Factors correlate with innovativeness of U.S. citizens

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Whether from a common-sense perspective or professional literature reviews, it is evident that technological advances always bring ground-breaking economic growth, as evidenced by past industrial revolutions. So, it is natural for us to ask what factors could potentially affect the emergence of innovators and, therefore, further influence policymaking to help more children become innovative in the future, especially at the time economic growth was impacted by the global pandemic. This research aims to find if there is a correlation between potential factors and innovativeness. Our main interest lies in the following questions: Is there a notable gender difference between the number of male and female innovators? Is there a geographical distribution of the number of innovators? Do parent income and family socioeconomic status affect the children's innovativeness? Is there a higher percentage of innovators in college compared to the general public?

These questions could help us to understand the relationships between factors and innovativeness. As it could determine whether there is something that professionals and policy makers could do to interfere and help cultivate more innovators.

The main findings of our study are the following: men are more innovative than women, there are significant differences in innovativeness across regions and parents' socioeconomic status, and innovativeness is relatively high and more variable among those who enter college overall.

Data

The data is from the dataset in *Who Becomes an Inventor in America? The Importance of Exposure to Innovation* on Opportunity Insights (https://opportunityinsights.org/data/). Most columns are percentages in specific populations, so there are no units. The dataset covers patenting outcomes of children who were born from 1980 to 1984, categorized by geography, gender, and parent income. One downside of the dataset is that it is based on information from children born relatively early, who were born before an era of information explosion. So, the research could not examine the influence of things such as the accessible internet on children's innovativeness. This could result in the findings from this research having limited reference value to the policymaking process. The specific meaning of each variable is in Appendix B.

Analysis

Comparison of male and female

The bar chart below plots the sum of male and female inventors in different states. In Figure 1, the blue bar at the top represents men, and the orange bar at the bottom represents women. We can see from the graph that the blue bars are longer than the orange bars in every state, which indicates that there are more male inventors than female inventors in each state. So, we could say that male kids are more innovative than females. However, since the data were collected in the early 1980s, still during the feminist movement, we can assume that the data may be downwardly biased and that a higher percentage of female inventors is expected in the future.

Figure 1 Gender vs. Number of Inventors by State
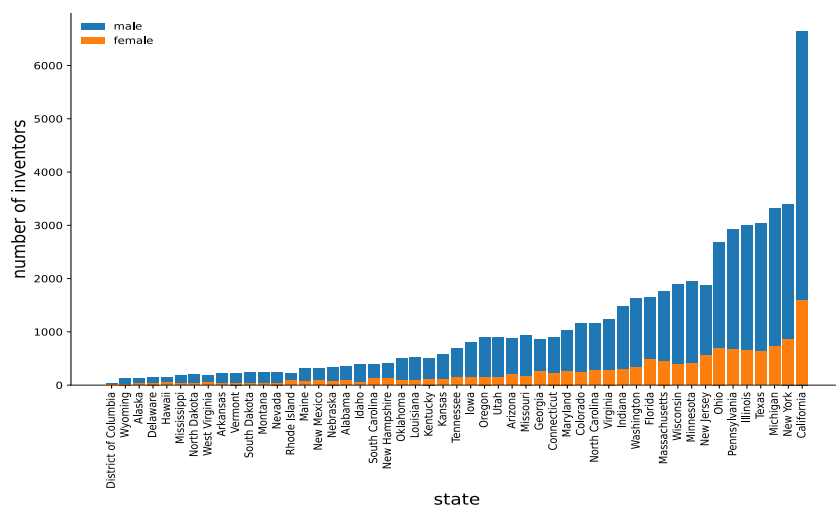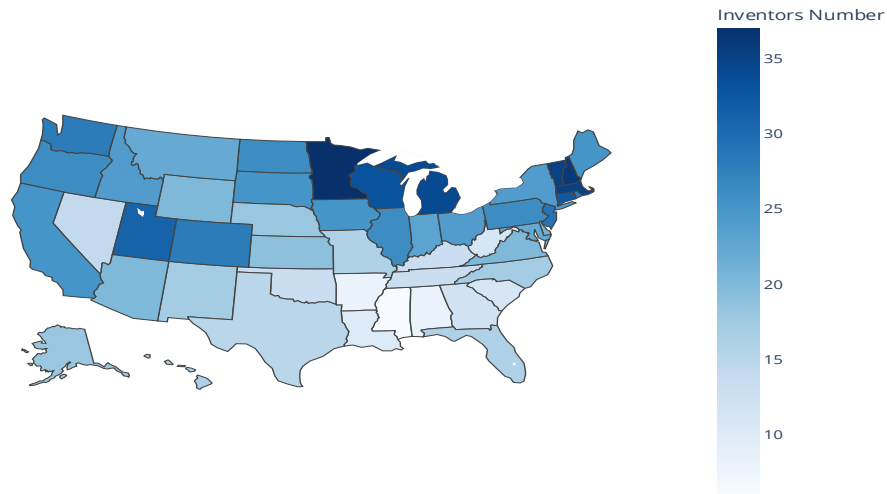
Comparison between regions

From Figure 1, we can also find that the number of inventors varies considerably between regions. Therefore, we have drawn in Figure 2 a map of the number of inventors among different regions in the United States. If we only consider the total number of innovators in each state, California is unsurprisingly the top one, with New York, Michigan, and Texas following. In addition, the central part is relatively less innovative.

Figure 2 Inventors by State (Before Population Adjustment)
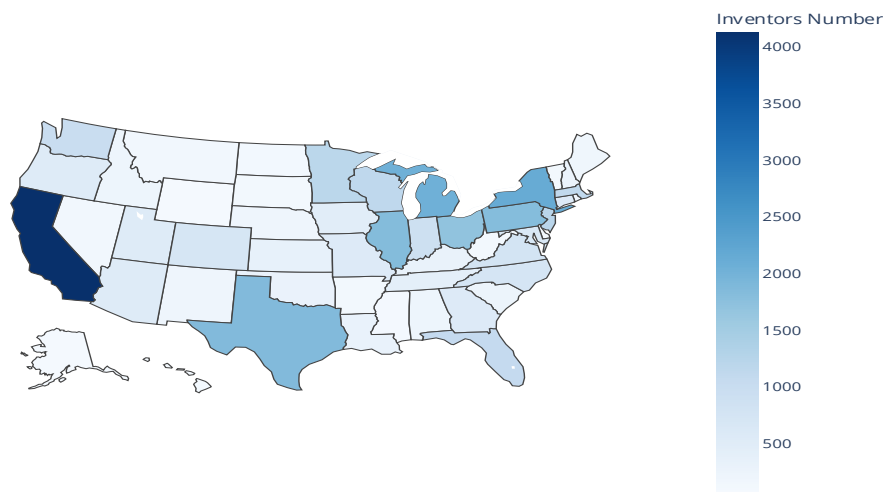
However, this result may be influenced by the population of each state. Therefore, we generalized the population size by finding the number of innovators per 10,000 children and created a map of inventor density. As shown in Figure 3, the northern part of the United States seems to have a higher density of innovators than the southern part. The states with the highest density of innovators are Minnesota, New Hampshire, Massachusetts, and Vermont, which do not coincide with any of the states with the highest total.

Figure 3 Inventors by State (After Population Adjustment)

Comparison between socioeconomic status

We have categorized parents' income status from low to high on a scale of 1 to 5 and compared the proportion of children who became inventors on each scale. We plotted Figure 4 for a random sample of five states from all states to make it clear to see the general situation (see Figure 5 in Appendix A for a comparison of all states, **notice that these 5 states were drawn randomly so every time rerun codes would generate slightly different graph**). From the graph, we can clearly see that the higher the parents' income status, the higher percentage of children becoming inventors. Moreover, when parents are in the most elevated status stratum, the proportion of children becoming innovators increases considerably relative to the situation in other strata. This could result from the fact that parents of higher economic status are more willing to invest more in their children's education, and their children have a relatively more comfortable upbringing to use their imagination and do not need to make a living prematurely. But this would only be preliminary assumptions, whether there is a causation relationship and reasons behind would need further research.

Figure 4 Parent Income vs. Innovative Rate (Random Sample of 5 States)
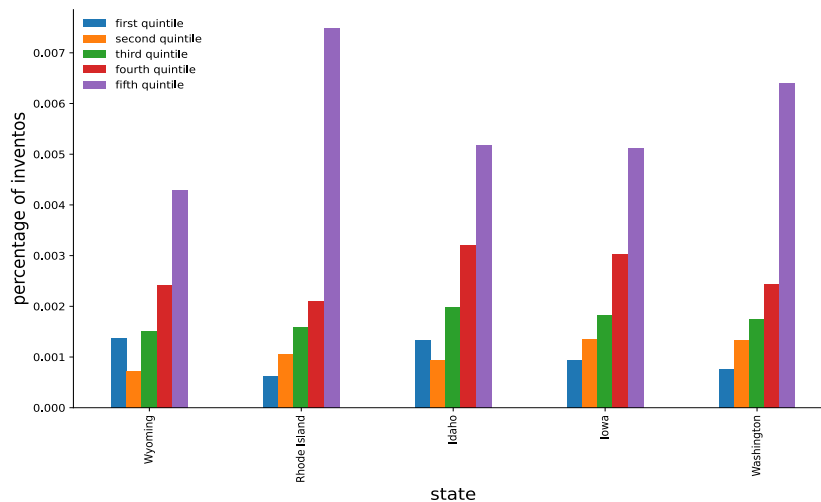
Comparison between college students and population

Based on our dataset, we calculated that the average rate of all students entering university who become inventors was 0.881%, while this value was 0.213% overall. This suggests that students who enter college are more likely to become inventors, although it is possible that only those who are more likely to become inventors enter college. Moreover, the standard deviation of students entering college to become inventors was 0.0157, while the overall was 0.0008. This indicates that the variability in the probability of becoming an inventor increases after entering university, further suggesting that university education might play a role in the development of inventors. But we could only show there might be correlation between college degree and innovativeness, but causation relationship would need more research.
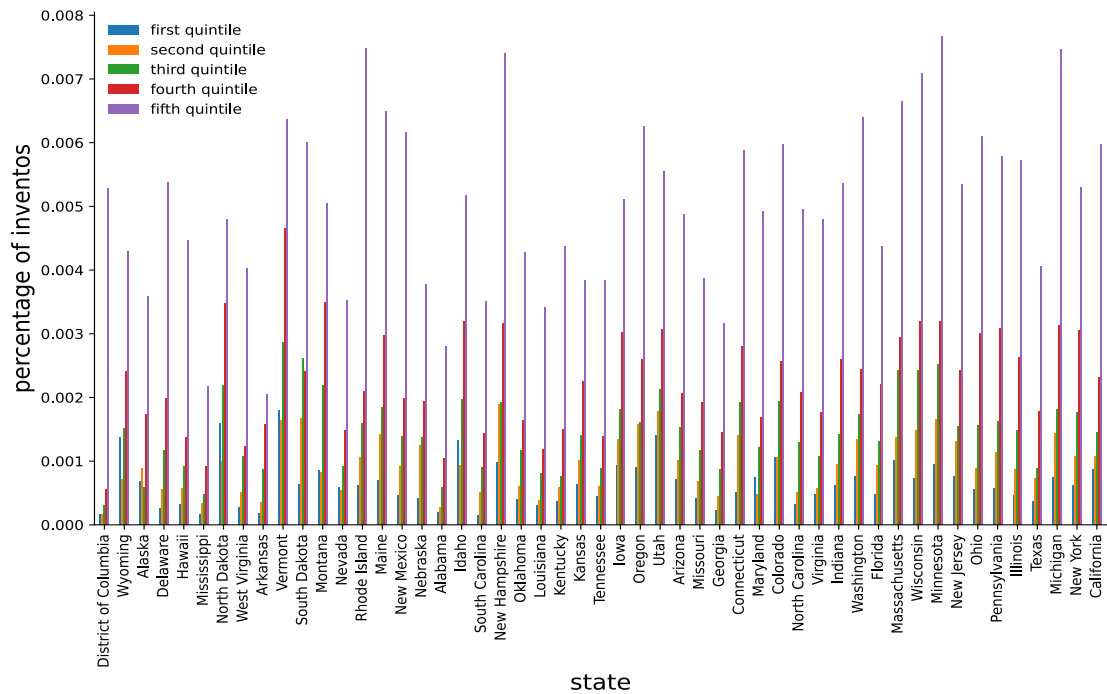
Conclusions and directions for future research

From the analysis we conducted and findings above, we found that gender, location, parent income and education all could be factors that correlate with kids' innovativeness development. Specifically in the United States, the number of male inventors outweighs female. After adjusting population, kids from northern states seem to be more innovative than their peers from southern part. We also see that the higher quintile parent income in, the higher proportion of kids became inventors. Lastly, it seems that a college degree would also have impact on innovativeness. This could be an indicator for policy makers that investing more to help students attending college might be a direction to work on to import citizen's innovativeness.

The downside of our research is also clear to see. We conducted the research merely based on a dataset produced by another research and only looked at kids born between 1980 to 1984, where worries about whether it could represent recent trend would rise. Future research could also go to a more detailed direction that focus on the top 5% of most cited inventors.

Appendix A: Figures and tables

Figure 5 Parent Income vs. Innovative Rate (All States)

Appendix B: Variable Description

Variable	Description
cz	Current commuting zone of residence
czname	Commuting zone name
state	Current state Federal Information Processing Standard (FIPS) code; CZs that cross state borders are assigned to the state which contains the largest population in the CZ, based on the 2010 Census
stateabbrv	Two-letter state abbreviation
cohort	Year of birth
age	Age at which patenting outcomes are measured
year	Calendar year
count	Number of individuals in population
applicant	Fraction of individuals who apply for a patent in current calendar year
grantee	Fraction of individuals who apply for a patent in current year that Is subsequently granted
num_grants	Average number of patents grants per individual, by application year
grantee_cat_[c]	Fraction of individuals granted a patent in technology category [c], by application year. Technology categories [c] are: 1 – Chemical 2 – Computers and Communications 3 – Drugs and Medical 4 – Electrical and Electronic 5 – Mechanical 6 – Others 7 – Design and Plant
[outcome]_g_m	Identical to variable [outcome], but restricting the sample to males.
[outcome]_g_f	Identical to variable [outcome], but restricting the sample to females.
super_opeid	Institution OPEID / Cluster ID when combining multiple OPEIDs
instnm	Name of Institution / Super-OPEID Cluster
count	Number of students
count_pq_[quintile]	Number of students with parents in quintile [quintile] of the income distribution
inventor	Share of inventors among students
inventor_pq_[quintile]	Share of inventors among students with parents in quintile [quintile] of the income distribution
top5cit	Share of individuals with total patent citations in top 5% of their birth cohort among all inventors matched to a college
total_patents	Total number of patents granted to students
total_cites	Total number of patent citations obtained by students