

# People and Firearms Sales

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## 1. Introduction

On average, each state adds about 100,000 new weapons to its arsenal each year. Much research has been conducted on crime and guns given the rise in homicides and suicides each year. While there is a lot of research on the topic of the effect of gun sales, little is said about the determinants of gun sales. Therefore, in this work, we performed exploratory research to determine whether there is a direct relationship between state demographics and gun sales.

The average age, racial makeup, income, and education levels are the main demographic factors we have selected for our study. We focus on the sales data of handguns and long guns collected by the FBI over the last two decades. We also include permits issued and background checks that are conducted annually. These factors provide some light on the State Department's vigilance in observing the sales of firearms.

Historically, Americans feel very strongly about gun ownership. On one hand, this has led to research that seems contradictory at times. On the other hand, it has armed enthusiasts with rhetoric that have gained more popularity than its statistical soundness. Therefore, our research might not reflect all that the gun debate usually encompasses. One such thing is the variable of illegal firearm sales, which is not present in our data due to the difficulty of quantifying this underground aspect of gun sales.

In our paper, the term 'Permit' refers to the legal permission to buy, hold, or carry any type of firearm as long as they are legal. The variable of background checks refers to any check conducted for any reason. This variable could potentially include repeat checks to the same individual or checks that did not result in the sale of a gun. Handguns and long guns are classified according to the Bureau of Alcohol, Firearms, Tobacco, and Explosives. We focus on a variable that measures these two categories' combined sales.

There is a lot of research on the effects of gun ownership on other variables while there is not much literature that explores the determinants of gun ownership. Our research focuses on trying to link state demographics to the sales of firearms, something most literature simply links to "gun culture" without much elaboration.

In our initial analysis, we found patterns that we feel need more research. We have found some correlation between the average age of the state and the sales of firearms, where some older states tend to buy more firearms. Some states are not affected by this trend, however. We also found a significant change in arms sales as education levels change.

## 2. Background

America is positioned uniquely in the world when it comes to firearm ownership. It is no secret that the U.S. owns the most amount of weapons and sales don't seem to slow down (Black, 2022). New legislation and a stronger emphasis on background checks have halted some sales (Molotsky, 2000) but not enough to change the direction of the overall trend. In 1999, the denied sales due to background checks not clearing an individual only accounted for 2.4% of attempted sales. Today, most gun owners seem to suggest some degree of safety

policies (Politico, 2022). However, no such policies are being discussed. In the 2022 midterms, only one state had a ballot measure on gun control (NBC, 2022) while other states seem focused on limiting the power of such potential measures (Niedelman, 2022).

While one-third of the population of the U.S. owns a gun (Kalesan, 2015), this is not an evenly distributed statistic. Northwestern states account for lower rates of gun ownership while the South accounts for the highest rates of gun ownership. Kalesan, et. al., point towards gun culture as the driving factor for this data. They found that states with active social gun cultures were associated with 2.25-times greater gun ownership (PR=2.25, 95% CI 2.02 to 2.52) than those without it. But what exactly constitutes gun culture?

In a survey of 539 Cincinnati Residents, the research found a significant correlation between protective and general (or "sport") firearm ownership based on gender and childhood socialization (Cao, 1997). Protective gun ownership appeared to be linked to crime-related factors. Residents of neighborhoods with higher crime rates indicated their increased possession of firearms was for defensive purposes. At the same time, informal collective security (the belief that neighbors help prevent crime victimization) reduced possession of protective weapons. But the perception of crime is not the only factor that determines gun ownership

According to a number of sociologists and cultural psychologists, the United States is primarily an individualistic country. Katazyna (2007) finds a unidimensional list of independence and collectivism to analyze weapon proprietorship and weapon control. The researcher identifies individualism as both a driving factor of weapon proprietorship and weapon control.

Research tends to focus on the effects of gun ownership. While this might be beyond the scope of this paper, they point to relevant variables that might still be of interest to us. A study determined a correlation between suicide rates, gun ownership, populace thickness, and county elevation (Kim, 2011). This research proves that the factors that constitute gun culture are not only social factors, and can extend to geographical and demographical factors.

Research even shows that gun culture might be propagated by specifically targeted marketing campaigns (Blair, 1995). In their research, they analyze the effects of the latest merchandising of weapons and gun-associated merchandise on girls, to primarily test the impact of gun-related promotions on women's and men's states of mind toward owning weapons or guns. After demonstrating a huge impact on the research matter, the researchers raise questions of legality and ethics regarding these practices.

### **3. Data**

The data cleaning process involved two separate datasets: The firearm background checks dataset from the FBI and the state demographics dataset from the Census Bureau.

For the firearm dataset, we first separated the *Month* column into two separate columns; one with the year and another with the month. This is so we would be able to match the dataset later on with another dataset by year. Next, we eliminated the rows corresponding to years not included in the census dataset. We kept the years going from 2002 to 2019 for this reason.

Next, we removed the territories not included in the dataset from the Census Bureau. These had: Guam, the District of Columbia, Puerto Rico, the Mariana Islands, and the Virgin Islands.

Then, we summarized the information in the firearms and background checks dataset by year and state. Since this dataset contains twelve data points (one for each month of the year) per state per year, we added all permits, handguns, long guns, and background checks so that each row represented the total amount of these variables sold or performed per state in a given year.

The last thing we did was select the variables we were interested in for this dataset. These variables were: *year*, *state*, *permit*, *handguns*, *long guns*, and *totals*. *Permits* represent the number of permits emitted in one year, *handguns* and *long guns* represent the number of handguns sold per year according to the guidelines established by the US Bureau of Alcohol, Tobacco, Firearms & Explosives. *Totals* correspond to the number of background checks performed that year, for whatever reason. This was all the data cleaning performed on the firearm and background check dataset.

For the dataset containing demographic information from the United States Census Bureau we first started by removing outliers that could potentially skew our data later on. We removed all the rows in the “total income” variable that contained a max amount of 99999999 because this meant that someone earned over this amount in a given year, or the minimum of 0 which could mean someone was homeless and unemployed or a stay at home parent. We chose to eliminate these rows because they could skew the data negatively.

Next, we removed any entries on territories like Guam, because the fact that they have military presences would bias the data toward an increased presence of firearms that does not reflect a pattern in the rest of the continental United States. Afterward, we eliminated columns that were not of interest or were redundant like the *detailed education*, *detailed race*, and *detailed Hispanic*, which only further subdivided these variables to a degree we did not have a need for.

The next step was to turn the categorical variable of race, which ranged from 1 to 6, into four binary variables. A 1 on this variable represented White, 2 represented African ancestry, 3 represented Native Americans, and variables 4, 5, and 6 represented 3 different subcontinents of Asia which were grouped into one variable for reduced complexity. The Hispanic variable was also turned into a binary variable where all the different subdivisions of Hispanics were grouped into one category for the same reasons as the last variable.

The sex variable was also turned into a binary variable. The original variable had 1 corresponding to male and 2 corresponding to female. This was turned into a Bernoulli variable (0 and 1) for better data storage. The last variable manipulated was the *static* variable, where the rows had code numbers that corresponded to a state. The codes were substituted for the state names to later join the two datasets by these names.

Once all this cleaning was done, the dataset was summarized by year and state, similar to what was done with the previous dataset. Grouped by state and year we summarized the age into a mean age variable, where each row displayed the average age of a given state in a given year. The *educ* variable was summarized into a mean educational attainment variable where each row corresponded to the average education level of each state in a given year. In the same vein, total income was averaged by the state each year. The demographics of sex, race,

and Hispanic ethnicity were summarized to show the percentage of the population of a given state that was part of said demographic. These percentages were then rounded to the nearest decimal for simplicity.

Afterward, these two datasets were joined to form one dataset where all the above information was displayed by state and year.

#### 4. Descriptive Statistics

Table 1 is the summary of the firearms dataset obtained from the FBI. The data collected are for the last twenty years. The variables in this dataset are permits emitted, firearms sold by type and total, and total background checks conducted.

The arithmetic mean for permits issued is 106,000 per state in a given year. There were some states that issued no permits and states that had a maximum of 4.6 million permits issued in one year. Similarly, the sales of firearms vary from 0 in at least one state to a maximum of 1.16 million in one year. The average falls around 194,000 for firearm sales. For background checks, some states conducted a minimum of 6.5 thousand background checks and a maximum of almost 5 million background checks. The average falls around 336,000 background checks conducted by a state in one year.

Table 1

	permits	handguns	long_guns	total_gun	bg_checks
Min.	0	0	0	0	6,521
1st Qu.	35	20,362	38,242	62,771	91,197
Median	18,386	52,258	81,608	142,328	197,470
Mean	106,159	91,201	103,643	194,844	336,542
3rd. Qu	89,954	119,706	137,807	251,248	372,993
Max.	4,655,016	662,308	873,543	1,166,589	4,949,570

Table 2 displays summary statistics of the dataset obtained from the Census Bureau, which gives us a brief overview of the arithmetic mean demographics in the U.S. for the last twenty years, approximately.

We can see that the average age is 49 years old, with younger states averaging 42 years old and older states being almost 54 years old. The average percentage of females is an even split of 50%, with the states with the lowest percentage of female population being around 46% and the highest being 54%.

The average educational achievement nationwide is that of finishing the first year of college. States with lower levels of educational achievement have, on average, a population that has finished high school. States with higher levels of education average the completion of the second year of college. When it comes to average total income, the median income nationwide over the last twenty years is about \$37,000. States with lower total income average around \$23,600 and states with higher levels of total income average around \$67,000.

When it comes to racial diversity we can see that, on average, 83% of the population identifies as White across all states. However, when all states are weighted equally, only 7% of

the population identifies as Black or African American. This can be explained by the unequal distribution of this racial population across all 50 states. This is evidenced by some states containing around 34% of the black population. Similarly, Native Americans represent almost 2% of the total population but represent 32% of the population of some states. People that identify themselves as Asian represent 4% of the total population but over 50% of some states.

**Table 2**

	avg_age	avg_ed	avg_inc	per_fem	per_white	per_black	per_nat	per_asian	per_hisp
Min.	42.24	6.198	23,626	0.46	0.26	0.002	0.001	0.003	0.005
1st Qu.	48.16	6.933	33,182	0.50	0.76	0.016	0.003	0.010	0.022
Median	49.33	7.140	37,597	0.51	0.86	0.052	0.005	0.017	0.042
Mean	49.14	7.148	38,465	0.50	0.83	0.076	0.018	0.036	0.068
3rd. Qu	50.33	7.345	42,575	0.51	0.92	0.110	0.012	0.034	0.074
Max.	53.88	8.032	67,002	0.54	0.98	0.340	0.323	0.568	0.382

## 5. Data Visualizations

Figure 1 shows the relationships of three important variables in the topic for firearms across time: Permits, background checks, and gun sales. We can see that while they fluctuate over time, these three variables maintain their relationship to each other.

There are always more background checks conducted than guns sold or permits emitted, and there are always more guns sold than permits emitted. The key difference is that a person can only hold one permit but can buy and own more than one firearm. This seems to indicate that people with firearm permits usually tend to own more than one firearm, at least at a national level.

**Figure 1**

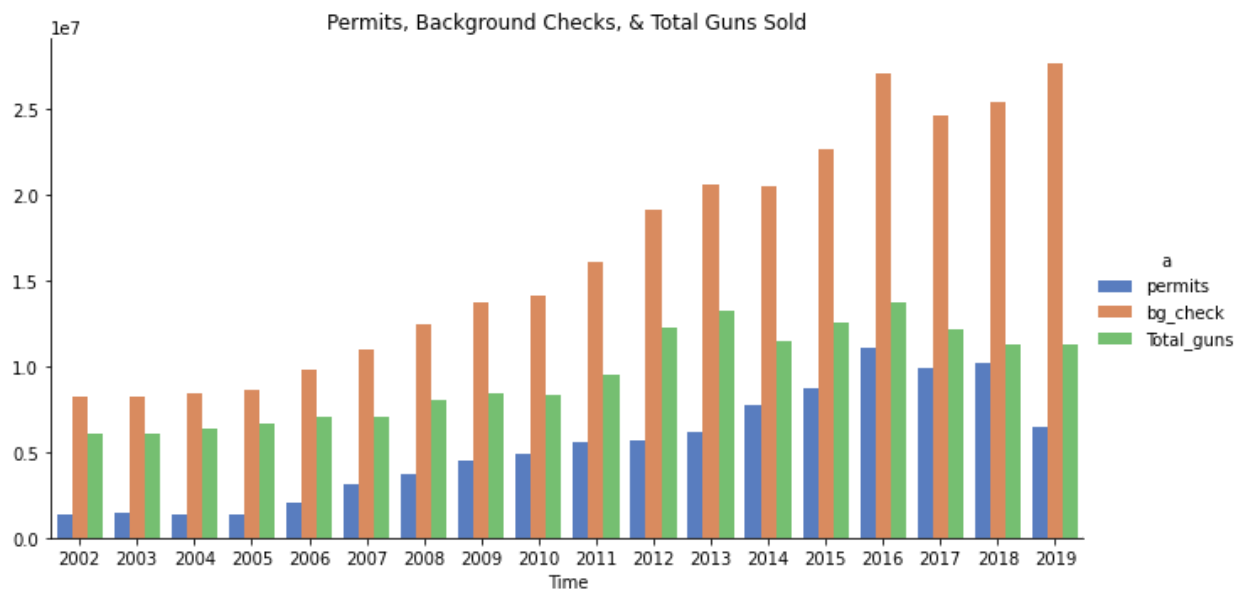


Figure 2 shows two distinct pictures of the different states. Some states have almost no change in the sales of firearms over time, Wyoming, Montana, and South Carolina. While on the other hand, some states have consistently bought more and more guns like California and Texas. Population plays an important role in this visualization, so even though every state experienced population growth during these 20 years there are some states where firearms sales didn't change significantly.

Figure 2



Figure 3 shows a pattern and indicates that there is some correlation between age and total firearms sold. As the average age increases there is a significant increase in total firearms sold as well. Although there are some outliers, the overall trend is bell-shaped where it rises

between the ages of 48 and 50 and then it falls. This seems to indicate there are one or more variables that can disentangle this relationship.

The data also shows that some individuals, despite their aging, do not follow the trend of buying more firearms later in life. This seems to suggest that age is not the only driving factor for this trend.

Figure 3

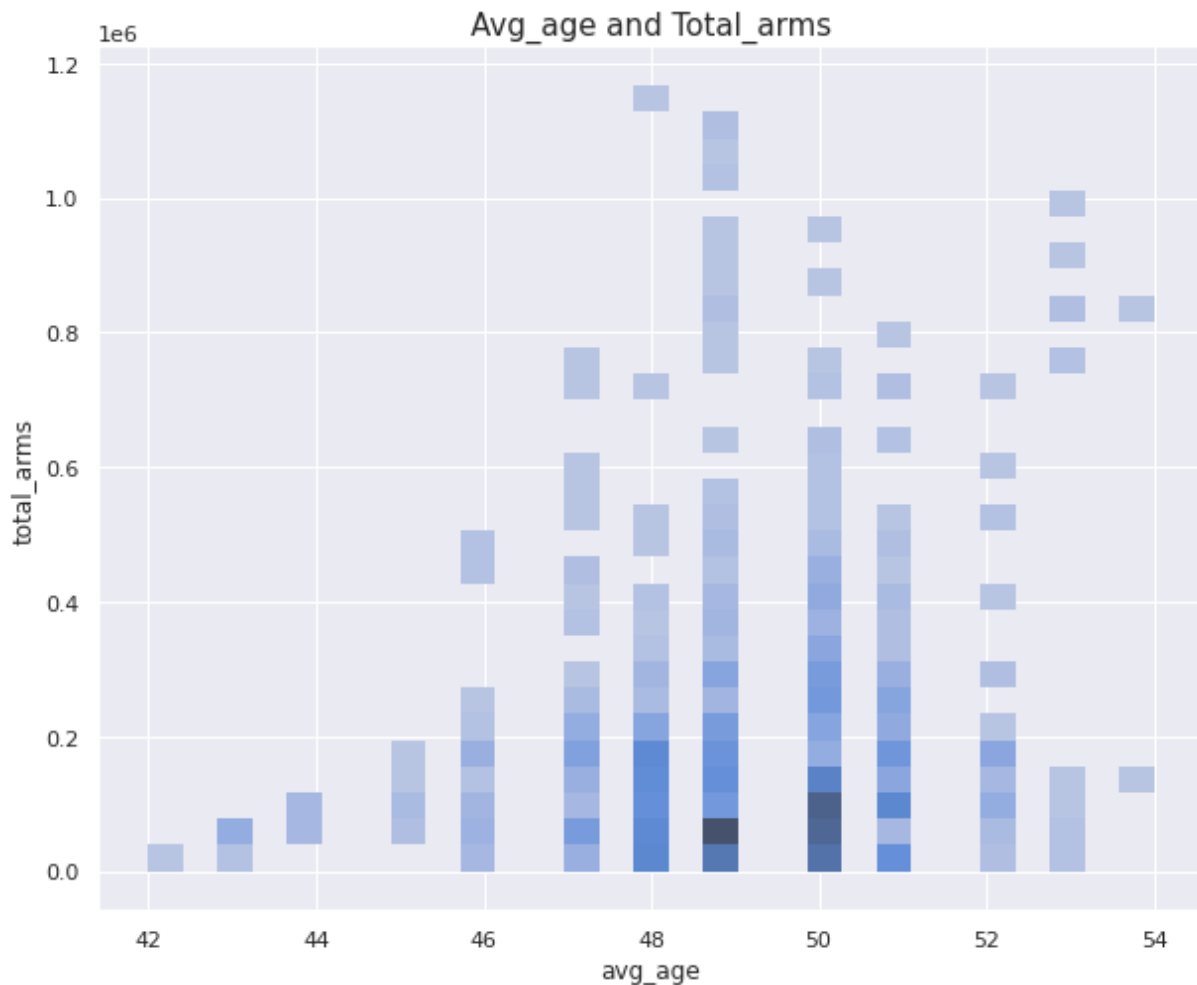


Figure 4 shows a gradual rise in the sales of firearms until the year 2012, where we have our first decrease. The trend continues to rise after this year before another decrease in the year 2016. While these years correspond to election cycles, it's unclear whether this is the variable affecting the trend.

Figure 4

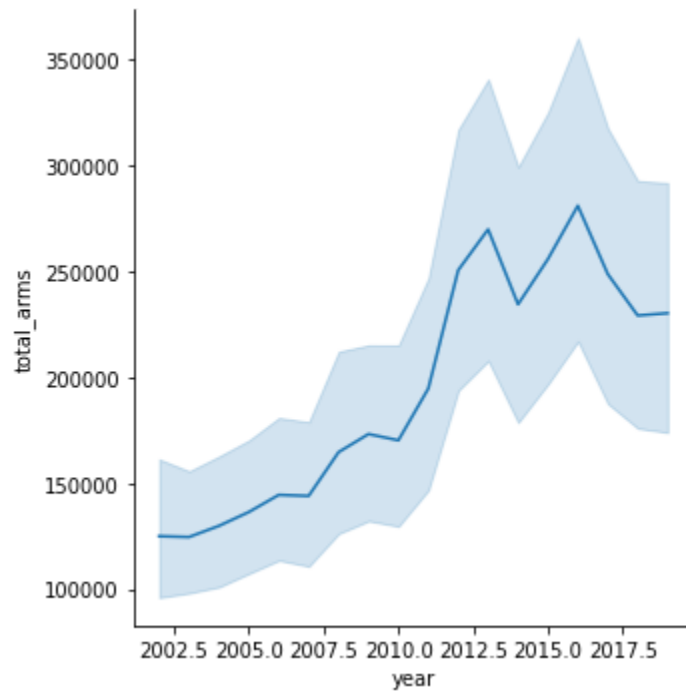


Figure 5 seems to imply that there is a relationship between average income and the number of gun sales. The distribution resembles a bell curve, one whereas income increases in a state, the sales of firearms also increase. However, at some point, this positive correlation reaches a peak, and then it becomes a negative correlation. After pouring through our data, we were able to find a variable that could explain this pattern

Figure 5

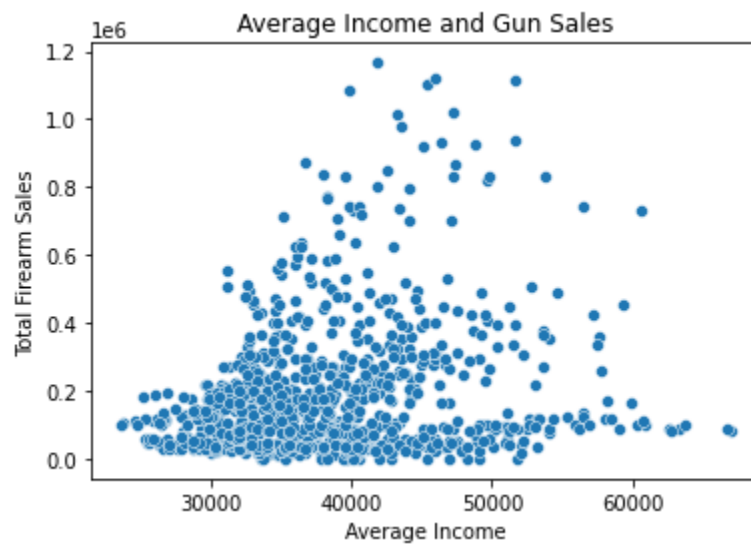
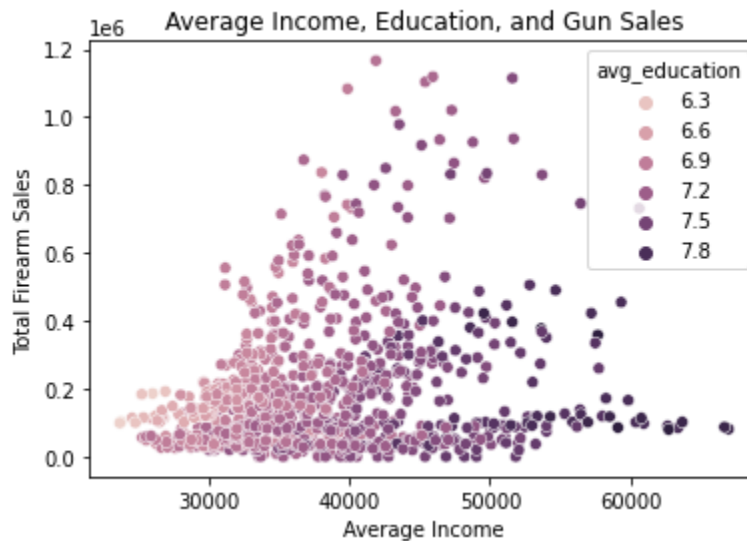




Figure 6 introduces the variable of average education. We can now see that states with lower levels of education are on the left side of the graph, which corresponds to lower levels of income. This relationship in itself is beyond the scope of our research but has been thoroughly documented by other researchers.

Given the cost and level of necessity of firearms, it is no surprise that their sales are correlated to the levels of income of a given state. However, the education level might explain the change in this pattern. As education levels grow, the sales of firearms decline.

Figure 6



## 6. Initial Inferences

From our initial data exploration we noticed a number of trends regarding the sales of firearms across different states. It seems that states with an older average age tend to buy more firearms. Some states are not affected by this trend, however. This suggests there is another variable to explore within this relationship. Placing states in a rural-to-urban spectrum might help disentangle the relationship between age and sales, as more rural states tend to have older populations. It is also worth factoring political leanings of states for this relationship, as it is likely that states that are usually on one side of the political aisle combined with an older population result in higher sales of firearms.

Another relationship we discovered is that of the average education of a state and sales of firearms. While some might be tempted to claim that increased education decreases the sales of firearms in a given state, further statistical testing is needed to ascertain the effect of education on the sales of firearms. It could be that states with higher levels of average education are more urban and therefore engage in less firearm shopping compared to rural areas.

To further our research, we propose to add the following variables: Rural to urban scale, historical political leaning, and region. The rural-to-urban scale data would control for the effect of population density on firearm sales. While there is not much literature exclusively on the topic of population density and urbanization indexes on their effect on gun sales, we assume these variables might share some correlation that could explain trends observed in our research.

In the same vein, historical political leaning could add a lot of depth to our research. “Gun culture” is a topic heavily discussed in past research, and we assume political leanings are tied to this term. By adding this data, we might control for correlations within states that consistently fall on one side of the political aisle, but it might fail to do so in states that are usually considered swing states. Regional data (separating states into West, East, South, and Midwest) could help us cluster data by regions and further explore relationships between states.

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