# A COMPARISON OF HOSPITAL CAPACITIES BETWEEN SINGLE-PAYER AND MULTI-PAYER HEALTHCARE SYSTEMS AMONG OECD NATIONS

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By

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## ABSTRACT

The healthcare systems of OECD nations are very diverse and complex. With the COVID-19 pandemic testing these systems to a breaking point not seen in generations, some nations performed better than others in handling the spike in hospitalizations that occurred throughout the world. In light of the ongoing health care debate in the United States among policymakers who support incremental changes to the existing multi-payer healthcare system and policymakers who support the nation transitioning to a single-payer system, this begs the question of whether there are statistically significant differences in the amount of hospital capacity between the two systems among OECD nations that are similar in economic and governmental structure. Using panel data for OECD countries in the time span between 1970 and 2018, I find a statistically significant negative relationship between nations with single-payer systems and the amount of hospital beds per 100,000 individuals that they had. As policymakers debate whether the U.S. should transition from a multi-payer system to a single-payer system, this may be an important estimated relationship to consider.

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# BACKGROUND

## Motivation

2020 has arguably been the most consequential year in the modern history of global healthcare. With the COVID-19 virus infecting tens of millions of individuals around the globe and tragically killing well over 2 million people at the time of writing this thesis, healthcare systems have been tested like never before, causing them to adopt new strategies and innovate in numerous ways to handle spikes in hospitalizations. Some healthcare systems throughout the world were well-equipped and had the proper resources to handle the pandemic. However, some, unfortunately, were not as successful.

The pandemic started spreading throughout the globe in the midst of the contentious Democratic Presidential Primaries in the United States, that ultimately saw former Vice President Joseph Biden win the nomination and eventually, the Presidency. One of the main areas of contention among the Democratic hopefuls was the topic of healthcare policy and how the candidates would expand on the Affordable Care Act (U.S. House of Representatives, 2010), which was enacted into law in 2010 by the Obama Administration and Democratic-majority Congress. Some candidates advocated for incremental and moderate improvements to the 2010 law in the form of expanded coverage and increased subsidies. However, others argued that the nation should transition to a single-payer healthcare system where the federal government provides universal health coverage and private health insurance is eliminated, if not severely restricted.

More progressive candidates like Vermont Senator Bernard Sanders and Massachusetts Senator Elizabeth Warren supported such a proposal, which they labeled “Medicare for All,” as

they believed that the single-payer system would cover virtually everyone in the nation and reduce administrative costs that makes the American healthcare system the most expensive in the world per capita (OECD, Health Spending). However, more moderate candidates, like former Vice President Biden and Minnesota Senator Amy Klobuchar, opposed "Medicare for All," as they cautioned about potential increases in federal government spending to establish and maintain such a program. They also warned of what they feared may result in a decline in the quality of healthcare should such a system be implemented and potential reduced hospital capacity. Now-President Biden even alluded to this latter concern in a debate on March 15, 2020, criticizing Italy's single-payer healthcare system as one that "doesn't work," referencing the nation's healthcare system that was strained beyond capacity during late February and throughout March as COVID-19 ravaged the nation.

Biden made the assumption that it was because of Italy's single-payer system that its hospital system could not handle the massive influx of COVID-19 cases that struck the nation abruptly, implying that single-payer systems cause nations to have less hospital capacity. However, this argument cannot be necessarily validated until proper policy analysis is conducted and other variables are factored in. With this debate over U.S. healthcare policy not going away, I thought that it would be worthwhile to conduct an analysis to see if there was a relationship between healthcare systems and hospital capacity.

## Research Question

This is exactly what this study will do, as it will seek to find the answer to the simple question: "Is there a discernible difference in the amount of hospital capacity that nations with single-payer systems have and the amount of hospital capacity that nations with multi-payer systems have?" To find out the answer to this question, I will consider numerous variables

related to nations' hospital capacities, including nations' demographic, economic, and overall health-related factors. The study will consider historic data from 1970 to 2018 among OECD nations, as the economies and governmental structures of these nations are relatively similar and comparable.

## Results of the Empirical Analysis

Using a random effects model with controls related to population density, population growth, life expectancy, GDP, and GDP per capita, I found a statistically significant negative relationship between OECD nations that had single-payer systems and the hospital capacity that these nations had in a given year between 1970 and 2018. This model also included year- and region-fixed effects. This relationship remained statistically significant when introducing a robustness check of including a lagged dependent variable into the model. While this study did not run controls pertaining to spending on healthcare (government, voluntary, and out-of-pocket) and hospital efficiency on hospital capacity due to the fear of post-treatment bias, I did find that when running these controls as dependent variables, there was not a statistically significant relationship between single-payer systems and multi-payer systems on any of these metrics except for voluntary spending on healthcare per capita, where I found that countries with single-payer systems had a statistically significant negative relationship with this variable.

## Context

Policymakers have made many arguments for and against transitioning the U.S. healthcare system into a single-payer structure over the years. These dissentions have related to healthcare spending, coverage, and efficiency, as the U.S. has struggled to outperform other OECD nations in all of these categories (OECD, 2021). Some believe that transitioning to a

single-payer system is the only solution to improve the American healthcare system, while others believe that the best path forward is to introduce incremental changes to the existing multi-payer system. Though single-payer advocates may have some evidence-based reasoning for their position, this thesis cautions that hospital capacity might not be one of them, as it shows that single-payer systems are associated with a reduced number of hospital beds per 100,000 people.

## LITERATURE REVIEW

### General Overview and Definitions

Most of the studies, reports, and data reviewed for this paper focused on the differences in healthcare systems between OECD nations. It should be no surprise that healthcare and health insurance systems among nations are very complex and difficult to classify into two categories, as even nations that are classified into their respective "single-payer" or "multi-payer" categories have their differences. One of the first challenges that I had to focus on was to solidify an exact and consistent standard for each of these systems. The study by Hussey (2003) and Anderson, "A comparison of single- and multi-payer health insurance systems and options for reform," does just this, with their definitions listed in Table 1 below. The OECD has also done extensive research on this topic, especially in their "Universal Health Coverage and Health Outcomes" report (Pearson, 2016). This report breaks down exactly which OECD nations are in which healthcare system category in the year it was published. The OECD paper actually breaks down the nations into two categories based on how the systems are funded and four subcategories based on the methods of how individuals receive health insurance. How the OECD defines these two categories are also included in Table 1 below:

**Table 1: Key Definitions**

| | |
|---|---|
| **Single-Payer Health Insurance System** | Hussey (2003) and Anderson describe this system as one that has "one organization – typically the government – [that] collects and pools revenues and purchases health services for the entire population." According to the study by Hussey (2003) and Anderson, single-payer systems "include all citizens within a single risk pool" and "have monopsony power in purchasing health services." Private health insurance in this model is either strongly limited or purely supplemental to public insurance (Hussey, 2003). This is primarily made up of systems that provide **residence-based coverage** and **contributory health coverage** with a single-payer (Pearson, 2016). |
| **Multi-Payer Health Insurance System** | Hussey (2003) and Anderson describe this system as one that "has several organizations [that] carry out these roles [(aforementioned in the Single-Payer definition)] for specific segments of the population." The study describes multi-payer systems as having "pools at different levels of health risk" and offering "the possibility of consumer choice of insurer" (Hussey, 2003). Multi-payer systems are contributory in nature, and either have automatic affiliation or a choice of multiple insurers. |
| **Residence-Based Health Coverage** | The OECD defines this type of coverage as reflecting "automatic enrollment based on residency and is mainly financed from taxes (Pearson, 2016)." In every one of these nations, residents and citizens are automatically enrolled into some sort of government health care system, whether that is administered at the national or provincial level. This universal system is single-payer in nature and considered as so for purposes of this study due to the fact that in this system, governments dominate the health insurance market, includes all of its citizens in the same risk pool through immediate enrollment in national and provincial health services, and can purchase health services with monopsony power (Hussey, 2003). |
| **Contributory Health Coverage** | The OECD defines this type of coverage as one that is financed through "social contributions or health insurance premiums (Pearson, 2016)." According to the OECD (Pearson, 2016), "this can be done through social contributions or health insurance premiums to a single national health insurance provider or through multiple insurers." In this category exist single-payer systems that are funded through contributions as well as multi-payer systems that have individuals become automatically affiliated in certain plans, or multi-payer systems that allow individuals the choice of insurer. |

Table 2 shows how the OECD classified these nations as of 2016, at the time Pearson's (2016) study was published:

**Table 2: 2016 OECD Categorization of National Health Systems**

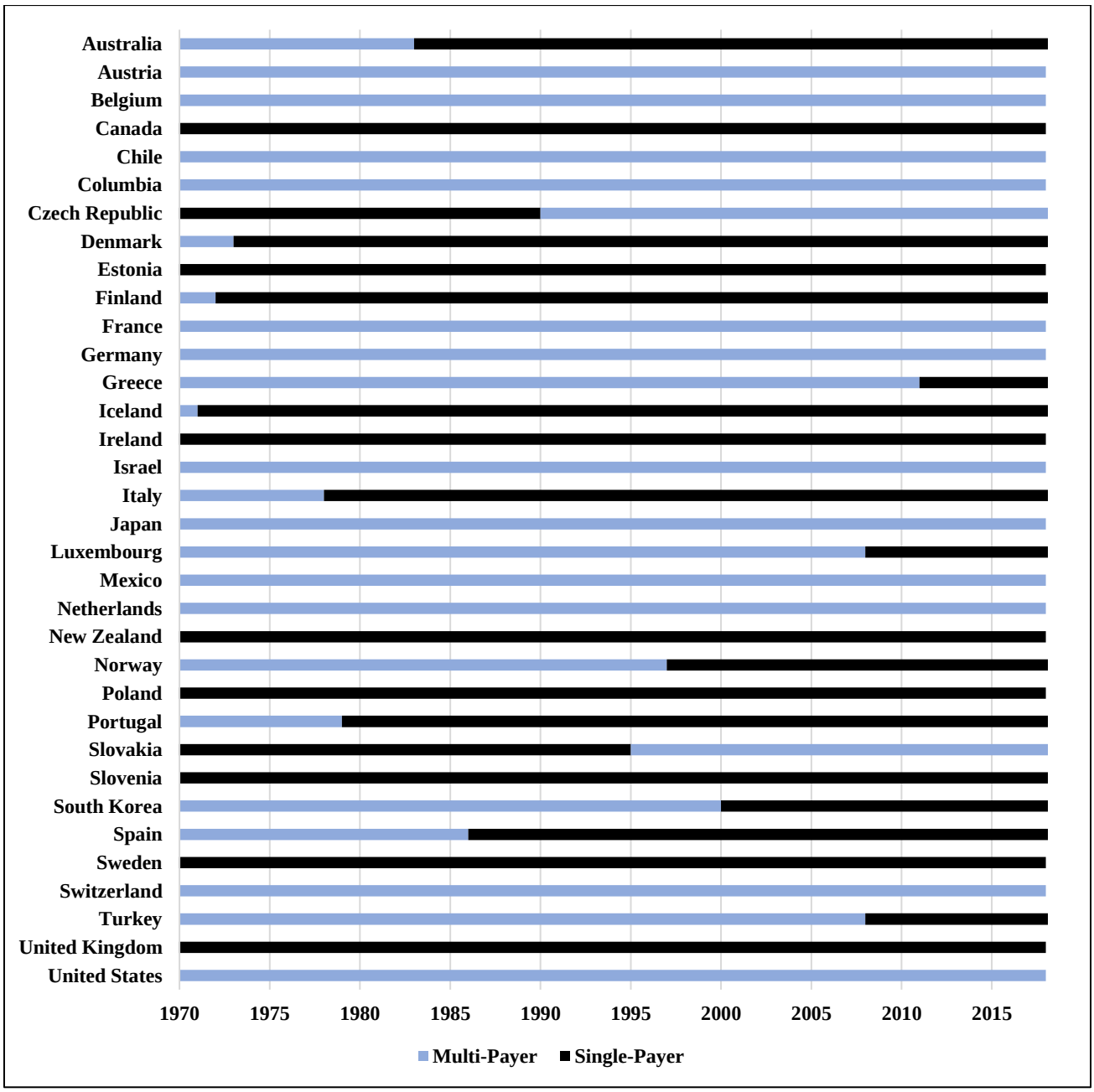
| **Single-Payer** | | **Multi-Payer** | |
|---|---|---|---|
| *Residence-Based Coverage* | *Contributory Single-Payer Coverage* | *Automatic Affiliation* | *Choice of Insurer* |
| Australia, Canada, Denmark, Finland, Iceland, Ireland, Italy, New Zealand, Norway, Portugal, Spain, Sweden, United Kingdom | Estonia, Greece, Hungary, Korea, Luxembourg, Poland, Slovenia, Turkey, Latvia*, Lithuania* | Austria, Belgium, France, Japan, Mexico | Chile, Czech Republic, Germany, Italy, the Netherlands, Slovak Republic, Switzerland, United States, Columbia* |

* The OECD study (Pearson, 2016) was completed in 2016, the year that Latvia first joined the OECD and before Lithuania joined in 2018 and Columbia joined in 2020. Latvia (Mitenbergs, 2012) and Lithuania (OECD/European, 2017) both have single-payer systems while Columbia (Webster, 2012) has a multi-payer system

One of the limitations of this list from the OECD is that it only captures a snapshot of what healthcare systems existed for these nations in 2016. Some of these countries' healthcare systems have switched from one category to another throughout the timeframe for which this thesis is conducted in. Notable examples include South Korea switching from a multi-payer system to a single-payer system in 2000 (Kwon, 2008), and the Czech Republic (Kinkorová, 2012) and Slovakia (Hlavačka, 2004), switching from single-payer systems under Soviet dominance during the Cold War, to multi-payer systems in the present. To accurately reflect the changes of system in our data, I extensively studied each healthcare system's laws and regulations through various academic sources to determine when some of these multi-payer nations became single-payer and when some of these single-payer systems turned into multi-payer systems, although the latter was much less common. The summary and background of the nations that transitioned from one system to another are listed in Table A1 in the "Appendix"

section. The timeline depicting the type of healthcare systems that OECD nations, which were ultimately included in the study, had throughout the scope of this study is listed in Table 3.

**Table 3: Timeline of OECD Healthcare Systems Between 1970-2018**




What I found throughout my research and analysis of the literature was that many of the studies on healthcare systems mainly focused on the systemic differences between the two

groups regarding their administration, funding, and coverage metrics. I did not come across any study that focused specifically on if the presence of a system itself illustrates a relationship with hospital capacity. One of the goals of my thesis is to contribute to the healthcare field and fill in this gap of determining if a significant relationship does exist between healthcare systems and hospital capacity.

**Hypothesis**

*$H_0$: There does not exist a statistically significant difference in hospital beds per 100,000 individuals between single-payer and multi-payer systems among OECD nations*

*$H_1$: There is a statistically significant difference in hospital beds per 100,000 individuals between single-payer and multi-payer systems among OECD nations*

The reasoning for this hypothesis is because I expect that single-payer healthcare systems will have less capital than nations multi-payer systems, hamstringing their ability to increase hospital capacity for their citizens. This is because single-payer systems that are primarily funded through national governments (Hussey, 2003) and may have less of an ability to raise capital and private funding than nations with multi-payer systems. It can then be expected that the revenues for single-payer systems, that mainly come through taxation, may be fewer than revenues for multi-payer systems, where revenue can come from more of a variety of sources. To provide some context, a research paper in the Journal of the American Medical Association (Schulman, 2019) claimed that hospitals would lose as much as $151 billion in annual revenues, a 16% decline, if the U.S. transitioned to a “Medicare for All” system. There is also expected to be much less competition for medical providers in a single-payer system than in a multi-payer system, also potentially contributing to a reduction of hospital capacity.

## STRUCTURE

### Conceptual Model

This study will analyze whether OECD nations with single-payer healthcare systems have more or less hospital capacity than nations with multi-payer systems. For clarification purposes, the exact dependent variable that will be examined for this research will be "Hospital Beds per 100,000" among OECD nations, while the main independent variable will be a dummy variable deciphering whether a nation has a single-payer healthcare system or a multi-payer healthcare system.

With the data being in panel form, representing numerous nations over a 49-year time period, I considered using a fixed effects model to conduct the empirical analysis. However, I believed that regional controls were relevant to include in this model, and since regions (North America, Europe, etc.) do not change over time, they would be omitted using a fixed effects model. Fixed effects models also are not well suited for main independent variables that have little variance, and since our main variable of "single-payer" is a binomial one, this poses a problem with using a fixed effects model.

This is why I determined that it was more appropriate to use a random effects model instead, with time- and regional-fixed effects included, as random effects models measure the mean of a random distribution of effects, such as the ones shown in this data. Random effects models are used for regressing panel data when differences across independent variables are expected to have an influence on the dependent variable. They allow for the estimation of effects of time-invariant controls (Williams, 2018), which make this type of model ideal in a study that

has time-invariant variables like *Region* and has a main independent binomial variable of *SinglePayer* that rarely changes over time.

This type of model is also able to accommodate the estimation of coefficients for binomial variables, such as the designation of a nation having either a single-payer healthcare system or a multi-payer systems. Random effects models accommodate and consider all variables that may be relevant in how many hospital beds per 100,000 a nation has over a period of time, and determine which of the variables are statistically significant regarding healthcare capacity among nations. Since there are only a finite number of variables that may affect how many hospital beds per 100,000 people a nation has, this is the best type of analysis to determine if types of healthcare systems have significant relationships with hospital capacities. The validity of using this model is confirmed by running a standard Hausman test.

It is also important to consider regional fixed effects because of the variation in hospital beds per 100,000 which we see in the data summary among different regions in the world. The fact that the average value of the dependent variable has a large amount of variation among these regions may suggest that regional controls could potentially be a significant determinant of healthcare capacity and this effect should not be left out of the model. Furthermore, region specific effects, such as the presence of a nation being located in Europe, might play an important role for the regulation of healthcare among member countries. I also include time-fixed effects in this random effects model to control for any major global shocks to hospital capacity that may occur in a given year, so this phenomenon does not skew my results. Formally, the model specification shows the following:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + B_i\,(\text{Controls})_{it} + \gamma + \delta + \varepsilon_{it}$$

Since the main dependent variable is not binary, it would not make much sense to use a logit model for this analysis. Therefore, this analysis will be conducted through Ordinary Least Squares (OLS) using a random effects model. The reasoning for this is because I am determining if the difference in hospital capacity between single-payer and multi-payer systems are statistically significantly different holding all other relevant variables constant, and the OLS model is the best type of model for estimating the unknown parameters for this. More specifically, the answer to the research question will be determined if there exists a statistically significant difference in Hospital Beds per 100,000 individuals between single-payer and multi-payer systems in the OECD.

## Data Description and Descriptive Statistics

The main dataset I used was the "Global Dataset on ICU, Ventilators, and Critical Care Capacity" panel data (University of Oxford, 2018) from the University of Oxford's Our World in Data publication. The dataset includes information from the World Bank, Eurostat, OECD, and national government records specifically regarding the total amount of hospital beds per 100,000 and total population each listed country has in a given year between 1960 and 2018. This includes all 37 OECD nations that were initially being studied in this thesis. As this thesis only limits the analysis of hospital capacity by healthcare system to OECD nations, all nations in this dataset that are not currently members of the bloc were excluded from the main dataset used for the analysis. All data points that were outside the 1970-2018 range were also excluded, as the analysis is limited to just these years. This is because 1970 is the year that most nations begin reporting data on hospital capacity and 2018 is the most recent year that this data was reported for most countries at the time of drafting this thesis.

Each datapoint included in this model has corresponding values representing the dependent variable of how many hospital beds per 100,000 an OECD nation has in a given year between 1970 and 2018. Each datapoint included in this model also has a corresponding binomial indicator representing the main independent variable, illustrating if a nation had a single-payer system or a multi-payer system in a given year between 1970 and 2018. This indication is represented through a dummy variable with "0" meaning that a nation has a multi-payer healthcare system in a given year, and "1" meaning that a nation has a single-payer healthcare system in a given year. The exact definitions for what constitute as a single-payer system and a multi-payer system are included in the "Literature Review" section, but each data point representing a nation in a given year is assigned either a "0" or a "1."

**Table 4: Characteristics of Dependent and Main Independent Variable**

| | |
|---|---|
| **Dependent Variable** | -Hospital Beds per 100,000;<br>-Term is interchangeable with "hospital capacity" and "healthcare capacity;"<br>-STATA Code: *HospitalBedsper100000* |
| **Independent Variable** | -Single-Payer Dummy Variable;<br>-Term is interchangeable with "healthcare system;"<br>-STATA Code: *SinglePayer*<br>-If a nation has a single-payer system in a given year, *SinglePayer* = 1<br>-If a nation has a multi-payer system in a given year, *SinglePayer* = 0 |

With the analysis being conducted through a random effects model, there were also numerous other variables that were considered to be included that are relevant to how many hospital beds per 100,000 a nation has in a given year. All of these variables were expected to correlate with the dependent variable and by including these variables, I sought to reduce the amount of confounding variables left in the error term for this model. Other than the main

independent variable of type of healthcare system, the controls used in this study included population density, population growth, Gross Domestic Product (GDP), GDP per capita, and life expectancy, as they are all theorized to be relevant when examining hospital capacity. Other variables like government/compulsory, voluntary, and out-of-pocket spending on healthcare per capita, in addition to the average length of hospital stay, or ALOS, which is typically used as an indicator for hospital efficiency (OECD, Length), were also considered to be included as independent variables in this model. However, these spending and efficiency controls were ultimately left out due to the risk of post-treatment bias, which will be discussed more in detail in the "Empirical Results" section of this paper.

The one variable that does not vary over time of *Region* will be accounted for through the use of fixed effects. Each region of North America, Europe, East Asia, South America, Oceania, and the Middle East is annotated with a specific identification number in the data in order to use fixed effects in the data properly. The main independent variable of type of healthcare system does not fall under that same category of a time-invariant variable, as some nations in the dataset have transitioned into different systems between 1970 and 2018. The other variables all vary over time and may have a relationship with the amount of healthcare capacity that a nation has. All of these variables have been frequently used in other studies that measure factors relevant to hospital capacity or other health-related factors. The relevancy of each independent variable in regard to healthcare capacity is listed in Table A2 in the appendix.

It was previously mentioned that the data illustrating the amount of hospital beds per 100,000 per OECD nation came from the Our World in Data dataset (University of Oxford, 2018). However, the data for many of the controls were not included in this original dataset. The data for most of these variables either came from common sense or other data sources. The data

for the regional classifications came from a common sense of just knowing the geographic region of where a nation belongs to. Government/compulsory spending per capita, voluntary spending per capita, out-of-pocket spending per capita, population growth, life expectancy, ALOS, GDP, and GDP per Capita were all extracted from various OECD datasets. Population density was extracted from a different Our World in Data (Ritchie, 2017) dataset. Each of these values were plugged into the main dataset coinciding with their nation and year.

The descriptive statistics of the variables used in the main regression are listed in Tables A3, A4, and A5. Though there are 37 OECD nations, Latvia, Lithuania, and Hungary were automatically dropped when running random effects regressions in STATA, as there were many missing values for at least one of the variables for these countries. Since the frequency of these three countries having missing values was higher than all other countries, STATA automatically omitted these groups. Therefore, the data shown in Tables A3, A4, and A5 in the appendix reflects the 34 OECD nations observed for this model.

The non-binary variables in this thesis will also be tested using logarithmic expressions rather than standard numerical ones. This is because logarithmic models narrow the distribution of logged variables and make its coefficient estimates less sensitive to outliers. Logarithmic models are very appropriate for this data as the relationships are nonlinear in the parameters and there exist major outliers in many of the independent variables that may skew the data. It is also important to include heteroskedastic-robust standard errors in our modeling to provide a conservative estimate of the relationship between the independent variable and the dependent variable. This use of robust standard errors “eliminates worries that about whether heteroskedasticity is present or not” (Stock, 2020) and is more conservative than using standard homoscedastic standard errors.

## EMPIRICAL RESULTS

Model 1, shown in Table 5 below (Models 2, 3, 4, and 5 are also shown in Table 5), represents our baseline for this study, as it measures the effect of nations having a single-payer system on the amount of Hospital Beds per 100,000 that it has, without any other controls, fixed effects, or lags. This model demonstrates the results of a single logarithmic regression, illustrating what the effects of *SinglePayer* would have on hospital capacity without any other controls based on the data provided. Unsurprisingly, this regression leaves out many confounding variables that may be relevant for this study and there are many variables that need to be included in this model to even get close to determining if I can or cannot reject the null hypothesis. Therefore, this model does not provide us a great deal of information, as it has no other controls included. Though Model 2 does include year and region fixed effects, there still needs to be more controls added to get a better understanding of the relationship between the dependent and independent variables in this study.

To account for confounding variables, other independent variables related to demographics of OECD nations were included in Model 3 that relate to population density, the growth rate of a nation, and life expectancy at birth. These demographic metrics were predicted to be relevant to the amount of hospital beds per 100,000 a nation has for various reasons listed in the "Data Description and Descriptive Statistics" section, and thus were worthwhile to be included in this model to reduce the value of the error term. Population density served as an indicator for how urbanized a nation is and was relevant to use because population density could potentially affect how many patients each hospital can provide services to, as high-density areas may have better access to healthcare facilities (Hamidi, 2020). The growth rate was important to include because it could be expected that nations with more rapidly increasing populations may

find it more difficult to keep pace with developing hospital beds and reduce the amount of hospital beds per 100,000 they may have (Ravaghi, 2020). Life expectancy also serves as an indicator for the overall health of a nation, making it relevant to include as a demographic metric, and a study by Narasimha Rao and Paul Baer (2012) found a slight correlation between life expectancy and hospital capacity.

It was found that the inclusion of these demographic metrics, in addition to the region and time fixed effects, made the *SinglePayer* variable's coefficient negative and statistically significant at the 0.01 level. Two of the independent variables, population growth rate and life expectancy, were also statistically significant in this model. In addition, the demographic controls in this model showed that there may have been an upward bias for the single-payer variable in Models 1 and 2, as Model 3 illustrated that *SinglePayer* had a coefficient of -.271. This is interpreted as meaning that according to this model, the expected decrease in hospital beds per 100,000 in geometric mean from multi-payer systems to single-payer systems is approximately 27%, holding all other relevant variables constant.

However, demographic and health controls may not be the only relevant factors in determining hospital capacity. This is why Model 4 also included economic metrics, including a control for the overall size of OECD national economies (Total GDP) and a control for mean wealth per capita (GDP per Capita) of OECD nations. These two metrics serve as indicators for the economic and financial capacity nations may have to develop hospitals and increase hospital capacity. Data published by the World Bank (2012) in an "Our World in Data" publication also found that there was a correlation between GDP per Capita and hospital capacity, indicating that these variables may be relevant to include. With GDP being a metric that was used in both of these controls in different forms, there was cause for concern that there may be multicollinearity

between these two variables. However, after running a correlation test, it was found that this issue was non-existent. This was the model that dropped three groups (Hungary, Latvia, Lithuania), which may have biased the estimates in the other models, so these three groups were subsequently dropped from Models 1 to 3 to provide consistency between the models. The results of the omissions of Hungary, Latvia, and Lithuania are reflected throughout this section.

When these economic controls were included in addition to the demographic controls, including time- and region- fixed effects, the GDP per capita coefficient was shown to be statistically significant. The inclusion of these economic metrics also found that the *SinglePayer* coefficient in Model 3 was slightly upwardly biased, as the coefficient for the main independent variable in Model 4 shifted more negatively to a value of approximately -.279, which is statistically significant at the 0.01 level. This would be interpreted as meaning that according to this model, the expected decrease in hospital beds per 100,000 in geometric mean from multi-payer systems to single-payer systems is approximately 28%, holding all other relevant variables constant.

With the coefficient for the single-payer variable being both statistically significant and relatively similar between Models 3 and 4 after controlling for demographic, health, and economic metrics as well as region- and year- fixed effects, there may be evidence to suggest there may be a negative relationship between single-payer systems and national hospital capacity compared to multi-payer systems. This notion was further underscored in Model 5 when a lagged dependent variable was included to measure the effects of the dependent variable in the previous periods compared to the current periods being measured in the regression. When this lagged dependent variable was included, I found that the coefficient for the single-payer variable did shift to the right and decrease in magnitude, but it still remained negative at a value of -.014, and

this negative relationship remained statistically significant at the 0.05 level. The inclusion of this lagged dependent variable served as a robustness check and still illustrated a negative and statistically significant effect of single-payer systems on national hospital capacity for OECD nations. Models 1 through 5 are shown below:

**Table 5: Regressing Hospital Beds per 100,000 People on Independent Variables**

| IV (ln for continuous var.) | Model 1 ln(DV) | Model 2 ln(DV) | Model 3 ln(DV) | Model 4 ln(DV) | Model 5 ln(DV) |
|---|---|---|---|---|---|
| Single-Payer = 1 | -.1326514 (.1607039) | .1702378 (.1493377) | -.271203*** (.0965077) | -.2788818*** (.0853189) | -.0142742** (.0055705) |
| Population Density (per sq. Km) | | | -.0842067** (.0420216) | -.0754834* (.0438759) | .0012689 (.0025615) |
| Population Growth Rate (%) | | | -.105307*** (.0324184) | -.1482845*** (.0331444) | -.0002463 (.0020175) |
| Life Expectancy at Birth | | | 3.329115** (1.504806) | .6410231 (1.533306) | -.2522492*** (.0834431) |
| Total GDP (Millions USD) | | | | -.011895 (.0310838) | -.0005216 (.0015786) |
| GDP per Capita (USD) | | | | .5648486*** (.1545757) | .0094487 (.0098596) |
| Constant | 6.302859 | 6.24187 | -7.214715 | -.2922377 | 1.171333 |
| $R^2$ (Overall) | 0.0015 | 0.4602 | 0.6246 | 0.6968 | 0.9890 |
| N | 1,120 | 1,120 | 973 | 928 | 844 |
| OECD Nations | 34 | 34 | 34 | 34 | 34 |
| Lagged Dependent Variable | No | No | No | No | Yes |
| Year Fixed Effects | No | Yes | Yes | Yes | Yes |
| Region Fixed Effects | No | Yes | Yes | Yes | Yes |
| Robust standard errors are shown in parentheses<br>***p<0.01, **p<0.05, *p<0.01 | | | | | |

Other variables were considered to be included in this model as well, as there is reason to believe that variables regarding government spending and individual spending on healthcare may also affect the amount of hospital capacity an OECD nation has. The reason why these potential controls were not included in any of the models was due to the risk of post-treatment bias. This is because government spending and individual spending are expected to be highly correlated with the single-payer variable and may run the risk of capturing some of the effect that the main independent variable may have on hospital capacity. This runs the risk of including an additional bias in the regression which may skew the data and provide an inaccurate illustration of the true effects that national healthcare systems may have on the amount of hospital beds a nation has per 100,000 people.

However, some of these controls could also be used to cross-check the implications of these results. This way, it could be determined if there were statistically significant differences between single-payer and multi-payer healthcare systems in how much governments in the OECD and individuals living in OECD nations spent on healthcare. It could also be determined if there were statistically significant differences between the two systems on other indicators, such as life expectancy and hospital efficiency

By using the data and the variables that this study had at hand, the data accounting for government spending per capita, voluntary spending per capita, and out of pocket spending per capita data, including data regarding life expectancy and average lengths of hospital stay, were able to be transformed into dependent variables. When running regressions using the same independent variables from Model 4, the following results are shown in Table 6.

**Table 6: Regressing Spending, Health, and Efficiency Metrics on Independent Variables**

| Model 6: Dependent Variable is Government/Compulsory Spending per Capita<br>Model 7: Dependent Variable is Voluntary Spending per Capita<br>Model 8: Dependent Variable is Out of Pocket Spending per Capita<br>Model 9: Dependent Variable is Life Expectancy at Birth<br>Model 10: Dependent Variable is Average Length of Hospital Stay | | | | | |
|---|---|---|---|---|---|
| IV (ln for continuous var.) | **Model 6 ln(DV)** | **Model 7 ln(DV)** | **Model 8 ln(DV)** | **Model 9 ln(DV)** | **Model 10 ln(DV)** |
| Single-Payer = 1 | -.0233022<br>(.0777079) | -.2732152**<br>(.1109925) | -.0808603<br>(.1355434) | .0078808<br>(.0060932) | -.0964824<br>(.0732727) |
| Population Density (per sq. Km) | -.0130915<br>(.033975) | .03235<br>(.0544191) | -.0306008<br>(.0511855) | -.0023671<br>(.0045495) | .0055689<br>(.0300193) |
| Population Growth Rate (%) | -.0751434***<br>(.0271829) | .0331936<br>(.0488899) | .0440062<br>(.0533973) | .0008055<br>(.0023461) | -.0449947*<br>(.0231462) |
| Life Expectancy at Birth | 4.824269***<br>(1.473118) | 3.355763<br>(2.057739) | 2.553946<br>(2.276165) | | 1.207534<br>(1.128678) |
| Total GDP (Millions USD) | .0216333<br>(.0288624) | .0446054<br>(.0447595) | .0347227<br>(.042452) | .0026548<br>(.003936) | -.0069999<br>(.0221927) |
| GDP per Capita (USD) | 1.115152***<br>(.1776771) | .8655426***<br>(.2811772) | .5928904***<br>(.1900036) | .0699608***<br>(.0145164) | .0412863<br>(.1403896) |
| Constant | -25.37135 | -18.39894 | -12.66219 | 3.606834 | -3.193451 |
| $R^2$ (Overall) | 0.9440 | 0.8396 | 0.8264 | 0.7969 | 0.5949 |
| N | 860 | 876 | 741 | 928 | 734 |
| OECD Nations | 34 | 34 | 33 | 34 | 31 |
| Lagged Dependent Variable | No | No | No | No | No |
| Year Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Robust standard errors are shown in parentheses<br>***p<0.01, **p<0.05, *p<0.01 | | | | | |

The results found that, for Models 6, 8, 9, and 10, which measured government spending, out of pocket spending, life expectancy, and hospital efficiency respectively, there was no statistically significant difference between single-payer and multi-payer nations, when using all the same controls and fixed effects that were used to measure the effects on national healthcare systems on hospital capacity. The only exception was in Model 7, where it was illustrated that single-payer systems had a negative effect on voluntary spending per capita compared to multi-payer systems, a value that was statistically significant at the 0.05 level.

These results may suggest that there may be no statistically significant difference between single- and multi-payer systems in terms of financial burden on the government, out of pocket spending from individuals, life expectancy, and hospital efficiency, but there may be reason to believe that there is a statistically significant difference with voluntary spending. These cross-checks may provide a glimpse into the estimated effects of healthcare systems on spending, hospital efficiency, and overall health outcomes. This also could signal that there may not be a difference between single-payer systems and multi-payer systems in their ability to collect funding and resources.

Therefore, this could lead us to believe that the main reason why there is a statistically significant negative effect of *SinglePayer* on hospital capacity might have to do with the presence of insurance competition that exists in multi-payer systems compared to monopsony single-payer systems, rather than the ability of the system to collect resources. However, as these regressions used the same independent variables as the regressions used to examine the effects of healthcare systems on hospital capacity, there may be other variables that may need to be included in future studies to better examine the effects of healthcare systems on these other metrics that were transformed into dependent variables.

Regardless, based on Models 4 and 5, there is reason to believe that there is a statistically significant negative difference between single-payer systems and multi-payer systems in terms of the amount of Hospital Beds per 100,000 a nation has. When population density, population growth, life expectancy, GDP, and GDP per Capita, in addition to time- and region-fixed effects, were controlled for in the random effects model illustrated in Model 4, it was found that there was a statistically significant negative effect of the *SinglePayer* variable on hospital capacity. This notion was further enforced with the inclusion of a lagged dependent variable in Model 5, which still showed that single-payer systems were expected to have less hospital beds per 100,000 than multi-payer nations, ceteris paribus.

## CONCLUSION

This thesis found that when controlling for economic, demographic, and health-related variables, in addition to time- and region- fixed effects, there existed a statistically significant negative relationship between OECD nations having single-payer healthcare systems and the amount of hospital capacity that they had. In the model that controlled for all of these variables and fixed effects, I found that there was an expected 28% decrease in hospital beds per 100,000 in geometric mean from OECD multi-payer systems to single-payer systems, holding these other relevant variables constant. This relationship was statistically significant at a 0.01 level and was still statistically significant at a 0.05 level when a lagged dependent variable was included. For these reasons, I can reject the null hypothesis that there does not exist a statistically significant difference in hospital beds per 100,000 individuals between single-payer and multi-payer systems among OECD nations, ceteris paribus.

It is very important to note that even though I found a statistically significant relationship between OECD nations having single-payer systems and having less hospital capacity, it does

not necessarily mean that this proves a causal relationship. Since my thesis only controlled for demographic, economic, and overall health variables, there still exists the potential of numerous other variables that may need to be controlled for in order to determine the overall effects of national healthcare systems on hospital capacity.

Each healthcare system is extremely complex and varies greatly in terms of structure, costs, funding, and coverage. While regulatory frameworks exist for all OECD countries' healthcare systems, these frameworks vary immensely. These contrasting regulations may not even just exist between nations with single-payer systems and nations with multi-payer systems, but also among nations with single-payer systems and among nations with multi-payer systems. I was not able to find proper data which would provide information regarding healthcare regulation controls that were available and consistent among all OECD nations observed in our data. It may be useful for researchers to consider this in future studies.

Although I cross-checked our results using the main independent variable of *SinglePayer* on other variables such as health spending, life expectancy, and hospital efficiency, it may be worthwhile for researchers in the future to also conduct full studies of the overall effects of national healthcare systems on these variables. Through my research, I was unable to find an exact study that studied the effects of OECD national healthcare systems on health spending, life expectancy, and hospital efficiency. However, there were some U.S.-centered studies that provided insights into these potential relationships.

For example, a recent study published in the Journal of the American Medical Association (Woolf, 2019) found that "although poor access or deficiencies in quality could introduce mortality risks among patients with existing behavioral health needs or chronic diseases, these factors would not account for the underlying precipitants (such as suicidality,

obesity) which originate outside the clinic." To put it simply, they noted that though hospital systems may pose risks to mortality rates, major contributions to decreases in the life expectancy in the U.S. were mainly attributed to other factors such as overdoses, suicide rates, and other health factors related to organ system diseases. Another study by the Commonwealth Fund and Urban Institute (Blumberg, 2019) found that if the U.S. were to switch to a single-payer system, health spending may become either more or less expensive depending on the exact provisions of the system. This finding underscores our previous limitation that health regulations within both systems may also be important to consider in future studies. Another study (Ridic, 2012) also touched upon hospital efficiency and found that in the U.S., "waiting times tend to be shorter than in rationed systems."

The controls used in this thesis were tailored to be relevant in attempting to determine if there was a specific relationship between healthcare systems and hospital capacity. For the other cross-checked variables, future studies should include controls that are tailored to do the same to attempt to discover relationships between types of healthcare systems and spending, life expectancy, and hospital efficiency. Although there have been relevant studies comparing the U.S.'s performance on these metrics compared to other nations, it would be interesting for future researchers to conduct broader studies among all OECD nations, similar to this thesis.

This study also only focused on OECD nations, due to the fact that these nations often have similar democratic structures and reliable data. However, researchers also may want to examine the effects of healthcare systems on hospital capacity in non-OECD nations as well. The issue with this is that researchers would have to make sure that the data from these nations are reliable and that they control for any major differences in systems of government (e.g. democracies compared to autocracies, etc.). Conducting this study for developing nations as well

instead of OECD nations could also provide some insight into the different dynamics that exist when determining hospital capacity between developed and developing nations.

I also considered breaking down the study further and examining if there were any statistically significant differences in hospital capacity among nations with "Residence-Based Health Coverage" and "Contributory Health Coverage" for healthcare and even between the four subcategories (Pearson, 2016) of "Single-Payer Residence-Based Health Coverage," "Single-Payer Contributory Health Coverage," "Multi-Payer Automatic Enrollment Coverage," and "Multi-Payer with Multiple Insurers." Though the OECD had data classifying their member nations into these categories as of 2016, I could not find sufficient data that showed which nations may have transitioned from one category to another throughout the 1970-2018 time period range that this thesis focuses on, unlike I was able to do for determining which nations switched from single-payer systems to multi-payer systems and vice versa. If researchers are able to determine if and when OECD nations transitioned between one of these categories to another, it may be useful to conduct this type of study as well.

Regardless, for U.S. policymakers who support the idea of "Medicare for All," or the idea of transitioning the current American healthcare system from a multi-payer system with private insurance to a single-payer system primarily administered by the federal government, these findings shown in this study may be concerning. Though it can be argued that single-payer systems have other benefits compared to multi-payer systems, this thesis shows that hospital capacity might not be one of them.

These implications are relevant approximately one year after the COVID-19 pandemic severely strained global hospital systems, causing many hospitals to be overflowed and unprepared to handle the influx of cases during that time. To be clear, this study does not imply

that single-payer systems did worse off than multi-payer systems in handling the influx of patients during this time, as other studies would have to be conducted in order to examine this specific type of relationship. However, hospital capacity is one metric of how prepared nations are to handle specific massive shocks in demand for healthcare, and these findings should be considered by policymakers when making decisions related to health regulatory policy.

Although these results provide insight into one aspect of the public policy debate over the regulatory landscape of healthcare systems, other factors should be considered as well when policymakers are developing the right path forward to construct the ideal healthcare system for the U.S. For example, factors such as overall health outcomes of nations, how much healthcare costs on average per person, and how efficient healthcare systems are, should also be taken into consideration when policymakers make these decisions. This thesis gives some insight into the differences between the two systems when measuring these other factors, but since they were not the main dependent variables of this thesis, there needs to be more thorough studies on the effects of healthcare systems on health outcomes, efficiency, and costs to determine their true relationships, as mentioned in the "Limitations" section of this paper.

Regardless, policymakers should consider both the costs and benefits of all of these factors when formulating improvements to the American healthcare system and determining if a multi-payer system should still remain or if the nation should transition to a single-payer system. There may very well be evidence-based reasons for policymakers to advocate for the latter type of healthcare system, but this study warns that hospital capacity just might not be one of them.

## APPENDIX

**Table A1: Nations that Transitioned Systems Between 1970 and 2018**

| Nation | Transition Date | Explanation and Citation |
|---|---|---|
| Australia | Transitioned from multi-payer to single-payer in 1984 | "Medicare as we know it came into operation on 1 February 1984, following the passage in September 1983 of the Health Legislation Amendment Act 1983." (Biggs, 2004) |
| Czech Republic | Transitioned from single-payer to multi-payer in 1990 | "In 1990 and 1991, during the democratisation process, a dramatic liberalisation of the healthcare system took place. The principle of free choice of healthcare facility was introduced." (Kinkorová, 2012) |
| Denmark | Transitioned from multi-payer to single-payer in 1973 | "Universal coverage developed gradually, starting in the latter part of the 1800s with nongovernmental insurance, known as sickness funds, covering primary care and user charges for hospital care. In 1973, the current universal public coverage system was founded through legislative reform." (Tikkanen, 2020) |
| Finland | Transitioned from multi-payer to single-payer in 1972 | "Finland has since 1972 had a primary health care system based on health centres run and funded by the local public authorities called 'municipalities'" (Kokko, 2009) |
| Greece | Transitioned from multi-payer to single-payer in 2011 | "After 2011, population coverage for health care was undertaken by a single entity, EOPYY, which covers the insured and their dependents." (Economou, 2017) |
| Iceland | Transitioned from multi-payer to single-payer in 1971 | "These are a new Social Security Act (Act No. 67/1971) and the Health Care Act (Act No. 56/1973). With the passage of the Social Security Act the whole of the population became covered by a single public health insurance scheme." (Sigurgeirsdóttir, 2014) |

| | | |
|---|---|---|
| Italy | Transitioned from multi-payer to single-payer in 1978 | "Universal coverage is provided through Italy's National Health Service (Servizio sanitario nazionale, or SSN), established through legislation in 1978." (Tikkanen, 2020) |
| Luxembourg | Transitioned from multi-payer to single-payer in 2008 | "The CNS was created by law in 2008 and is now the single payer fund for health benefits and long-term care insurance." (Spranger, 2015) |
| Portugal | Transitioned from multi-payer to single-payer in 1979 | "Since 1979, the Portuguese health care system has been based on a National Health Service structure that is expected to promote equity, efficiency, quality, accountability and the devolution of power." (Oliveira, 2005) |
| Slovakia | Transitioned from single-payer to multi-payer in 1995 | "On 1 January 1995 Act No. 273/1994 on Health Insurance paved the way for the establishment of multiple health insurance companies." (Hlavačka, 2004) |
| South Korea | Transitioned from multi-payer to single-payer in 2000 | "In 2000, there was a major change in the structure of the health insurance programme, and all insurance societies were merged into one single payer." (Kwon, 2008) |
| Spain | Transitioned from multi-payer to single-payer in 1986 | "Based on the constitutional mandate, Law 14/1986 on General Public Health[9] created a National Health System (NHS) that integrates and coordinates all health services of the autonomous communities, including those rendered at centers and hospitals managed by the municipalities.[10]." (Economou, 2017) |
| Turkey | Transitioned from multi-payer to single-payer in 2008 | "By October 2008, the harmonisation of the benefit package was completed and finally UHI gathered all insured citizens (Bag-kur, SSK, Emekli Sandigi and Green Card holders) under a single insurance umbrella." (Özdeniz, 2011) |

**Table A2: Relevance of Controls**

| | |
|---|---|
| **Population Density** | The amount of people per square kilometer may play a role in how large hospitals are, where they are located, how many potential patients each hospital can provide services to, and if this population density provides any limitations to the potential amount of hospital beds a nation can physically provide. Higher density areas may also have greater access to healthcare (Hamidi, 2020). |
| **Population Growth** | The rate in which a nation's population growth may play a factor in how many hospital beds per 100,000 it has in a given year, as it can be assumed that nations with higher population growths can have fewer hospital beds per 100,000 if the rate in which hospital beds increase does not keep up. Furthermore, population growth and aging can affect the demand for hospital care (Ravaghi, 2020). |
| **Region** | Regional factors could play a factor in influencing national healthcare capacities, as neighboring and nearby nations can potentially have similar insurance models and cultures regarding medical care. This can be seen in the main dataset, as there exists a large variation of hospital capacity between different regions. |
| **GDP** | How large a nation's economy is may increase their ability to build hospitals and increase their healthcare capacity (World Bank, 2012). |
| **GDP Per Capita** | The mean wealth per individual that a nation has can also play a role in healthcare capacity, as nations with greater individual wealth can be predicted to have larger healthcare capacities (World Bank, 2012). |
| **Life Expectancy** | The life expectancy at birth for a given nation is an indicator for the overall health of that nation, meaning that there could be a possibility that nations with lower life expectancy rates may have a need for more hospital beds, or that nations may have higher life expectancies because of the healthcare capacities they may have. A study also found that there was a slight correlation between life expectancy and hospital capacity (Rao, 2012). |

**Table A3: Descriptive Statistics of Continuous Controls Used in Examining Hospital Capacity and Healthcare Systems**

| Variable | Observations | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Hospital Beds per 100,000 | 1,120 | 599.0333 | 308.5663 | 70 | 1990 |
| Population Density per Sq. Km | 1,087 | 124.947 | 123.0328 | 1.628028 | 527.9668 |
| Population Growth Rate (%) | 1,121 | .7148905 | .7257675 | -2.541 | 6.1993 |
| Life Expectancy at Birth | 1,114 | 74.16167 | 4.205004 | 52 | 81.7 |
| Total GDP (in Millions of USD) | 1,088 | 962728.7 | 2036302 | 786.937 | 1.87e+07 |
| Total GDP per Capita (USD) | 1,067 | 26266.79 | 15978.96 | 1781.111 | 116622.2 |

**Table A4: Logarithmic Descriptive Statistics of Continuous Controls Used in Examining Hospital Capacity and Healthcare Systems**

| Log. Variable | Observations | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Hospital Beds per 100,000 | 1,120 | 6.257584 | .5472676 | 4.248495 | 7.59589 |
| Population Density per Sq. Km | 1,087 | 4.174451 | 1.394224 | .4873695 | 6.269033 |
| Population Growth Rate (%) | 1,121 | -.5966264 | 1.107351 | -9.21034 | 1.824436 |
| Life Expectancy at Birth | 1,114 | 4.304585 | .0582414 | 3.951244 | 4.403054 |
| Total GDP (in Millions of USD) | 1,088 | 12.6729 | 1.547299 | 6.668148 | 16.74644 |
| Total GDP per Capita (USD) | 1,067 | 9.981571 | .662357 | 7.484993 | 11.6667 |

**Table A5: Descriptive Statistics of Single-Payer and Region Variables Used in Examining Hospital Capacity and Healthcare Systems**

| Group | Observations | Percent of Total |
|---|---|---|
| Single-Payer System | 586 | 52.27 |
| Multi-Payer System | 535 | 47.73 |
| North America | 117 | 10.44 |
| Europe | 764 | 68.15 |
| East Asia | 59 | 5.26 |
| South America | 40 | 3.57 |
| Oceania | 65 | 5.80 |
| Middle East | 76 | 6.78 |

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