The Effect of Government Spending on Quality of Health Services

Final Draft

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Table of Contents

1. Abstract

I used multivariate regression analysis with an instrumental variable and fixed effects to assess the relationship between increasing government spending in a country's healthcare system and the quality of that healthcare system. My method differs significantly from previous work on this topic because instead of using mortality rates or life expectancy to assess the health of a country, I used thirteen different indicators of healthcare system quality. The outcome variables I chose to assess the quality of the healthcare system consist of measures of healthcare technology, healthcare employment, and healthcare infrastructure. Higher levels of technology, employment, and infrastructure in a country's healthcare system suggest higher quality healthcare because these indicators demonstrate a greater supply of resources in the healthcare system. More plentiful healthcare system resources improve the quality of a healthcare system because they increase the ability of the healthcare system to provide high volumes of patients with access to timely care. Specifically, having more healthcare professionals also leads to higher quality healthcare because they have to compete with each other for patients through delivering better care. The regression results suggest that increased involvement of the government in funding healthcare has a negative effect on the quality of a country's healthcare system by decreasing the availability of healthcare personnel, technology, and infrastructure. These results are consistent with the idea of there being a trade-off between attempts to lower healthcare costs by increasing government funding and the quality of care.

2. Introduction

With many developed countries reforming their healthcare systems, the question of how to achieve high quality, low cost healthcare is a common subject of debate among economists and policy markers around the world. Healthcare is puzzling because so far, there is no obvious way to achieve high quality care at a low cost. It seems that in every situation, the benefits of one strategy come with serious trade-offs, while low cost and high quality remain elusive.

We see these trade-offs in Michael Tanner's 2008 descriptive article comparing the healthcare systems of ten developed countries. Tanner concluded that although the structures of the healthcare systems vary widely with differing levels of government funding, they all struggle to keep costs down and provide high quality healthcare to their citizens. Tanner's argument pointed out that countries with both high levels of government involvement in the healthcare system and a lack of market mechanisms in the healthcare system struggle with accessibility issues such as long waiting lists and overly strict rationing of care. Tanner applauded countries like France, Germany, and the Netherlands who employ market mechanisms in their healthcare systems and criticized countries like Great Britain that have more socialized healthcare systems. Tanner's overall point was that the most effective healthcare systems are those that both implement market mechanisms and minimize government involvement. Take Great Britain for example, who has universal healthcare coverage and relies heavily on government-financed care. The British healthcare system struggles with quality of care, namely long waiting lists for care and strict rationing of care. As a result, Great Britain's private health insurance market is growing as people turn towards private care in search of higher quality healthcare (Tanner 2008). On the other hand, the Netherlands has a universal care policy that requires citizens to purchase insurance from one of 41 private insurance companies. This system promotes market mechanisms because consumers can choose their plans, leading to competition between health insurance companies. The Dutch have also seen the length of their waiting lists decrease, which has also improved the quality of care. One drawback to this structure comes with the difficulties associated with verifying that all citizens do indeed purchase health insurance, which in many cases leaves some uninsured (Tanner 2008). The Dutch have seen the rate of healthcare spending as a percentage of GDP grow more slowly compared to countries like the United States with faster growth of healthcare spending as a percentage of GDP. The United States, whose government has historically been less involved in the healthcare system than other developed country governments, leads the world in medical research and access to modern medical technology. While these are indicators of high quality care, the United States still struggles with a high percentage of GDP spent on healthcare compared to other countries. While Tanner's examples and logic seem to be conclusive, his article does not attempt to confirm his hypothesis using quantitative analysis.

This leads me to further investigate the question: Does more government spending and involvement in a country's healthcare system lead to higher quality care? Instead of trying to compare various structures, I decided to take a step back and approach the question from the lens of how involved the government is in funding the healthcare system. I used regression analysis of healthcare system quality indicators and the percentage of total healthcare spending that is government funded to uncover the relationship between increased government spending in the health care system and quality of care. I found a negative relationship between percentage of healthcare spending that comes from the government and indicators of healthcare system quality. These results are consistent with idea that as the government funds more of a country's healthcare system, they experience a trade-off in quality.

3. Literature Review

There have been many descriptive articles on the topic of healthcare system structure and government spending on health, but there have been relatively few empirical studies on the relationship between government spending in healthcare systems and quality of care. In 1996, Philip Musgrove published a normative article on the ideal role of the state in providing healthcare services. He concluded that the state should finance healthcare because health services have many characteristics of a public good since health services have significant positive externalities. Thus, the government should work to ensure that health services are produced and consumed in optimal amounts in a society. He said a state should do this by regulating the insurance market to reduce adverse selection among the consumers of insurance and the government should also provide or subsidize care for the poor. Musgrove also touched on the challenges of defining how much the government should be involved and acknowledged that significant trade-offs make executing optimal health service delivery a difficult task for governments.

In 2006, Farasat A. S. Bokhari, Yunwei Gai, and Pablo Gottret studied the relationship of per capita government health expenditures and per capita income with under-five mortality and maternal mortality in both developed and developing countries. They found that government health spending decreases both under-five mortality and maternal mortality, and thus the authors concluded that increasing government health expenditures improves population health.

In 1999, Deon Filmer and Lant Pritchett studied the impact that public spending on health and non-health factors have on the under-five and infant mortality rates in a country. They found that public spending on health does not have a significant impact on either mortality rate, but that income per capita, inequality of the income distribution, the extent of female education, ethnic fragmentation, and the predominant religion do have significant impacts on the mortality rates.

In 2013, Roy Carr-Hill and Elizabeth Currie studied the effect of physicians per capita and nurses per capita on infant mortality rates, under-five mortality rates, and maternal mortality rates. They found that increased physicians per capita decreases all three mortality rates and that increased nurses per capita does not have a significant effect on any of the mortality rates.

In 2006, Soeren Mattke, Arnold M. Epstein, and Sheila Leatherman assessed how to measure the quality of a country's healthcare system in a descriptive article. The goal of the study was to compile a list of indicators to use to measure the quality of OECD countries' health care systems in order to accurately compare them to each other. The study chose five priority health areas to target as areas of particular importance. The five areas are cardiac care, diabetes, mental health, patient safety, and primary care/prevention. The indicators for these areas were chosen based on feasibility, clinical importance, and scientific soundness. They compiled a list of 86 different indicators: 9 for diabetes, 12 for mental health, 17 for cardiac care, 21 for patient safety, and 27 for primary care/prevention.

In 2012, Rodrigo Moreno-Serra and Peter C. Smith reviewed the existing empirical evidence on the links between expansions in healthcare coverage and the health outcomes of the populations of countries throughout the world. Their conclusion suggests that increased healthcare coverage improves the health of the populations, in particular for the poorest people of a nation. They also concluded that financial risk pooling is a key to having universal health coverage in a country. They highlight the need for further research to understand how to maximize the effectiveness of increased health care coverage including the effect of the quality of health care systems.

4. Methodology

I used a set of multivariate regressions in which the outcome variables are thirteen measures of healthcare system quality. The main explanatory variable of interest is the percentage of total healthcare spending that is funded by the government. The outcome variables that I chose for this study differ from those typically used in studies assessing healthcare systems and quality of care. Life expectancy, maternal mortality, under-five mortality, and infant mortality are commonly used to measure the level of health of a country, and thus the quality of the healthcare system. I have chosen not to use these variables because I want to more directly measure the quality of the healthcare system, not the health of the population. Many other factors can affect the life expectancy and mortality rates of a population that are not related to the quality of the healthcare system. Societal factors like diet, exercise, and smoking have large effects on a nation's overall health. Also, whether or not a country has legalized abortion can affect infant and child mortality rates because if abortion is legal, babies that are likely to die in the first year of their life are more likely to be aborted, so abortion can decrease the infant mortality rate. Instead, the outcome variables that I use are measures of healthcare technology, healthcare employment, and healthcare infrastructure.

To measure government spending in healthcare systems, I used the percentage of healthcare spending that is funded by the government. This measure tells how much of the total healthcare spending in a country is government funded versus privately funded. The higher the percentage, the more involved the government is in funding the healthcare system.

I decided not to measure government involvement in the healthcare system based on whether or not a country has universal healthcare or socialized healthcare. Universal healthcare can mean many different things and within the list of countries that have declared universal healthcare, levels of government spending and involvement can widely vary. As Tanner showed, there is a wide range in structure among countries with universal healthcare systems with varying levels of government funding and control. In 2013, Andrew B. Feigl and Eric L. Ding concluded that of the 75 countries worldwide that have legally declared universal healthcare, only 51 of those countries have achieved what Feigl and Ding call Evidenced Formal Coverage, which is their measure of sufficient universal healthcare coverage. Evidenced Formal Coverage is based on the legal framework, population coverage, and accessibility.

My methodology is also different from previous studies because I chose to use only the 34 OECD member countries because they are all developed countries instead of all countries in the world. The healthcare systems of developed and developing countries differ significantly in structure and in the challenges they face. Given these differences, I think it is better to study them separately when comparing the impact of government involvement in healthcare systems because they differ by too much to accurately compare them.

In order to examine the effect of government spending on healthcare quality, I assembled panel data for the thirteen healthcare quality indicators for the 34 countries in the OECD. For the years 1960-2014, I observe the healthcare quality indicators and measure of government spending on healthcare. Some indicators only have data points for 1980-2014 or 2000-2014, but the available data is usually still sufficient for achieving statistically significant results.

4.1 Empirical Model

I used an Ordinary Least Squares ("OLS") multivariate regression model with fixed effects to assess the relationship between increasing government spending in a country's healthcare system and the quality of that healthcare system.

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 D_1 + \beta_6 D_2 + \beta_7 D_3 + u \quad (1)$$

Y = Health care system quality indicator
X_1 = % of total health care spending funded by the government
X_2 = % of population above the age of 65
X_3 = Gross National Income ("GNI") per capita
X_4 = % of the population with tertiary (post-secondary) education
D_1 = Dummy variables for each year
D_2 = Dummy variables for each region
D_3 = Dummy variables for each income group
u = error term

I constructed a log-linear regression model instead of a level regression model because taking the logs of the variables lessens the effect of outliers on the regression, producing more robust results. Also, logs provide a more natural economic interpretation of the results.

4.2 Outcome Variables

There are 13 quality indicators that will be the outcome variables of this study. The indicators are:

1. Physicians per 1,000 population
2. Midwives per 1,000 population
3. Midwives per 1,000 live births
4. Nurses per 1,000 population
5. Dentists per 1,000 population
6. Pharmacists per 1,000 population
7. Physiotherapists per 1,000 population
8. Health employment per 1,000 population
9. Hospitals per million population
10. Hospital beds per 1,000 population
11. Computerized tomography ("CT") scanners per million population
12. Magnetic resonance imaging ("MRI") units per million population
13. Positron emission tomography ("PET") scanners per million population.

Having more physicians, midwives, nurses, dentists, pharmacists, physiotherapists, and health employees per 1,000 population are indicators of higher quality healthcare because they demonstrate a greater supply of healthcare professionals per capita. More healthcare professionals reduce problems with patients having to wait a long time to receive care and create more competition among healthcare professionals, encouraging the healthcare professionals to provide higher quality care. Having higher levels of healthcare infrastructure such as hospitals per million population and hospital beds per 1,000 population indicates a higher quality healthcare system because more hospitals and hospital beds allows healthcare systems to handle higher volumes of patients. Higher levels of healthcare technology indicates higher quality healthcare systems because patients have greater access to the healthcare technology, which is why higher levels of magnetic resonance imaging units, computerized tomography scanners, and positron emission tomography scanners per million populations indicate higher quality in a health care system.

4.3 Explanatory Variables

The main explanatory variable of interest, the measure of government spending in the health care system, is the percentage of total health spending that is by the government. The OECD defines health spending as:

> The final consumption of health goods and services. It includes spending by both public and private sources (including households) on curative, rehabilitative and long-term care as well as medical goods such as pharmaceuticals. It also covers spending on public health and prevention programmes, and on administration. This indicator is presented as a total and per financing agent (public, private and out-of-pocket expenditure) and is measured in percentage of GDP, in percentage of total expenditure on health, and in USD per capita (using PPP).

The percentage of total health spending that is by the government (public) is a good measure of government spending in a healthcare system because the proportion of healthcare spending that is by the government increases as the government becomes a greater provider of a nation's health services. This measure avoids the problem of countries that nominally have universal, government-provided healthcare systems, but whose citizens heavily supplement the government care with private insurance. Even though these countries have universal healthcare systems, the portion of healthcare spending that is government spending will be lower than countries where the government is actually funding most of the healthcare.

The other explanatory variables in the multivariate regression model are the percentage of the population over the age of 65, GNI per capita, and the percentage of the population with tertiary education. I control for aging population with the percentage of the population over the age of 65 because as a population ages, the older members of the population will demand more health services than a younger population. I use GNI or gross national income per capita to control for income differences in the countries because wealthier nations will have citizens with more disposable income to spend on health services. I use education as a control variable because more highly educated countries would tend to spend more on healthcare because increased education would increase the number of healthcare professionals with advanced degrees and would also increase the knowledge of a country's citizens on the importance of seeking medical care throughout a person's life.

4.4 Addressing Endogeneity

Endogeneity bias may be an issue in this model because it is possible that the outcome and explanatory variables are simultaneously determined. For example, a country that has poor health may have higher numbers of the indicator variables and more government spending as a percentage of total healthcare spending. In this case both the outcome and explanatory variables will be correlated with the error term and the OLS estimates will be biased. Below is an explanation for why endogeneity bias is a problem for estimating coefficients.

$$\hat{\beta}_1 = (X^T X)^{-1} X^T Y$$
$$Y = X\beta + u$$

$$E[\hat{\beta} \mid x] = [(X^T X)^{-1} X^T (X\beta + u) \mid x]$$
$$= E[(X^T X)^{-1} X^T X\beta + (X^T X)^{-1} X^T u \mid x]$$
$$= E[\beta] + E[(X^T X)^{-1} X^T u \mid x]$$
$$\hat{\beta}_1 = \beta + \frac{Cov(x,u)}{Var(x)} \qquad (2)$$

If x and u are correlated, then $\hat{\beta}_1$ will be upwardly biased because $Cov(x,u) \neq 0$ as shown in equation (2). For $\hat{\beta}_1$ to be an unbiased estimate of $Cov(z,u) = 0$, $Cov(x,u)$ would have to equal zero.

To address this potential endogeneity, I used Evidenced Formal Coverage, a binary dummy variable, to instrument the percentage of healthcare spending that is government funded. As mentioned in the introduction, Feigl and Ding compiled an index in 2013 of which countries have achieved Evidenced Formal Coverage and in what year. Evidenced Formal Coverage is based on legal framework, population coverage, and accessibility. I chose this as an instrumental variable because it is highly correlated with the percentage of healthcare spending that is by the government, but is not endogenous with the other explanatory variables because it is based on legislature in the country. The explanation below, with the instrumental variable denoted by z, demonstrates how the instrumental variable being uncorrelated with the error term avoids the problem of endogeneity bias.

$$Cov(x,u) \neq 0$$
$$Cov(z,u) = 0 \qquad (3)$$

$$Cov(z,y) = Cov(z, x\beta + u)$$
$$= Cov(z,x)\beta + Cov(z,u)$$
$$\beta = \frac{Cov(z,y)}{Cov(z,x)}$$
$$= \frac{Cov(z, x\beta + u)}{Cov(z,x)}$$

$$= \frac{Cov(z,x)\beta}{Cov(z,x)} + \frac{Cov(z,u)}{C(z,x)} \quad (4)$$

$$\hat{\beta}_1 = \beta \quad (5)$$

Since $Cov(z,x)$ is in both the numerator and the denominator of the first term of equation (4), the two terms cancel to leave β. Equation (3) states the assumption that if the instrument is valid, $Cov(z,u) = 0$, so the second term in equation (4) equals zero, leaving equation (5).

In addition to the OLS regression model shown in equation (1), I used a Two-Stage Least Squares regression model with the EFC dummy variable instrumenting the percentage of healthcare spending that is government funded to estimate the effect of the percentage of healthcare spending that is by the government on the healthcare quality indicator outcome variables.

4.5 Fixed Effects

I used fixed effects to control for persistent country-specific heterogeneity overtime. I used dummy variables for each year, region, and income level to check the robustness of the results. I chose not to use a dummy variable for each country because this eliminated nearly all variation in the instrumental variable, the binary indicator of Evidenced Formal Coverage. I therefore rely on dummy variables for each year, region, and income group. The regions are North America, Eastern Asia, Western Asia, Oceania, Southern Europe, Western Europe, Eastern Europe, Northern Europe, and South / Central America. These regions are based on the regions used by the United Nations Statistics Division. For income level dummy variables, I divided the countries into five income groups. The groups are based on each country's GNI per capita and are under \$20,000, between \$20,000 and \$30,000, between \$30,000 and \$40,000, between \$40,000 and \$50,000, and above \$50,000.

5. Data

I used data from the OECD and the WHO data repositories to assemble datasets of measures of healthcare system quality and government spending levels in healthcare systems. The dataset includes data from the 34 OECD countries for thirteen different healthcare quality indicators, one government spending indicator, and three control variables for the years 1960 to 2014. The following table summarizes all of the data used.

Table 1. Healthcare Infrastructure Quality Indicators Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Hospital beds per 1,000 population	904	6.363	3.123	1.510	15.640
Hospitals per million population	751	34.212	21.002	8.660	103.560

Table 2. Healthcare Technology Quality Indicators Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
CT scanners per million population	489	16.686	13.537	0.000	101.280
MRI machines per million population	309	6.129	6.610	0.040	43.100
PET scanners per million population	263	1.199	1.176	0.000	6.060

Table 3. Healthcare Employment Quality Indicators Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Health employees per 1,000 population	673	43.100	22.457	6.380	110.440
Nurses per 1,000 population	317	8.865	3.632	2.080	17.360
Physicians per 1,000 population	858	2.436	0.866	0.500	4.990
Dentists per 1,000 population	531	0.595	0.228	0.050	1.050
Pharmacists per 1,000 population	571	0.624	0.246	0.110	1.610
Physiotherapists per 1,000 population	502	0.833	0.610	0.010	2.550
Midwives per 1,000 live births	383	32.415	18.104	1.850	83.750
Midwives per 1,000 population	391	0.390	0.245	0.020	1.140

Table 4. Government Spending Variable Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
% of healthcare spending that is government funded	483	72.246	11.362	36.613	89.998

Table 5. Control Variables Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
% of the population with tertiary education	270	0.283	0.100	0.083	0.526
% of the population 65 years and older	440	0.043	0.010	0.018	0.066
GNI per capita	801	24932	11525	4140	67920

There are large differences in the number of observations for the different variables. Some variables have data for 1960-2014 while others only have data for 2000-2014, which causes significant variation in the number of observations. The indicators that start the earliest (in 1960) are hospital beds per 1,000 population and physicians per 1,000 population. The data that start the latest are GNI per capita, aging, and tertiary education. The GNI per capita data starts in 1990, and aging and tertiary education data start in 2000. Some countries started collecting data later than others for multiple indicators. For example, Chile, Turkey, and the Czech Republic are often the last countries to have started collecting data for the various quality indicators. These three countries are also some of the poorer countries compared to the other OECD countries, which could potentially bias the results. The indicators with the most missing data are the three indicators for healthcare technology (CT scanners per million population, MRI machines per million population, and PET scanners per million population). Despite these instances of missing data, the full dataset is complete enough to achieve statistically significant results.

Table 6 Variables Key for the Regression Results

Variables Key:	
Hospital beds	Hospital beds per 1,000 population
Hospitals	Hospitals per million population
CT scanners	Computed Tomography scanners per million population
MRI machines	Magnetic Resonance Imaging units per million population
PET scanners	Positron Emission Tomography scanners per million population
Health Employment	Health Employees per 1,000 population
Nurses	Nurses per 1,000 population
Physicians	Physicians per 1,000 population
Dentists	Dentists per 1,000 population
Pharmacists	Pharmacists per 1,000 population
Physiotherapists	Physiotherapists per 1,000 population
Midwives / population	Midwives per 1,000 population
Midwives / births	Midwives per 1,000 live births
Gov spending	Percent of total health spending that is by the government (public)
Aging	Percent of the population over the age of 65
Income	Gross National Income per capita
Education	Percent of the population with tertiary education

6. Results

6.1 OLS and Instrumental Variable Regression Results

The following tables show the results from the OLS regressions and the regressions using the Evidenced Formal Coverage dummy variable as an instrumental variable for the percentage of government spending that is government funded.

Table 7. Healthcare Infrastructure Regression Results

Variables	Hospital beds		Hospitals	
	OLS	IV	OLS	IV
Gov Spending	-0.046	-0.453**	-0.312***	-0.644
	0.0402	0.187	0.108	0.43
Aging	-0.055	0.013	-0.0985	-0.0351
	0.063	0.0808	0.159	0.181
Income	0.780*	1.722***	2.570**	3.290**
	0.425	0.656	1.084	1.427
Education	-0.432**	-0.500*	-1.140**	-1.200**
	0.214	0.257	0.538	0.554
Constant	-2.699	-10.30*	-21.25*	-23.06*
	4.035	6.191	11.23	12.35
Observations	270	270	243	243
R-squared	0.786		0.289	

Standard errors beneath coefficients
Fixed Effects included in all regressions
*** p<0.01, ** p<0.05, * p<0.1

The OLS regression results show that as government spending as a percentage of total healthcare spending in a country increases by 1%, the number of hospital beds per 1,000 population in that country decreases by 0.453%. A decreasing number of hospital beds indicates lower quality access to healthcare because a country with fewer hospital beds will be less able to accommodate patients seeking medical treatment in hospitals. In addition, patients may not be able to stay in the hospital as long as they would if the country had more hospital beds because if there is a shortage of hospital beds, hospital personnel will be more likely to have patients leave the hospital sooner. The coefficient for number of hospitals is also negative but not significant.

The Instrumental Variable ("IV") regression results show that as the percentage of healthcare spending that is government funded increases by 1%, the number of hospitals per million population decreases by 0.312%. As the government becomes more involved in the healthcare system and funds more of the healthcare expenditures, the number of hospitals decreases. This could be the result of more government funded systems being more centralized, resulting in larger but fewer hospitals. Fewer hospitals results in less competition between hospitals for business, which could have a negative impact of the quality of healthcare. More centralized hospitals though could streamline information sharing of patient files, increasing efficiency and quality of care. The IV regression results show a negative but insignificant coefficient for the number of hospital beds. All of these results indicate that as government spending in the healthcare system increases, the availability of hospital care decreases.

Table 8. Healthcare Technology Regression Results

Variables	CT scanners		MRI machines		PET scanners	
	OLS	IV	OLS	IV	OLS	IV
Gov Spending	-0.0667	-2.718***	-0.309	-2.494*	0.13	-0.876
	0.153	0.962	0.211	1.482	0.125	0.575
Aging	-0.0225	0.509	-0.222	0.393	-0.216	-0.0146
	0.217	0.386	0.451	0.761	0.177	0.231
Income	-0.424	6.180*	4.901**	9.940**	2.487**	4.992**
	1.51	3.304	2.071	4.46	1.228	1.975
Education	-2.428***	-2.565**	-2.888***	-3.640**	-1.061*	-1.113
	0.738	1.15	0.998	1.506	0.6	0.688
Constant	10.63	-54.69*	-51.43**	-100.5**	-24.82*	-50.62***
	16.01	32.54	22.18	44.27	13.03	19.45
Observations	234	234	125	125	234	234
R-squared	0.247		0.294		0.429	

Standard errors beneath coefficients
Fixed Effects included in all regressions
*** p<0.01, ** p<0.05, * p<0.1

The IV regression results show that as government spending as a percentage of total healthcare spending in a country increases by 1%, the number of CT scanners per million population in that country decreases by 2.718% and the number of MRI machines in that country per million population decreases by 2.494%. CT scanners and MRI machines are medical technology used to diagnose medical conditions and injuries in patients. Fewer machines in a country could make it take longer to get an appointment to use a machine. This could delay diagnoses and treatment, which could have a negative effect on the health of patients, lowering the quality of the overall healthcare system. The IV regression results for PET scanners, though insignificant, show a negative coefficient, which is consistent with the significant negative impacts on MRI machines and CT scanners.

The percentage of healthcare spending that is by the government does not have a significant impact on the number of CT scanners, MRI machines, or PET scanners in the OLS regression results. These results differ from when the Evidenced Formal Coverage variable is used as an instrumental variable because those results showed a significant decrease in CT scanners and MRI machines. Although the OLS regression results for MRI machines and CT scanners are insignificant, the coefficients are negative, which is consistent with the IV regression results.

Table 9. Healthcare Employment Regression Results

Variables	Health employment		Physicians		Nurses		Pharmacists	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Gov Spending	0.0126	0.380**	0.0084	-1.148	-0.022	-0.783*	-0.196*	-3.752*
	0.0365	0.169	0.144	0.737	0.0991	0.451	0.105	2.245
Aging	0.146**	0.0844	0.459**	0.659**	-0.175	-0.0099	0.453**	1.164*
	0.0571	0.0733	0.219	0.279	0.161	0.209	0.176	0.65
Income	-0.328	-1.179**	-3.142**	-0.113	-3.862***	-2.144	-1.005	11.01
	0.385	0.595	1.512	2.555	1.09	1.6	1.127	8.116
Education	-0.275	-0.214	1.826**	2.072**	-3.476***	-3.440***	0.736	1.128
	0.194	0.233	0.816	0.944	0.795	0.92	0.772	2.095
Constant	6.926*	14.25**	37.41***	12.99	36.89***	22.84	10.76	-93.89
	3.661	5.611	14.28	21.19	10.35	14.15	12.13	73.5
Observations	270	270	234	234	198	198	207	207
R-squared	0.837		0.232		0.396		0.298	

Standard errors beneath coefficients
Fixed Effects included in all regressions
*** p<0.01, ** p<0.05, * p<0.1

In the IV regression results, as government spending as a percentage of total healthcare spending increases by 1%, total health employment increases by 0.38%. This result indicates that as the government funds more of the healthcare system, the total number of health employees increases. As government spending as a percentage of total healthcare spending increases, nurses per 1,000 population decreases by 0.783% and pharmacists per 1,000 population decreases by 3.752%. These results indicate that as the government pays for more of the total health expenditures in a country, the country has fewer nurses and pharmacists per capita. It is interesting that nurses and pharmacists decrease with more government funding of the healthcare system while total health employment increases. This result could be because more government-funded systems have more of other types of health employment like administrative and supporting roles to deal with the increased government oversight in the healthcare system. In contrast, healthcare systems that are more private, and thus have more competition, have more nurses in order to deliver better service to attract customers. In addition, although the results for physicians are insignificant, the coefficient shows a negative relationship between government funding as a percentage of healthcare spending and the number of physicians.

In the OLS regression results, as the percentage of healthcare spending that is government funded increases by 1%, the number of pharmacists per 1,000 population decreases by 0.196%. Fewer pharmacists indicates lower quality healthcare because patients could have a harder time having their prescriptions filled. This decrease in the number of pharmacists could also be the result of healthcare systems with more government involvement being more centralized, so the pharmacies could just be larger since there are fewer smaller private pharmacies. This result is consistent with the IV regression result that also shows decreasing pharmacists with increasing government funding. The result for nurses in the OLS regression is insignificant, but is still negative, which is consistent with the IV regression results. The result for total health employment is insignificant with the OLS regression results, but is still positive, which is also consistent with the IV regression results

Table 10. Healthcare Employment Regression Results (continued)

Variables	Midwives / births		Midwives / population		Dentists		Physiotherapists	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Gov Spending	0.0304	-0.685	0.0375	0.101	-0.0792	-2.079	0.0902	0.076
	0.132	0.531	0.0352	0.131	0.11	1.437	0.071	0.338
Aging	0.0689	0.246	-0.0075	-0.0233	0.148	0.435	0.281	0.281
	0.224	0.276	0.0598	0.0681	0.164	0.35	0.173	0.173
Income	-2.608*	-0.726	0.13	-0.0372	0.161	7.308	-0.532	-0.507
	1.388	2.033	0.371	0.501	1.191	5.494	0.789	0.971
Education	-0.893	-0.691	0.0919	0.0739	1.654*	2.329	1.991***	1.989***
	0.993	1.1	0.265	0.271	0.894	1.619	0.372	0.376
Constant	31.75**	13.43	0.372	3.608	3.815	-56.84	10.96	9.575
	14.77	20.52	3.948	5.053	10.55	46.77	7.405	9.552
Observations	162	162	162	162	189	189	243	243
R-squared	0.341		0.711		0.341		0.684	

Standard errors beneath coefficients
Fixed Effects included in all regressions
*** p<0.01, ** p<0.05, * p<0.1

The OLS and IV regressions both yielded insignificant results for midwives, dentists, and pharmacists.

6.2 OLS Regressions using EFC

The following tables show the results of the OLS regressions using the Evidenced Formal Coverage variable as an explanatory variable in place of the percentage of healthcare spending that is by the government.

Table 11. Healthcare Infrastructure Regression Results

Variables	Hospital beds	Hospitals
EFC	-0.403***	-0.561
	0.138	0.372
Aging	-0.0564	-0.151
	0.0617	0.16
Income	1.400***	2.899**
	0.478	1.262
Education	-0.596***	-1.329**
	0.219	0.569
Constant	-9.594*	-25.77*
	5.077	13.23
Observations	270	243

Standard errors beneath coefficients
Fixed Effects included in all regressions
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

In countries with Evidenced Formal Coverage, the number of hospital beds per 1,000 population in that country decreases by 0.403%. This result is almost identical to the results when Evidenced Formal Coverage is used to instrument the percentage of healthcare spending that is government funded. A decreasing number of hospital beds indicates lower quality access to healthcare because a country with fewer hospital beds will be less able to accommodate patients seeking medical treatment in hospitals. In addition, patients may not be able to stay in the hospital as long as they would if the country had more hospital beds because if there is a shortage of hospital beds, hospital personnel will be more likely to have patients leave the hospital sooner.

Table 12. Healthcare Technology Regression Results

Variables	CT scanners	MRI machines	PET scanners
EFC	-2.182***	-1.747**	-0.703*
	0.472	0.716	0.401
Aging	-0.0144	-0.273	-0.183
	0.205	0.44	0.174
Income	3.420**	7.406***	4.102***
	1.64	2.377	1.394
Education	-3.341***	-3.572***	-1.363**
	0.73	1.03	0.621
Constant	-31.48*	-80.60***	-40.48***
	16.62	25.93	14.12
Observations	234	125	234

Standard errors beneath coefficients
Fixed Effects included in all regressions
*** p<0.01, ** p<0.05, * p<0.1

In countries with Evidenced Formal Coverage, the number of CT scanners per 1,000 population decreases by 2.182%, the number of MRI machines per 1,000 population decreases by 1.747%, an the number of PET scanners per 1,000 population decreases by 0.703%. These results indicate that a country having Evidenced Formal Coverage significantly decreases the availability of medical imaging technology in that country. These results are very similar to when the Evidenced Formal Coverage dummy variable is used as an instrumental variable except that when it is not used as an instrumental variable, we see a significant decrease in the number of PET scanners in addition to a decrease in the number of CT scanners and MRI machines.

Table 13. Healthcare Employment Regression Results

Variables	Health Employment	Physicians	Nurses	Pharmacists
EFC	0.338***	-1.035*	-1.019**	-2.032***
	0.125	0.577	0.502	0.43
Aging	0.143**	0.482**	-0.124	0.475***
	0.056	0.216	0.16	0.167
Income	-0.909**	-0.771	-1.52	3.285**
	0.434	1.957	1.581	1.464
Education	-0.133	1.808**	-3.773***	-0.254
	0.199	0.809	0.8	0.764
Constant	13.62***	14.5	13.57	-36.50**
	4.606	18.78	15.42	15.89
Observations	270	234	198	207

Standard errors beneath coefficients
Fixed Effects included in all regressions
*** p<0.01, ** p<0.05, * p<0.1

Table 14. Healthcare Employment Regression Results (continued)

Variables	Midwives / births	Midwives / population	Dentists	Physiotherapists
EFC	-0.889	0.131	-1.160**	0.0611
	0.623	0.168	0.456	0.273
Aging	0.142	-0.0079	0.16	0.284
	0.225	0.0606	0.161	0.175
Income	-0.353	-0.0923	2.743*	-0.451
	2.027	0.547	1.577	0.85
Education	-1.112	0.136	1.02	2.005***
	0.998	0.269	0.909	0.396
Constant	8.146	3.675	-23.02	9.793
	21.78	5.875	15.34	7.997
Observations	162	162	189	243

Standard errors beneath coefficients
Fixed Effects included in all regressions
*** p<0.01, ** p<0.05, * p<0.1

In countries with Evidenced Formal Coverage, health employees per 1,000 population increases by 0.338%. This shows that countries with Evidenced Formal Coverage have more healthcare employees than countries without Evidenced Formal Coverage. In countries with Evidenced Formal Coverage, the nurses per 1,000 population decreases by 1.019%, the number of physicians per 1,000 population decreases by 1.035%, the number of dentists per 1,000 population decreases by 1.16%, and the number of pharmacists per 1,000 population decreases by 2.032%. These results show that if a country has Evidenced Formal Coverage, almost each of the measures of accessibility to healthcare personnel decreases except general health employees, which includes administrative and support staff. These results are dramatic in that they show an across the board decrease in healthcare personnel when a country has Evidenced Formal Coverage. These results differ from when the Evidenced Formal Coverage dummy variable is used as an instrumental variable for the percentage of healthcare spending that is government funded because there are a greater number of significant decreases. In addition to decreasing numbers of nurses and pharmacists we see decreases in physicians and dentists.

6.3 Results Summary Tables

The following tables summarize the statistically significant results from tables 7 through 14.

Table 15. Instrumental Variable Results Summary

EFC as instrument for government spending as a % of total healthcare spending	
Increase	Decrease
Health Employment	Beds
	CT scanners
	MRI machines
	Nurses
	Pharmacists

When the percentage of healthcare spending that is government funded is instrumented by the EFC dummy variable, there are significant decreases in the number of beds, CT scanners, MRI machines, nurses, and pharmacists, while there is a significant increase in total health employment.

Table 16. OLS Results Summary

Government speaning as % of total healthcare spending	
Increase	Decrease
	Hospitals
	Pharmacists

When the percentage of healthcare spending that is government funded is an explanatory variable in the OLS regressions there are significant decreases in the number of hospitals and the number of pharmacists.

Table 17. OLS using EFC Results Summary

EFC	
Increase	Decrease
Health Employment	Beds
	CT scanners
	MRI machines
	PET scanners
	Nurses
	Physicians
	Dentists
	Pharmacists

Overall, the most striking results come from the OLS regression with the EFC dummy variable as an explanatory variable. These results show significant decreases in the number of hospital beds, CT scanners, MRI machines, PET scanners, nurses, physicians, dentists, and pharmacists, while there is a significant increase in total health employment.

7. Conclusions

My results indicate that as the percentage of healthcare spending that comes from the government increases, the overall quality of a country's healthcare system decreases. The more dramatic results lie in the regression where the dummy variable for whether or not a country has Evidenced Formal Coverage is used as an explanatory variable. Countries that have achieved Evidenced Formal Coverage have significantly fewer numbers of hospital beds, CT scanners, MRI machines, PET scanners, nurses, physicians, dentists, and pharmacists. Despite all of these decreases, total health employment increases. From this, I conclude that the increased employees are not in personnel that directly provide care to patients, but are in other areas of health employment such as administrative and support roles. This may be the result of more heavily government-funded systems needing more administrative staff to handle government paperwork and other administrative duties that are not necessary under a more privately structured system. In addition, more private healthcare systems have larger numbers of employees directly providing care to patients, like physicians, nurses, and dentists, because they have to work harder to compete with other private healthcare providers in a more competitive market. The overall implications of these results are that more heavily government-funded healthcare systems have lower levels of accessibility, and thus lower quality health services.

7.1 Limitations

The data is not available for every country in every year, so a larger dataset with the data for each country in every year for all of the variables would be ideal. Additionally, I tried to control for country level differences persistent overtime with dummy variables for each country, but there was insufficient variation. Instead, I used region dummy variables and income dummy variables.

I do not attempt to assess whether or not increased government funding as a percentage of total healthcare spending is better for population health. The outcome variables used in this study only indicate whether or not the healthcare system is higher quality through increasing accessibility through larger amounts of healthcare infrastructure, healthcare technology, and healthcare employment. Although these indicators are more available with lower percentage of healthcare spending that is government funded, these systems might have more members of the population that cannot afford to use the healthcare resources as a result of the healthcare system being more privately funded.

7.2 Recommendations for Future Study

An interesting topic to study that is similar to this paper would be to go through countries' legislative histories and study the impact that specific changes in healthcare legislation had on the indicators used in this study to measure the quality of healthcare systems. Another idea is to look at the makeup of the types of employees in the healthcare system as government involvement increases. The results of this study suggest that certain types of healthcare employees increase while others decrease, so studying how the overall landscape of health employees changes with changes in government involvement could provide useful insights on the effect of government involvement in healthcare systems.

8. Appendix

8.1 Definitions of Variables provided by the OECD data repository

Computed Tomography Scanners per million population:

A Computed Tomography (CT) scanner is an x-ray machine which combines many x-ray images with the aid of a computer to generate cross-sectional views and, if needed, three-dimensional images of the internal organs and structures of the body. They help physicians diagnose a range of conditions by producing images of internal organs and structures of the body. This indicator is measured in the numbers of equipment per million inhabitants.

Hospital beds per 1,000 population:

This indicator provides a measure of the resources available for delivering services to inpatients in hospitals in terms of number of beds that are maintained, staffed and immediately available for use. Total hospital beds include acute care beds, psychiatric care beds, long-term care beds, and other beds in hospitals. It is measured in number of beds per 1,000 inhabitants.

Magnetic Resonance Imaging units per million population:

Magnetic Resonance Imaging (MRI) is an imaging technique designed to visualize internal structures of the body using magnetic and electromagnetic fields, which induce a resonance effect of hydrogen atoms. The electromagnetic emission created by these atoms is registered and processed by a dedicated computer to produce the images of the body structures. MRI units help physicians diagnose a range of conditions by producing images of internal organs and structures of the body. Unlike conventional radiography and CT scanning, MRI exams do not expose patients to ionizing radiation. This indicator is measured in the numbers of equipment per million inhabitants.

Health Spending:

Health spending is defined as the final consumption of health goods and services. It includes spending by both public and private sources (including households) on curative, rehabilitative and long-term care as well as medical goods such as pharmaceuticals. It also covers spending on public health and prevention programs, and on administration. This indicator is presented as a total and per financing agent (public, private and out-of-pocket expenditure) and is measured in percentage of GDP, in percentage of total expenditure on health, and in USD per capita (using PPP).

Nurses per 1,000 population:

Nurses are defined as all the "practicing" nurses providing direct health services to patients, including self-employed nurses. However, for some countries (France, Greece, Ireland, Italy, the Netherlands, Portugal, Slovakia, Turkey and the United States), due to lack of comparable data, the figures correspond to "professionally active" nurses, including nurses working in the health sector as managers, educators, researchers, etc. Midwives and nursing aides (who are not recognized as nurses) are normally excluded although some countries include midwives as they are considered specialist nurses. This indicator is measured per 1,000 inhabitants.

Physicians:

Practicing physicians provide services directly to patients. Inclusion: Persons who have completed studies in medicine at university level (granted by adequate diploma) and who are licensed to practice, Interns and resident physicians (with adequate diploma and providing services under supervision of other medical doctors during their postgraduate internship or residency in a health care facility), Salaried and self-employed physicians delivering services irrespectively of the place of service provision, Foreign physicians licensed to practice and actively practicing in the country. Exclusion: Students who have not yet graduated, Dentists and stomatologists / dental surgeons, Physicians working in administration, research and in other posts that exclude direct contact with patients, Unemployed physicians and retired physicians, Physicians working abroad.

Hospitals:

Comprise licensed establishments primarily engaged in providing medical, diagnostic and treatment services that include physician, nursing, and other health services to inpatients and the specialized accommodation services required by inpatients. Hospitals provide inpatient health services, many of which can be delivered only by using specialized facilities and professional knowledge as well as advanced medical technology and equipment, which form a significant and integral part of the provision process. Although the principal activity is the provision of inpatient medical care they may also provide day care, outpatient and home health care services as secondary activities. The tasks of hospitals may vary by country and are usually defined by legal requirements. In some countries, health care facilities need in addition a minimum size (such as number of beds and medical staff to guarantee 24-hour access) in order to be registered as a hospital.

Physiotherapists:

Assess, plan and implement rehabilitative programs that improve or restore human motor functions, maximize movement ability, relieve pain syndromes, and treat or prevent physical challenges associated with injuries, diseases and other impairments. They apply a broad range of physical therapies and techniques such as movement, ultrasound, heating, laser and other techniques. Inclusion: Geriatric physical therapist, Pediatric physical therapist, Orthopedic physical therapist. Exclusion: Podiatrist, Occupational therapist, Acupressure therapist, Hydrotherapist, Massage therapist, Physiotherapy technician, Shiatsu therapist, Chiropractor, Osteopath.

Pharmacists:

Practicing pharmacists prepare, dispense or sell medicaments and drugs directly to patients (clients) and provide advice. Inclusion: Persons who have completed studies in pharmacy at university level (granted by adequate diploma) and who are licensed to practice, Salaried and self-employed pharmacists delivering services irrespectively of the place of service provision, Foreign pharmacists licensed to practice pharmacy and actively practicing in the country. Exclusion: Students who have not yet graduated, Pharmacists working in administration, research and in other posts that exclude direct contact with the patients (clients), Unemployed pharmacists and retired pharmacists, Pharmacists working abroad.

Dentists:

Practicing dentists provide services directly to patients. They include stomatologists/dental surgeons. Inclusion: Persons who have completed studies in dentistry / stomatology at university level (granted by an adequate diploma) and who are licensed to practice, Interns (with an adequate diploma and providing services under supervision of other dentists or dental specialists during their postgraduate internship in a health care facility), Salaried and self-employed dentists delivering services irrespectively of the place of service provision, Foreign dentists licensed to practice and actively practicing in the country. Exclusion: Students who have not yet graduated, Dentists working in administration, research and in other posts that exclude direct contact with the patients, Unemployed dentists and retired dentists, Dentists working abroad.

Nurses:

Practicing nurses provide services directly to patients. Inclusion: Professional nurses (see definition below), Associate professional nurses (see definition below), Foreign nurses licensed to practice and actively practicing in the country. Exclusion: Students who have not yet graduated, Nursing aids/assistants and personal care workers who do not have any recognized qualification/certification in nursing, Midwives (unless they work most of the time as nurses), Nurses working in administration, management, research and in other posts that exclude direct contact with patients, Unemployed nurses and retired nurses no longer practicing, Nurses working abroad.

Midwives:

Practicing midwives provide services directly to patients. Inclusion: Midwifery professionals and midwifery associate professionals, Persons who have completed their studies/education in midwifery and who are licensed to practice, Salaried and self-employed midwives delivering services irrespectively of the place of service provision, Nurses (or nurse midwives) who are working most of the time as midwives, Foreign midwives licensed to practice and actively practicing in the country. Exclusion: Students who have not yet graduated, Midwives working in administration, management, research and in other posts excluding direct contact with patients, Unemployed midwives and retired midwives, Midwives working abroad.

Health Employment:

Total health and social employment. Number of persons (head count) working in health care and social work. Human health activities, Veterinary activities, Residential care activities, Social work activities, Social work activities without accommodation.

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