	$42,020	$39,721	$38,625	$36,970	$35,903	$35,163	$34,460	$33,618
Genesee	$42,365	$40,570	$40,359	$39,293	$38,003	$37,092	$36,074	$34,826
Greene	$46,210	$44,120	$43,476	$41,980	$40,165	$38,813	$36,924	$35,059
Hamilton	$52,436	$49,259	$46,906	$46,976	$42,428	$41,683	$40,755	$39,683
Herkimer	$40,320	$38,115	$37,562	$36,491	$36,144	$35,375	$34,247	$32,843
Jefferson	$45,069	$43,275	$43,311	$42,494	$42,041	$41,983	$42,862	$41,425
Lewis	$42,814	$40,780	$40,691	$41,165	$40,174	$38,919	$39,576	$35,984
Livingston	$43,071	$39,058	$37,624	$36,799	$35,824	$35,967	$35,361	$33,427
Madison	$42,380	$40,550	$39,485	$38,266	$36,829	$36,542	$35,211	$33,674
Monroe	$50,894	$48,846	$48,235	$45,991	$45,224	$45,998	$43,531	$41,638
Montgomery	$41,070	$38,978	$38,157	$36,714	$36,323	$35,801	$35,472	$34,674
Nassau	$84,763	$80,574	$78,959	$75,988	$73,243	$74,252	$68,916	$65,957
Niagara	$43,866	$41,683	$40,875	$39,198	$38,198	$37,719	$36,638	$34,963
Oneida	$43,198	$40,968	$40,023	$38,804	$38,431	$38,105	$37,123	$36,177
Onondaga	$50,244	$48,140	$47,401	$45,307	$44,013	$43,867	$42,065	$40,440
Ontario	$51,331	$49,236	$49,456	$46,940	$44,171	$43,261	$41,504	$39,455

Figure 2: The Primary Dataset, After Cleaning



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A1 County of Residence

	A	B	C	D	E	F
1	County of Resi	2017	2008	1988	geometry	
2	Bronx	35564	28272	13526	MULTIPOLYGON (((2147396 -	
3	Kings	48758	34338	15569	MULTIPOLYGON (((2147385 -	
4	New York	175960	120077	41126	MULTIPOLYGON (((2144809 -	
5	Queens	46829	36378	19515	MULTIPOLYGON (((2149973 -	
6	Richmond	54908	43566	20953	MULTIPOLYGON (((2134164 -	
7	Albany	58048	43628	20287	MULTIPOLYGON (((2069685 4	
8	Allegany	33942	27521	12077	MULTIPOLYGON (((1752163 -	
9	Broome	42825	34014	17030	MULTIPOLYGON (((1925604 -	
10	Cattaraugus	38644	31055	13174	MULTIPOLYGON (((1692671 -	
11	Cayuga	40797	31185	14020	MULTIPOLYGON (((1866463 2	
12	Chautauqua	39624	29914	14088	MULTIPOLYGON (((1645125 -	
13	Chemung	42577	33605	14977	MULTIPOLYGON (((1872883 -	
14	Chenango	41118	29216	14099	MULTIPOLYGON (((1934310 3	
15	Clinton	42720	32730	14185	MULTIPOLYGON (((1998454 3	
16	Columbia	53436	40129	16857	MULTIPOLYGON (((2069685 4	
17	Cortland	39465	29563	13750	MULTIPOLYGON (((1903058 3	
18	Delaware	37981	28755	12856	MULTIPOLYGON (((1987819 -	
19	Dutchess	54093	42203	20092	MULTIPOLYGON (((2120855 -	
20	Erie	49330	37795	17335	MULTIPOLYGON (((1685825 -	
21	Essex	43857	32653	14386	MULTIPOLYGON (((2017326 2	
22	Franklin	36617	29223	12351	MULTIPOLYGON (((1947143 3	
23	Fulton	42020	31627	14004	MULTIPOLYGON (((2008301 1	
24	Genesee	42365	33467	15781	MULTIPOLYGON (((1722535 2	
25	Greene	46210	31994	15345	MULTIPOLYGON (((2055990 1	
26	Hamilton	52436	37150	15119	MULTIPOLYGON (((1994613 1	
27	Herkimer	40320	30262	13581	MULTIPOLYGON (((1875669 2	

The datasets, "*A-9-Population-by-Race-and-Hispanic-or-Latino-Origin-NYS-by-County*" and "*Table 2: Population, Land Area, and Population Density by County, New York State 2017*" were used. See Figures 3 and 4;

Figure 3: Secondary Dataset 1, Population by Race

Population by Race[1] and Hispanic or Latino Origin
New York State by County — July 2018

County	Total	White	Black/African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Two or More Races	Hispanic or Latino Origin[2]
United States	327,167,434	250,139,096	43,804,319	4,147,521	19,330,600	799,418	8,946,480	59,871,746
New York State	19,542,209	13,619,931	3,447,729	190,414	1,750,013	26,745	507,377	3,754,130
New York City	8,398,748	4,422,345	2,325,798	118,016	1,259,976	17,641	254,972	2,449,450
Bronx	1,432,132	642,607	624,800	41,726	64,447	5,940	52,612	807,228
Kings	2,582,830	1,278,770	881,296	23,841	327,010	2,961	68,952	492,700
New York	1,628,701	1,050,536	292,091	19,200	208,760	2,921	55,193	421,022
Queens	2,278,906	1,092,235	471,907	30,186	611,274	5,285	68,019	639,612
Richmond	476,179	358,197	55,704	3,063	48,485	534	10,196	88,888
Rest of State	11,143,461	9,197,586	1,121,931	72,398	490,037	9,104	252,405	1,304,680
Albany	307,117	233,072	43,393	911	20,834	207	8,700	18,737
Allegany	46,430	44,368	666	147	601	19	629	779
Broome	191,659	164,864	11,972	514	8,485	128	5,696	8,321
Cattaraugus	76,840	70,569	1,178	2,726	670	29	1,668	1,632
Cayuga	77,145	71,104	3,446	360	499	53	1,683	2,348
Chautauqua	127,939	119,804	3,532	912	871	67	2,753	10,005
Chemung	84,254	74,456	5,509	294	1,260	30	2,705	2,683
Chenango	47,536	45,834	496	198	309	8	691	1,062
Clinton	80,695	74,249	3,667	329	1,177	34	1,239	2,402
Columbia	59,916	54,012	3,141	197	1,176	33	1,357	2,909
Cortland	47,823	45,230	946	171	539	17	920	1,310
Delaware	44,527	42,356	942	166	463	23	577	1,777
Dutchess	293,718	238,528	34,885	1,368	11,138	236	7,563	36,670
Erie	919,719	730,860	128,502	6,890	34,265	437	18,765	52,409
Essex	37,300	35,253	1,019	196	293	20	519	1,122
Franklin	50,293	42,293	3,221	3,814	238	13	714	1,805
Fulton	53,591	51,015	1,225	161	373	21	796	1,731
Genesee	57,511	53,461	1,837	665	380	7	1,161	1,952
Greene	47,491	42,656	2,997	216	615	22	985	2,871
Hamilton	4,434	4,268	45	14	35	4	68	76
Herkimer	61,833	59,461	895	206	357	19	895	1,377
Jefferson	111,755	97,711	7,841	732	1,877	355	3,239	8,701
Lewis	26,447	25,692	210	90	115	32	308	473
Livingston	63,227	59,194	1,881	234	859	32	1,027	2,310
Madison	70,795	67,104	1,360	533	638	26	1,134	1,654

Figure 4: Secondary Dataset 2, Population Density by County

County	Total Population	Population Density
Bronx	1471160	34944.42
Kings	2648771	37401.45
New York	1664727	72918.4
Queens	2358582	21732.07
Richmond	479458	8214.12
Albany	309612	592.22
Allegany	46894	45.56
Broome	193639	274.37

A grouping of the average income per capita of the regions of New York State was also created using the dataset, "*C-14-Personal-Income-NYS-by-Cty-Residence*", and information from citation 4 (NYSOGA)[4]. See figure 5;

Figure 5: Income Per Capita in NYS, Grouped by Region

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	A	B	C	D
1	Sections of NYS	2017	2008	1988
2	Long Island	75261	58202	25010
3	New York City	72404	52526	22137
4	Hudson Valley	57356	45259	17443
5	Catskills	47542	35967	16206
6	Saratoga	45817	34780	14948
7	Central New Yor	42458	32781	14607
8	Finger Lakes	45992	33115	15371
9	Chautaugua	37403	29497	13113
10	Greater Niagra	42424	32663	15382

The first set of graphs that were made were point plots. Figures 6, 7, and 8 show the relationship between the average income per capita of the 9 regions of New York State in 1988, 2008, and 2017. See the figures below;

Figure 6: Average Income per Capita per Region of New York State in 1988 vs 2008

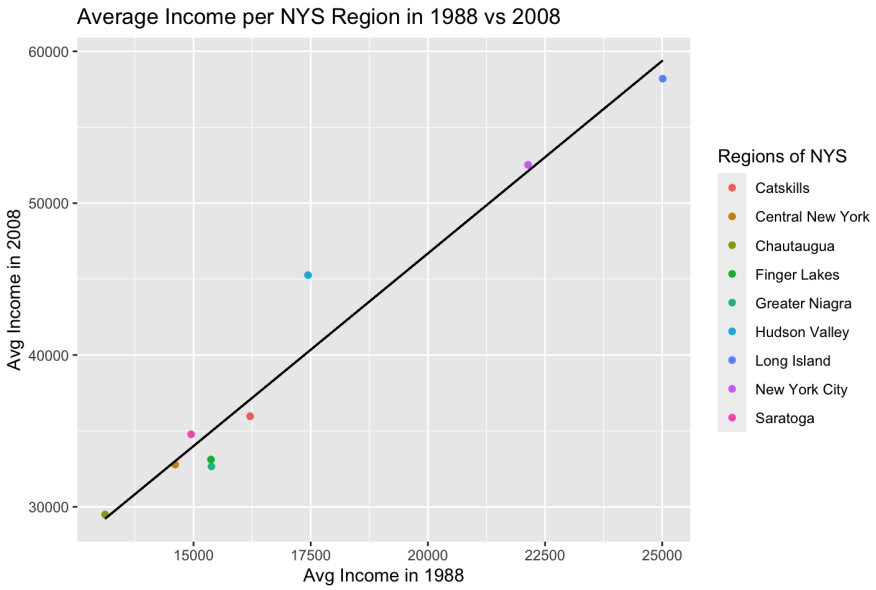


Figure 6: Average Income per Capita per Region of New York State in 2008 vs 2017

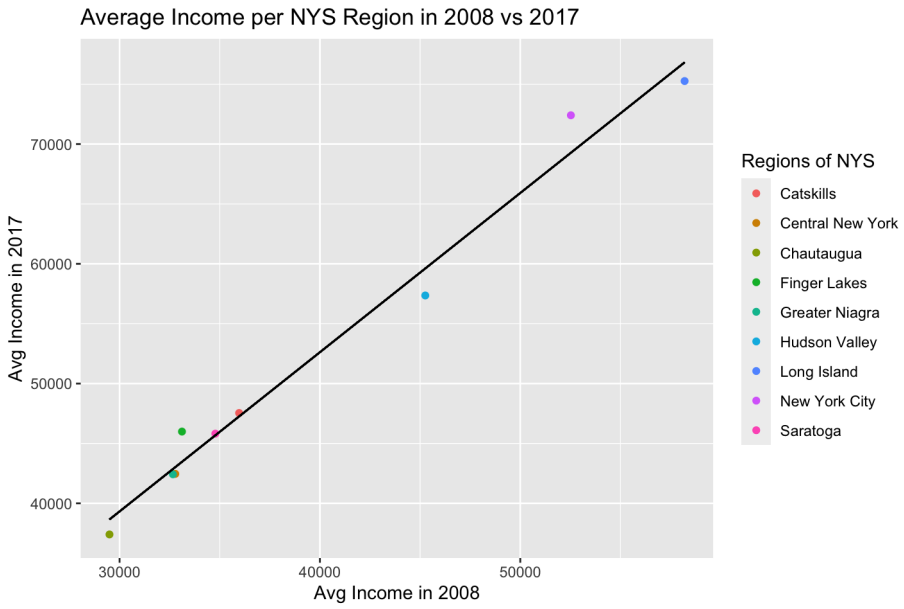
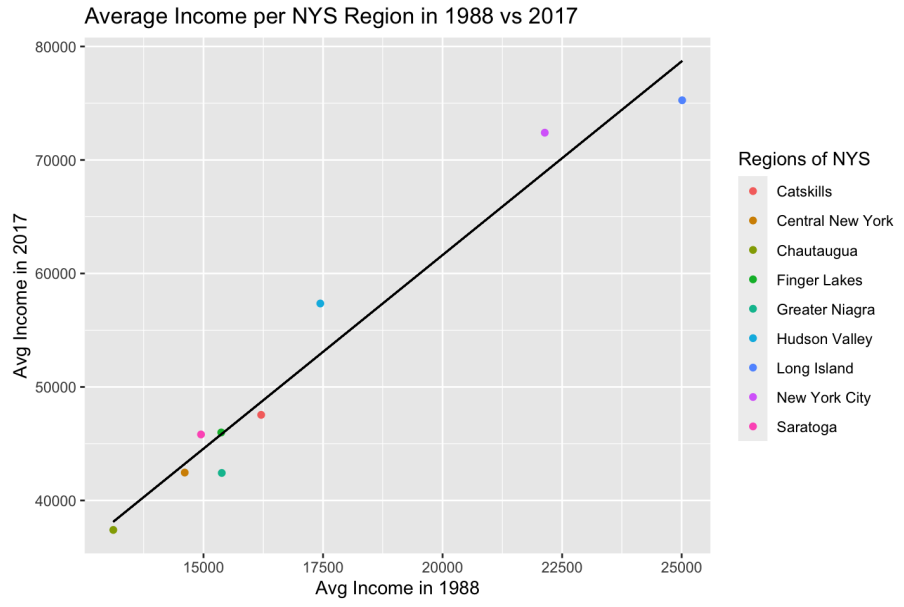


Figure 6: Average Income per Capita per Region of New York State in 1988 vs 2017



All three of these graphs resulted in a linear trendline. Additionally, because of how close each point was to the trendline, the conclusion that there was little variance among the data was made. Based on these graphs, it was hypothesized that the change in income per capita throughout New York State was proportional. To further investigate this claim, point plots of the

average income per capita of each county in New York State in 1988, 2008, and 2017 were made. See Figures 9, 10, 11, and 12.

Figure 9: The Legend for Figures 10, 11, and 12

Figure 10: Average Income per Capita per County of New York State in 1988 vs 2008

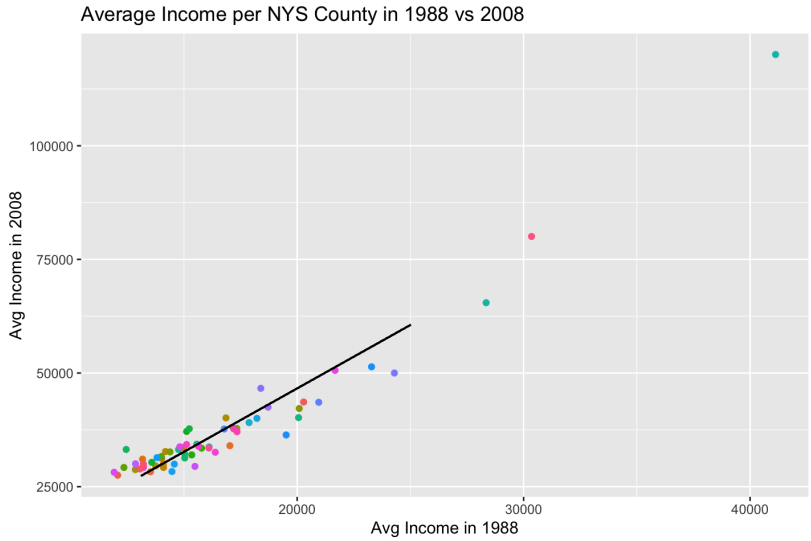


Figure 11: Average Income per Capita per County of New York State in 2008 vs 2017

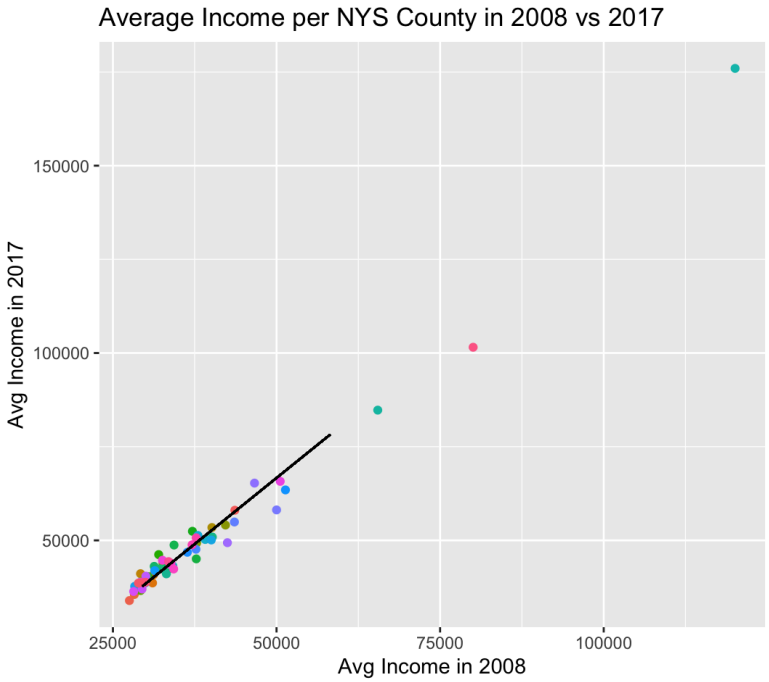
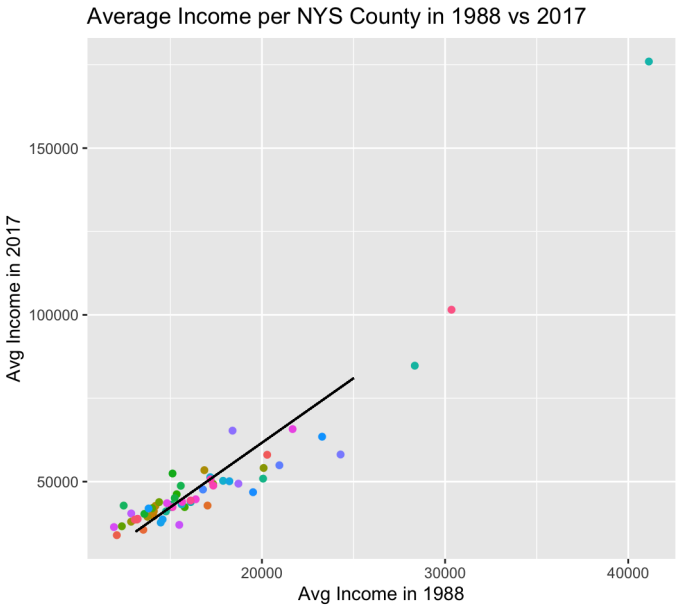


Figure 12: Average Income per Capita per County of New York State in 1988 vs 2017



Like Figures 6, 7, and 8, each of these graphs displays a linear relationship. The six-point plots demonstrate that the average income per capita of the counties in NYS has changed at proportional rates to be made.

Using the "*C-14-Personal-Income-NYS-by-Cty-Residence"* taken from the SUNY website, two maps were made to further analyze the breakdown of the income per capita in NYS in the following years: 1988 and 2008 which are shown by Figures 13 and 14 below.

Figure 13: NYS Income Per Capita Per County in 1988

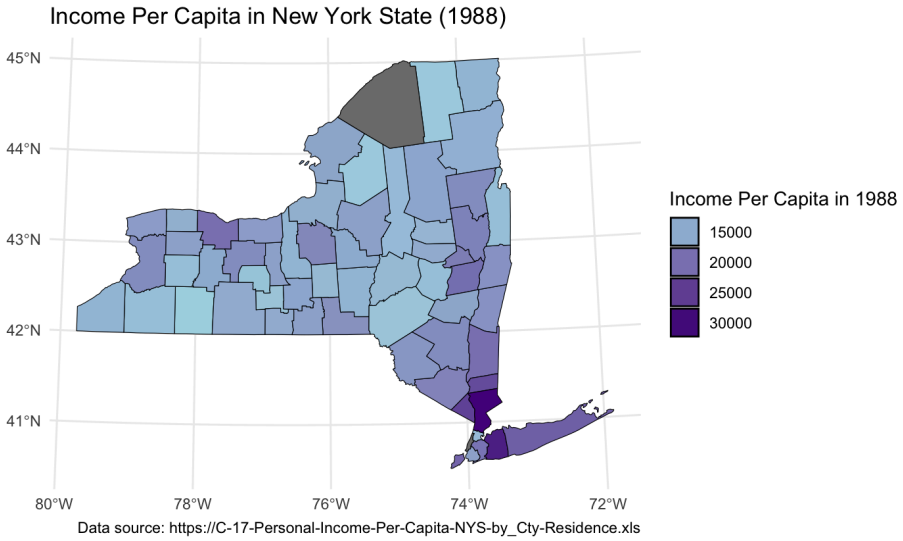
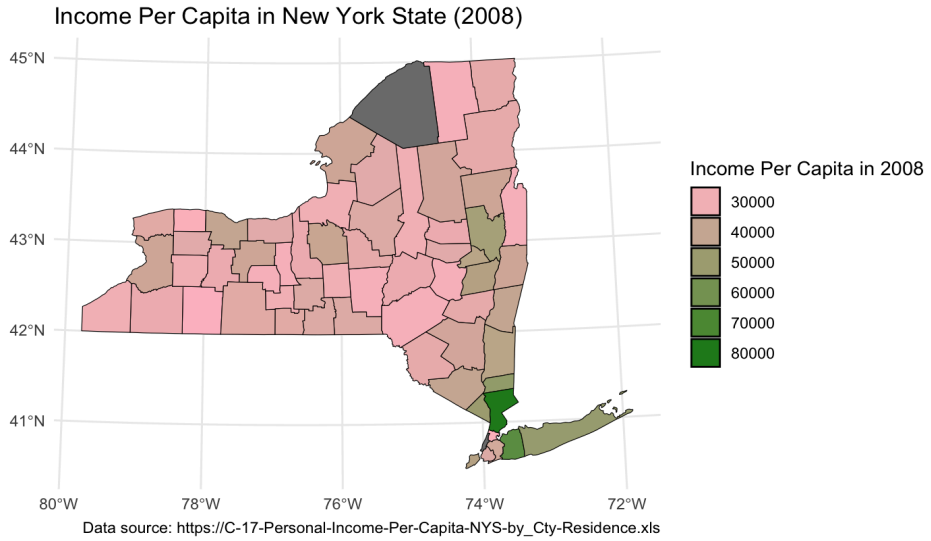


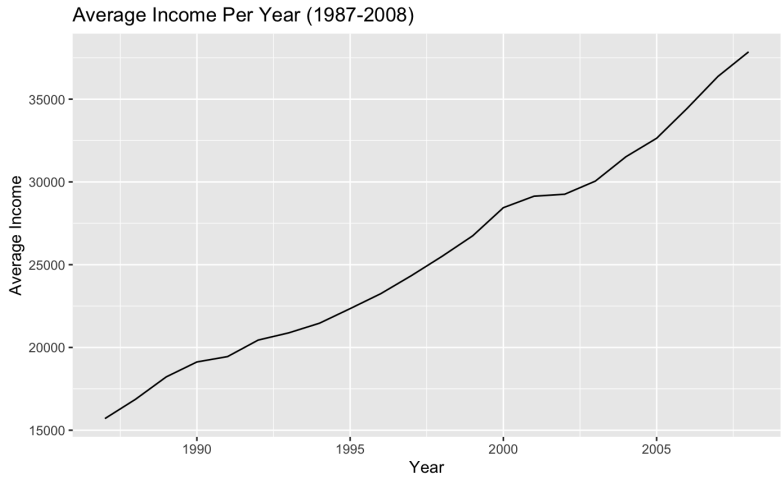
Figure 14: NYS Income Per Capita Per County in 2008



In these figures, there seems to be a similar pattern: the income per capita tends to increase towards the southern region of NY, particularly the Westchester, Manhattan, and Long

Island areas. What was interesting about this analysis was the fact that Brooklyn – in both maps – tends to be the only area in that region that has a lower income per capita compared to its surrounding neighborhoods. This could be due to many factors like economic development, the cost of living, the level of education, and demographic differences, some of which were explored in this analysis. Lastly, looking at both maps, the same county in the northern area of NYS, Saint Lawrence County, is gray due to the NA value found in the dataset. To further analyze this theory, a line plot was made which can be shown by Figure 15.

Figure 15: Average Income Per Capita Per County from 1987-2008



This line plot shows the overall average income per capita in NYS, spanning from 1987 to 2008. The positive linear relationship between average income and years shows that as time goes on, average income tends to increase at a steady rate. To expand on possible conclusions about the result shown in Figure 15, this positive correlation can potentially show the economic growth over the 21 years. In other words, because of economic expansion, peoples' income increases. Therefore, this relationship can also be correlated with an improvement in the standard of living. A rise in income, means a greater purchasing power, which means that individuals have access to things like housing, better education and healthcare.

Another conclusion drawn from this result is the concept of wage growth. Looking at the labor market, a positive trend in income can be influenced by labor market conditions, changes in the industry, and demand for skill proficiency. All in all, this allowed for the conclusion that the economic crisis of 2008, despite having a grave effect all over the world, affected each region of New York State equally, as each county's average income per capita changed proportionally.

To inspect how racial makeup and population density have an impact on personal income per capita in NYS, an analysis of population density and race was carried out to look for any correlation to income per capita in NYS and seek confirmation of our conclusion that these demographic factors have proven to have a significant effect on the personal income of individuals living in New York. To begin with, the two maps below visualize the population density and the Income Per Capita of NYS respectively. In both maps, there are similar patterns with a higher concentration in the Southern parts closer to the city and the numbers go down as you go further North. There are also a few outliers in Western New York, but overall these maps show areas with high population density also having high personal income per capita.

Figure 16: Population Density per Sq mile in 2017 (excludes NYC)

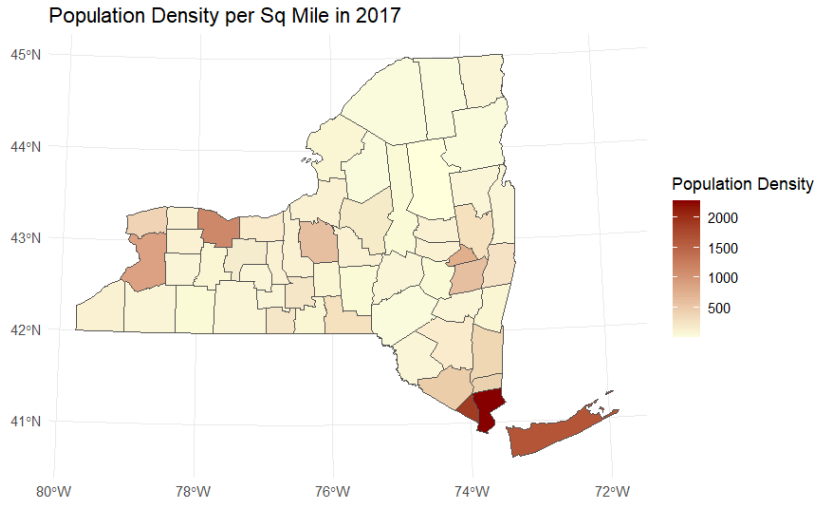
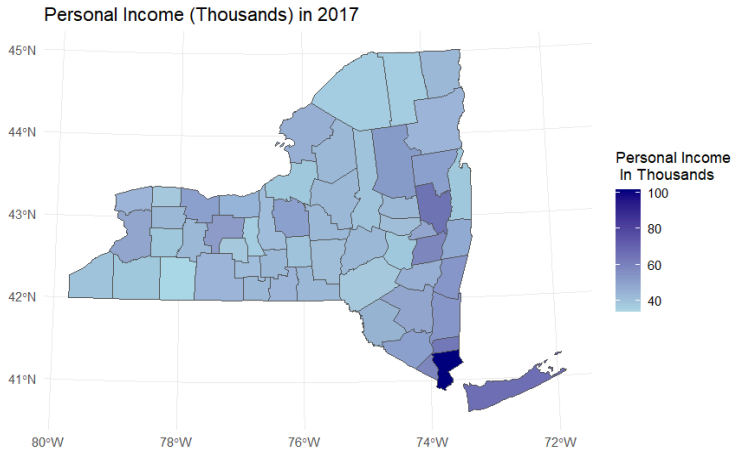


Figure 17: Personal Income in Thousands in 2017 (excludes NYC)



To get an idea of the racial distribution of New York State, a basic leaflet map was first made. See figure 18;

Figure 18: Link to Leaflet Map of the Racial Distribution of New York State by County in 2017

https://rpubs.com/mckenzies125/1181203

For the ensuing maps, data from 2017 was exclusively used. Research showed that the racial makeup of New York State did not change significantly from 1988 to 2017 (USA Facts)[5]. The exception to this was New York City, which saw an increase in people of color and a decrease in white populations (The Furman Center for Real Estate & Urban Policy)[6]. In addition, there was a similar pattern from before with the more diverse areas of NYS being in the Southern part, closer to the city, and corresponding with the areas that had a high population density and a higher personal income. Although there seems to be a correlation between the demographic factors and personal income in NYS, further analysis was needed before establishing a causal relationship. A spatial regression analysis was done using the spatial lag model which was found to be the most significant under the Lagrange Multiplier Test (Figure 19).

Figure 19: Spatial Lag Regression Results

```
Call:lagsarlm(formula = standardized_income ~ Population.Density +
    white_perc + black_perc + asian_perc + hispanic_perc, data = model,
    listw = ny_list1, na.action = na.omit, zero.policy = TRUE)

Residuals:
     Min       1Q   Median       3Q      Max
-15.1861  -5.2271  -1.3352   1.6513  37.1329

Type: lag
Coefficients: (asymptotic standard errors)
                     Estimate  Std. Error z value  Pr(>|z|)
(Intercept)       -2.0159e+02  1.0096e+02 -1.9966  0.045864
Population.Density -1.4187e-03  3.0485e-04 -4.6538 3.258e-06
white_perc         2.3583e+00  1.0342e+00  2.2803  0.022587
black_perc         3.2240e+00  1.2088e+00  2.6671  0.007652
asian_perc         3.4231e+00  1.0823e+00  3.1627  0.001563
hispanic_perc      3.7685e-01  2.3642e-01  1.5940  0.110932

Rho: 0.21171, LR test value: 1.8386, p-value: 0.17512
Asymptotic standard error: 0.14507
    z-value: 1.4593, p-value: 0.14447
Wald statistic: 2.1297, p-value: 0.14447

Log likelihood: -213.225 for lag model
ML residual variance (sigma squared): 70.718, (sigma: 8.4094)
Number of observations: 60
Number of parameters estimated: 8
AIC: 442.45, (AIC for lm: 442.29)
LM test for residual autocorrelation
test value: 14.072, p-value: 0.00017592
```

The results of the regression above were contrary to our exploratory analysis because although they showed a positive relationship between racial groups and personal income, there was a negative relationship for population density. There was also evidence of spatial autocorrelation in the model, but the significance level was very low which means there are spatial patterns not accounted for in the model. The result of this regression brought us to the conclusion that population density and racial composition are associated with income, but there may be other spatial factors not captured by the model that influence it. One of these factors was thought to be the proximity to New York City. Therefore, there is a need for further investigation into residual autocorrelation and potentially adding more spatial variables to improve the model's fit and its predictability of personal income in NYS.

In this project, the goal was to investigate how personal income in New York State has changed over time and how demographic factors continue to influence this rate of change. Through the visualizations in the explanatory analysis and the regression model, conclusions were made to only partially confirm the hypothesis that although the economy of New York State was greatly affected by the 2008 recession and the economy’s crash, demographic factors like

population density and race have recently proven to have a greater effect on the personal income of New York State. The results of the analysis showed that over time, personal income changed proportionally and the change was consistent in the different counties of NYS. In addition, there was evidence of a correlation between population density, racial composition, and personal income per capita, with areas that had a more dense and diverse population appearing to have a higher personal income. However, although this similarity in the patterns shows that the demographics of NYS affect personal income, the regression presented another factor affecting both population density and race which we believe to be proximity to New York City.

While the analysis offered great insights to answer the research questions, it also encountered some challenges and identified potential ways to better the research. One challenge was in the preparation of data that required combining numerous data sets and ensuring that every county had accurate information. Another challenge was deciding how to visualize the data, especially with the scatter plots, and this was combated by deciding to focus on the New York State regions for some of the graphs. To better understand personal income, further analysis could be done by incorporating more demographic factors like education level and political affiliation. The scope of analysis could also be expanded by looking at personal income in all of the United States to see if there are similar trends among the different states across the country.

Lastly, looking back at both research questions, a conclusion was made that there are similar patterns in all three factors of population density, race, and income per capita within the following years of 1988, 2008, and 2017. However, it is important to acknowledge that there may exist additional spatial factors beyond those included in the model, such as proximity to New York City, which could also impact income levels in New York State.

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