

# Estimating the Effect of Aging Populations on Healthcare Quality

## Introduction/Theoretical Background

Access to high quality healthcare is extremely important for late-life individuals. Not only does it prolong their life, it also improves their general quality of life. For older individuals who have the means to choose where they live, it might be important to select a place to retire close to a high-quality hospital, especially if some kind of specific care is needed. Often, retirement communities can seem like a natural choice as they are purpose-built communities which offer services tailored to people in their later life. However, there is the potential that living in a retirement community might be correlated with lower-quality hospital care. This becomes an increasingly important issue as the baby boomer generation begins to enter late-life and the national percentage of people ages 65 and above increases year over year.

There are three economic theories that might explain how aging communities connect with healthcare quality.

1. Economics of scale: Healthcare professionals working in older communities might be more experienced at treating ailments that occur in older individuals.
2. Competition among hospitals: For medicare patients specifically, hospitals are awarded funds based on diagnosis related groups (DRGs) (Center for Medicare & Medicaid Services 2016). This reward varies on intensity of treatment resources, type of ailment, and other factors. This encourages hospitals to offer competitive, higher quality healthcare to attract more patients.
3. Patient Competition: Competition among patients for hospital space is likely to decrease the quality of healthcare. In an aging community, more people will demand access to a finite amount of hospital space and treatment time, which would lead treatment quality to decline patients.

## Dataset

The dataset is comprised of three sub-datasets:

1. The first dataset is the hospital quality star ranking dataset from the Center for Medicaid and Medicare Services (CMS) (Center for Medicare & Medicaid Services 2022). This dataset includes data from over 4000 hospitals around the US, and assigns them a star rating based on data from patient surveys and studies. The overall metrics used to determine the star rating is summarized in table 1. This is the target variable of my regression.

Measure Group	Weighting
Mortality	22%
Safety	22%
Readmission	22%
Patient Experience	22%
Timely and Effective Care	12%

Table 1: Weight and measure group for the CMS Hospital Star Rating dataset

Additionally, in figure 1, we can see the distribution of star ratings in the CMS Hospital Star Rating dataset. This dataset is also geographically visualized in the bottom right map. Note the 4000 hospitals do not cover all counties, so there are some left blank.

2. The second dataset contains temperature data (the instrumental variable for the regression). The dataset contains the average temperature in March 2022, broken out by US county (National Center for Environmental Information 2022). This data is visually represented in the middle bottom map.
3. The third dataset contains various county-level data from the US Census Bureau including the percentage of the population greater than 65 years old, the independent variable for my regression. Figure 2 shows the frequency distribution of the independent variable. Most US counties have an elderly population in the range of 10 and 25%, with the lowest being around 5% and the highest being around 45% (excluding the one outlier at 58%). This dataset is also geographically visualized in the bottom left map.

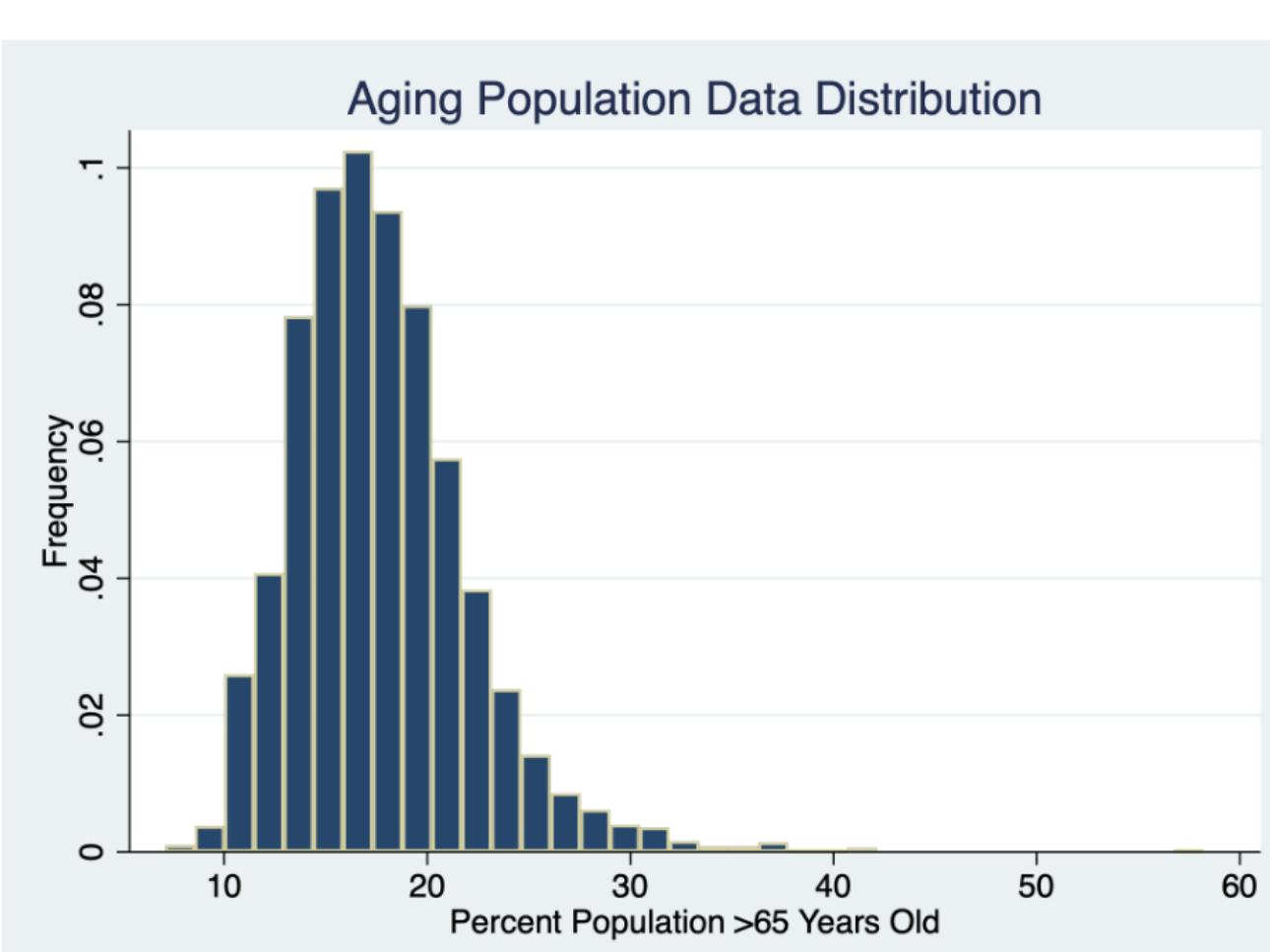
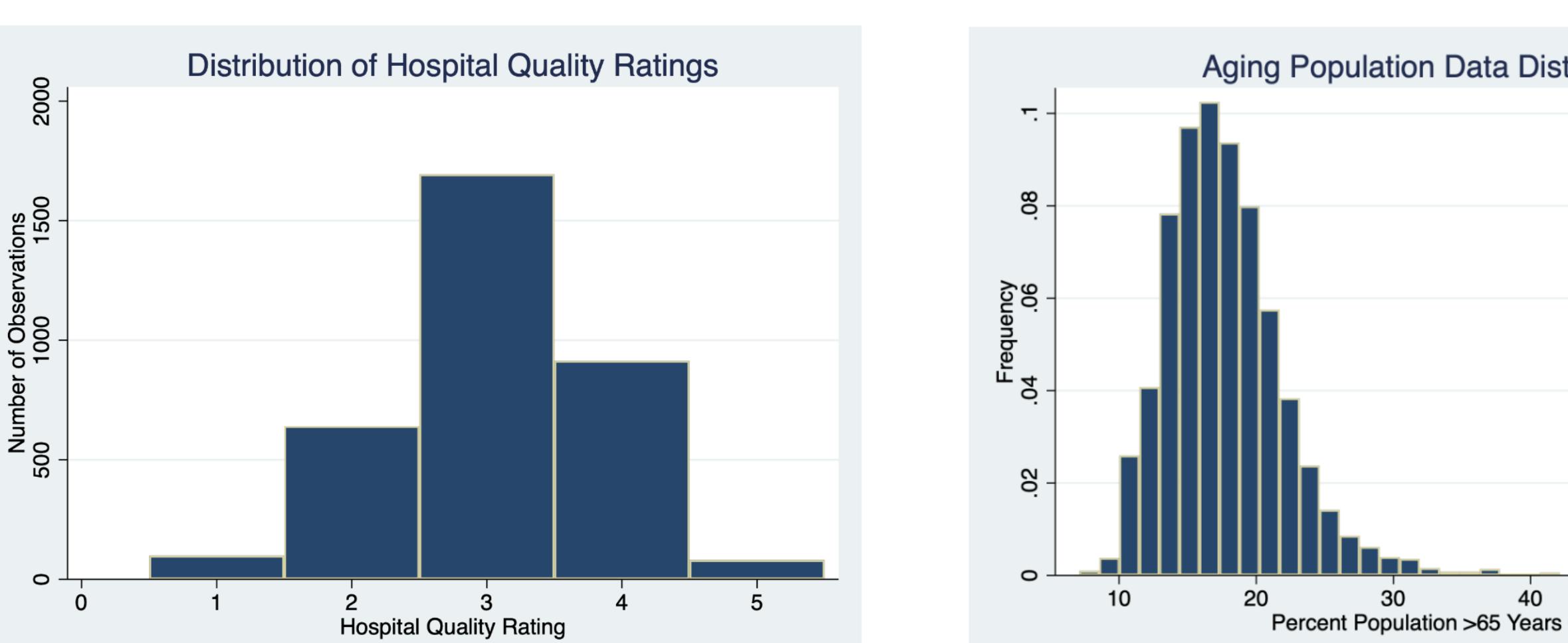


Table 2: First Stage Least Squares

	Percent > 65 Years
Temp	0.0223*** (0.00)
F	31.42
Prob < F	0.0000

t statistics in parentheses

\* p < 0.10, \*\* p < 0.05, \*\*\* p < 0.01

## The Model

The model is a 2-stage least squares (2SLS) ordered probit model. The instrumental variable for the model is the average temperature in March 2022. The reasoning behind this choice is that older individuals are more easily able to choose where they retire and often choose to live in warmer climates. This theory is supported by Table 2, which shows that temperature is indeed a strong instrument, as it is statistically significant.

### First Stage Estimation:

$$\widehat{Age} = \gamma_0 + \gamma_1 Temp + \gamma_k' \mathbf{x}_k$$

### 2nd Stage Ordered Probit:

$$Pr(HospitalRating = 1 | \widehat{Age}) = \Phi(\beta_0 + \beta_1 \widehat{Age})$$

$$Pr(HospitalRating = 2 | \widehat{Age}) = \Phi(\beta_0 + \beta_1 \widehat{Age})$$

$$Pr(HospitalRating = 3 | \widehat{Age}) = \Phi(\beta_0 + \beta_1 \widehat{Age})$$

$$Pr(HospitalRating = 4 | \widehat{Age}) = \Phi(\beta_0 + \beta_1 \widehat{Age})$$

$$Pr(HospitalRating = 5 | \widehat{Age}) = \Phi(\beta_0 + \beta_1 \widehat{Age})$$

## Area Controls:

- Land Area
- 2020 Population
- Home-ownership Rate

## Demographic Controls:

- % < 18 Years Old
- % Pop. With Bachelor's Degree
- % White
- % Female

## Income Controls:

- Median Value of Housing
- Per Capita Income

## Results

Table 3 shows the marginal effects of of percentage population > 65 years old on hospital rating. The coefficient on each row is the percentage change in the likeliness of having a hospital in that category given a 1% increase in the percentage population > 65 years old.

- For example, for the 5th row and 4th column, a 1% increase in the percentage population > 65 years old decreases your chance of having a 5-star hospital by 1.06%.

Figure 3 shows the percentage probability of having different rated hospitals depending on the percentage population > 65 years old.

- For example, if you live in a county with 10% of the population older than 65, then you have a 40% chance of a 4 star, a 40% chance of having a 5 star hospital, a 20% chance of having a 3 star hospital, and 0-5% chance of having a 1 or a 2 star hospital.

## Probability of Hospital Quality

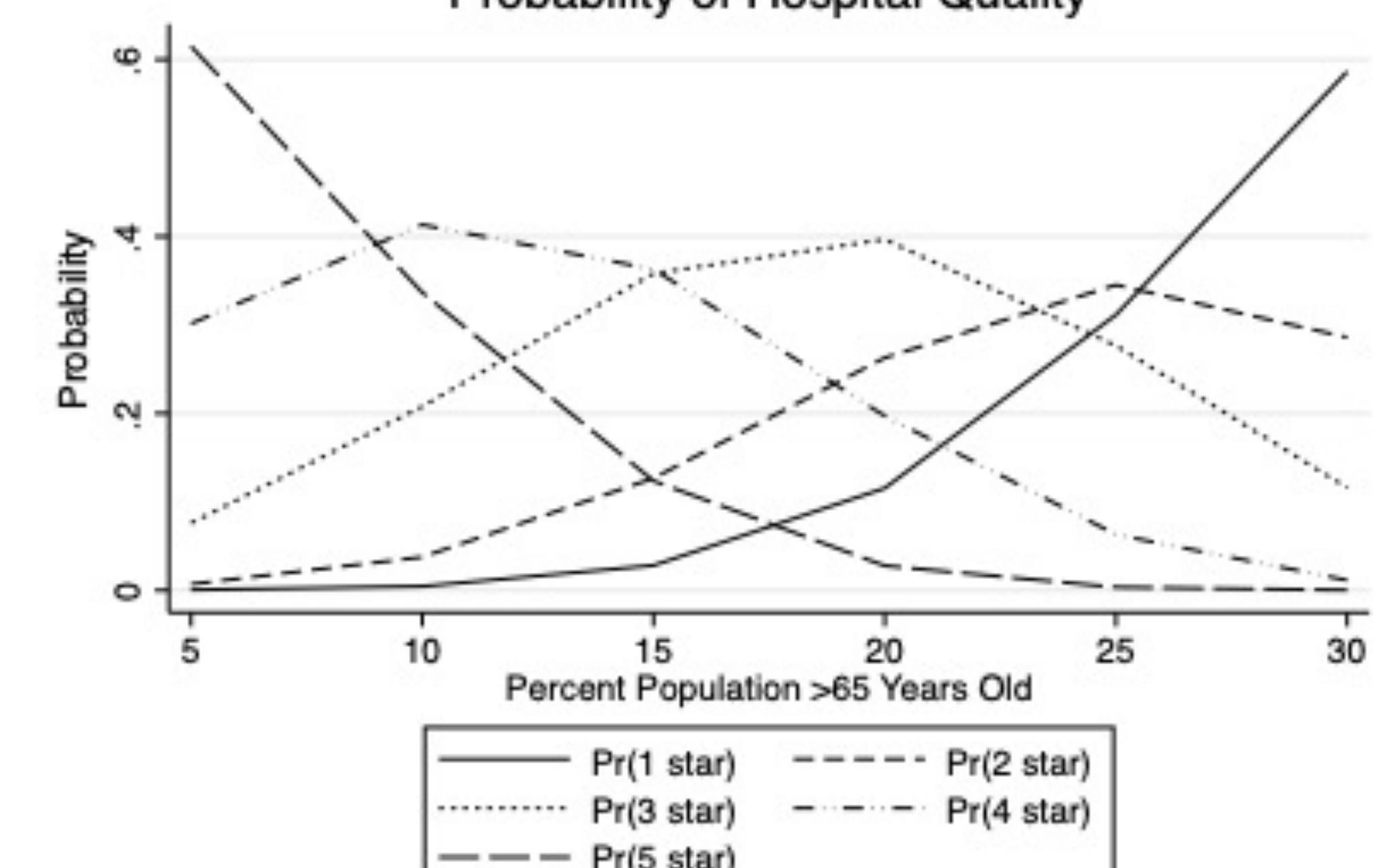


Figure 3: Percentage Probability of Having a Hospital Rating Given the Percent Population > 65 Years Old

## References

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