The Income Elasticity of Demand for Health Insurance

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Spring 2017

Abstract

The level of national health expenditure as a percent of GDP has more than doubled since 1970 in OECD countries. Many health economists theorize that rising income causes the increased health share of GDP. The goal of this paper is to estimate the national and global income elasticity of demand for the health share of GDP, and to determine whether income is the main driver of increased health share. OECD data is used to examine this question through Ordinary Least Squares, Two Stage Least Squares, and Lasso regressions. The health share of GDP is found to be income inelastic and non-zero with an income elasticity estimate of 0.4. This suggests that national health expenditure is elastic, and relative increases in health expenditure will continue to outpace the rate of rising income. Non-income, country-specific factors are more important indicators of the health share of GDP.

1. Introduction

In the United States, health care expenditure as a share of GDP has greatly increased over the last 50 years. In 1970, health care spending was only 6.2% of GDP; but by 2015 it had risen to 16.9% of GDP. Similar trends have been seen in other developed countries. In France, the share of GDP devoted to health care rose from 5.2% in 1970 to 11% in 2015. Japanese health care spending was 4.4% of GDP in 1970, and 11.2% in 2015. The share of GDP going to health expenditure more than doubled in most OECD countries from 1970-2014.

There are several theories for the increase in health expenditure. Technological change and innovation are often cited as the causes of some of the increase, as demand for expensive technologies to prolong life increases. Hall and Jones (2007) argue that increasing income will always result in increased health expenditure because there are no diminishing returns to health consumption. They base this argument on a model of an economy with two types of consumption: health consumption and non-health consumption. Non-health consumption has decreasing marginal returns in each period, they argue, and to increase lifetime utility one must increase the number of periods in which they can consume –in other words, their life expectancy. Health consumption will increase life expectancy and thereby lifetime utility. Non-health consumption, on the other hand, has diminishing returns to period utility and therefore will not increase lifetime utility. It follows that as income increases, non-health consumption will grow at a slower rate than income, and health consumption will grow at a faster rate than income. Hall and Jones (2007) predict that based on the undiminishing marginal utility of extending one's life, the optimal level of health care expenditure in the United States will exceed thirty percent of GDP by the middle of the twenty-first century.

Another theory of increased health expenditure centers around the social value of improvements in health – the gains in social welfare that result from improvements in health. Murphy and Topel (2005) show that the social value of improvements in health are greater with larger populations, higher average life incomes, greater existing levels of health, and closeness in population age to the onset of disease. They conclude that as the U.S. population grows, lifetime income increases, health levels improve, and the baby boom generation approaches the age of disease-related death, the social improvements in health will continue to rise. This hypothesis justifies the increases in health expenditure seen in recent decades, and suggests that health expenditure will continue to grow at an equal or greater rate.

A study by Finkelstein et al. (2013) further examines the causal relationship between rising incomes and health spending as a percent of GDP. The study uses the interaction of oil prices and oil reserves to instrument for local area income effects in its causal relationship with health spending. Finkelstein et al. finds that the income elasticity of demand is below unity, or in other words, that rising incomes do not, in fact, explain the rising health share of GDP. However, this study measures health expenditure through hospital expenditure instead of total health expenditures, and aims to measure local area effects, not national or global ones. For these reasons, a different income elasticity of demand may be found when estimating the effect of rising national income on total health share of GDP.

In his 2007 paper, White compares the growth of health expenditure between the United States and other OECD countries. He decomposes the growth in per capita health expenditure into three components: real growth in per capita income, national annual population aging, and "excess growth," defined as real growth in health expenditure not attributable to the first two categories. He finds that the United States had far more excess growth in health spending from

1970-2002 compared to OECD countries. White suggests that this trend is not due to high cost technological improvements because technology flows freely between high income countries. Instead, he argues, it is likely due to institutional factors such as the organization of health care financing and delivery: namely, the fact that OECD countries give a central body – either the national government or social insurance administrators – more authority to constrain health spending than the United States.

This paper will examine three distinct models of national health care and determine whether there is a relationship between health care model and health expenditure as a share of GDP over time. Most cross-sectional time series studies have found an income elasticity of demand at or around unity in developed countries (Hitris and Posnett; Hansen and King). However, Hitris and Posnett (1992) suggest that parameters related to the financing and delivery of health care may have direct or indirect effects on national demand for health care, and that treating developed countries as a single homogenous group may be problematic. This study will therefore analyze the relationship between health expenditure and GDP on a country-by-country, as well as model-by-model basis.

The first model will be the Private Model, employed by only the United States. In this model, health delivery is mostly private and is paid for in part by private insurance companies. Individuals in turn pay these private insurance companies to receive health services. Misleadingly, the United States "Private Model" is not entirely private. Medicare, Medicaid, and the Veterans Health Administration may all be considered as some of the non-private elements of the United States health care system. The U.S. underwent a large health care transition in 2010, when the Patient Protection and Affordable Care Act (ACA) was passed. This law had multiple components, including a mandate that all individuals obtain health insurance coverage or risk paying a fine, and expansion of certain publically provided services, such as the proportion of the population covered by Medicaid. However, even before the ACA, almost half of all health spending was public, so the categorization of the U.S. as employing a “Private Model” is a relative term used for the purposes of this paper.

The second model of study is the Beveridge model, which is funded publically through taxation and centrally organized into a national health service of some type. Countries that employ this model include the United Kingdom, Italy, Spain, Sweden, Denmark, Norway, and Finland. Health services are publicly distributed through the same central organization. The United Kingdom has been following the Beveridge model since the inception of the National Health Service in 1948. The Italian National Healthcare Service was created in 1978 and is inspired largely by the British system. Although Spain had some form of national health care since the mid-1970s, they were considered a Bismarck model until their financial reorganization in 1989, whence they switched to Beveridge. Sweden passed their National Health Insurance Act in 1946 to fund health care through taxes, and Denmark moved to their National Health Security System in 1973. Norway was extremely early, passing the Health Practitioners’ Act of 1912 to guarantee all citizens equal access to physician services regardless of income, and finessing their publically-funded care since then. The Finnish health care system has developed gradually as well, and no exact year has been identified as the introduction of their tax-based system.

The final model of study will be the Bismarck model, found in Germany, France, Switzerland, Japan, the Netherlands, and Belgium. The Bismarck model is often called a “mixed” model because there is both private and public provision of care. Funding is public, achieved through the compulsory health insurance premiums. Germany introduced mandatory national health insurance in 1883, and the model’s namesake, Otto von Bismarck, proposed the initial Health Insurance Bill of 1883. France instituted statutory health insurance as a part of the social security system in 1945. In Switzerland, attempts to nationalize health care were made as early as 1890, but strong centralization and reform were not successful until 1994. Japan established national health insurance in 1961, but the Netherlands established mandatory insurance in just 2006. In Belgium, health insurance was made compulsory for all salaried workers in 1944.

Model	**Description**	**Countries**
Private	Private insurance, private providers	United States
Beveridge	Public insurance, government-employed providers	United Kingdom Italy Spain Sweden Denmark Norway Finland
Bismarck	Public insurance, private providers	Germany Japan Netherlands Belgium *France (omitted)* *Switzerland (omitted)*

2. Data Overview – Increasing Health Expenditures

This paper primarily uses data from Organization for Economic Cooperation and Development (OECD) database from 1970-2014. As mentioned previously, this paper includes data on the United States, Germany, Netherlands, United Kingdom, Japan, Italy, Spain, Sweden, Finland, Norway, Denmark, and Belgium. The countries of Switzerland and France were omitted from this study due to data constraints. The main outcome of interest is national health expenditure, which measures the final consumption of health care goods and services, excluding any spending on health care investments. National health expenditure is given as a percent of annual GDP throughout the entirety of this paper.

From 1970 to 2014, income per capita has increased steadily across the board. The average increase in GDP per capita across all study countries was 987.8 USD from 1970-2014 (Figure 1). Health expenditure also increased over this period, an increase of 106.7 USD per capita. As may be expected, there is a strong relationship between per capita health expenditure and GDP. Richer countries tend to spend more on health care goods and services (Figure 2). This positive correlation between GDP per capita and national health expenditure per capita is very clear in the most recent data from 2014 (Figure 3).

However, the positive correlation between income and national health expenditure is not sufficient to explain the increases in health expenditure; the growth in health expenditure has exceeded the growth in GDP since 1970. Figure 4 shows that health expenditure as a percent of GDP has continuously risen in all study countries 1970-2014. Although all countries have experienced increases in health expenditure as a percent of GDP, the United States has shown substantially more growth in this metric 1970-2014, as displayed in Figure 4 and Figure 5.

Figure 6 examine differences in health expenditure between Bismarck (blue) and Beveridge (red) countries. Bismarck countries appear to have higher health spending on average, but the growth in health spending appears to be approximately the same in both groups.

There are many nation-level factors affecting the relationship between GDP and health expenditure. The demographic makeup of a country's population may be related to both income and spending on health. An important consideration is the average age of the population in a country. Typically, people consume more health services in later stages of their life. In 2004, the per capita health spending in the U.S. for males and females aged 65 and over was over three times the average level of per capita health spending for those aged 19-64 (Cylus et al., 2011). There is also a strong relationship between life expectancy and income, although the direction of this relationship is debated (Servellati and Sunde, 2011; Lorentzen et al., 2008; Acemoglu and Johnson, 2007). These two trends are also seen in the countries examined in this paper; the relative size of the elderly population is associated with higher income levels and higher health share of GDP (Figure 7a, Figure 7b). All three variables – health expenditure, GDP, and the relative size of the elderly population – have increased from 1970-2014 in all study countries (Figure 8).

Another variable taken into consideration is public education spending. Education is a publicly and privately provided good, just like health care. The share of income spent on public education may be indicative of the value a country places on public goods and services. Health expenditure and public education expenditure are positively correlated, as are GDP and public education expenditure (Figure 9a and Figure 9b). The level of public education expenditure varies by country, but generally rests between 3% and 7% of annual GDP (Figure 9c). The average level of public education spending is consistent across health care models (Figure 9d).

A country's budget deficit or surplus as a percent of GDP was also considered in this paper. Deficit or surplus indicates the amount of total government spending relative to national income: a positive value represents annual government spending is less than the national income of the country and a negative value represents government spending exceeds national income in that year. A country's annual deficit relative to national income may be related to the level of national health expenditure relative to income (Figure 10). In particular, Norway and the United States show signs that there may be a negative correlation between the level of government surplus and health expenditure as a share of GDP. Norway has a consistently high surplus, and a relatively low share of GDP spent on health care; from 1995 to 2014 Norway ran an average surplus of 11% of GDP, and from 1970 to 2014 health expenditure was 7% of GDP. By contrast, in 2014 the United States ran a deficit equal to 5% of GDP, and health expenditure was over 16% of GDP. Despite this evidence, deficit was not considered in the final regressions due to data constraints.

Following the study by Finkelstein et al., global oil price and national oil reserves are included in the dataset. Oil prices gradually decreased 1980-1990 and remained fairly consistent 1990-2000, before increasing sharply 2000-2014 (Figure 11). National oil reserves vary by country and year, but the United States consistently had the highest oil reserves during the study period (Figure 12).

3. Results

The main goal of this paper is to discern any differences in the income elasticity of demand for health share of GDP between Beveridge and Bismarck models. The income elasticity of demand for health share will be taken as the coefficient on the natural log, or percent growth, of GDP, the independent variable, when regressed on the natural log of health expenditure as a percent of GDP. This estimate is represented as β_1 in equation 2.

The preliminary regression (Table 1) shows again the positive relationship between GDP and health expenditure as a percent of GDP, and that approximately the same relationship is seen in both Bismarck and Beveridge countries. Table 1 shows the regression results of equation 1.

$$healthexp_{it} = \beta_0 + \beta_1 gdp_{it} + \varepsilon_{it} \tag{1}$$

[Table 1, page 38]

$$\ln(healthexp_{it}) = \beta_0 + \beta_1 \ln(gdp_{it}) + \varepsilon_{it} \tag{2}$$

Using equation 2, the baseline estimate of the income elasticity of demand is shown in Table 2. The baseline estimate excluding all other variable is an income elasticity around 0.29 for all study countries, 0.25 for Beveridge countries, and 0.28 for Bismarck countries.

[Table 2, page 38]

3.1 Results: The Role of Education and the Elderly

Although these results appear very statistically significant, it is possible that they are a result of country-level confounding factors. For this reason, it is important to include variables for country fixed effects, and certain country-level covariates. The first covariate examined is the elderly population, retrieved from the OECD website, and measured as the percent of the population over 65. With a large population over 65, a country may face increased health costs because individuals aged 65 and over are closer to the age of death and therefore statistically more likely to consume life-lengthening and enhancing health goods and services. This contributes to a potentially higher level of health expenditure as a percent of GDP.

The next covariate examined is education spending as a percent of GDP, retrieved from the Urban Institute for Statistics. Health spending is potentially related to education spending because both metrics may reveal a trend in the tendency of a country or its government to spend on public goods.

$$healthexp_{it} = \beta_0 + \beta_1 gdp_{it} + \beta_2 eldlypop_{it} + \beta_3 educ_{it} + \gamma_i + \varepsilon_{it} \qquad (3)$$

In regression 3, $eldlypop_{it}$ represents the percentage of the population over 65 in country *i* during year *t*. The variable $educ_{it}$ represents the percent of GDP spent by the government on education in country *i* during year *t*. The variable γ_i is a set of country indicators, used to capture the country fixed effects relative to the health expenditure found in Belgium.

[Table 3, page 38]

The regression results displayed in Table 3 show that GDP still has a positive relationship with health expenditure. The coefficient of 0.0001 on GDP can be interpreted as an increase of 1 USD in per capita income is related to an increase of 0.0001 in the percent of GDP spent on health care, on average. Elderly population also has a positive relationship with health expenditure in all study countries, with a one percent increase in the population over 65 related to an increase of 0.122 in the percent of GDP going to health expenditures. Education spending is positively correlated with health expenditures as well – a one percent increase in the percent of income spent on education is related to a 0.215 increase in health spending as a percent of GDP, averaging across all study countries. All three relationships are significant at the one percent level, and are seen when countries are separated into their respective Bismarck or Beveridge groups as well.

Relative to the level of health expenditure in Belgium, Regression 3 shows that Germany, Denmark, and the United States all spend significantly more on health when accounting for variation in GDP, the elderly population, and education spending. In contrast, the United Kingdom and Norway both spend significantly less. Out of all the coefficients, the United States has the greatest magnitude, suggesting that when controlling for differences in GDP, education spending, and the elderly population, the United States still has a far higher level of health spending than other countries.

3.2 Results: Shocks and Instrumental Variables

Another important consideration in determining the relationship between health expenditure and GDP is the deviations or shocks to either metric. Health expenditure shocks may be caused by a sudden change in the organization of a country's health system, or a new government-provided health service with a large target population. Sudden changes in GDP may be caused by a recession or a spike in global oil prices, if oil is a big part of the national economy.

To account for this, health expenditure is smoothed over five year periods by taking a moving average of health expenditure in each country. Exogenous GDP shocks are considered by adding a variable for the annual global crude oil price, given in USD per barrel. Each country's economy relies to a different degree on oil, and therefore has a different level of sensitivity to changes in oil price. National oil reserves are used to measure this sensitivity, given in billions of barrels. An interaction variable for oil reserves and the price of oil is created is also added to the regression. The oil price data is from Federal Reserve Economic Data (FRED), and oil reserves are from the U.S. Energy Information Administration.

$$healthexp_{it} = \beta_0 + \beta_1 gdp_{it} + \beta_2 eldlypop_{it} + \beta_3 educ_{it} + \beta_4 oilprice_t + \beta_5 oilreserves_{it} + \beta_6 oilprice_t * oilreserves_{it} + \gamma_i + \varepsilon_{it} \quad (4)$$

The results for Regression 4 are displayed in Table 4.

[Table 4, page 39]

Table 4 reveals that smoothing health expenditure and adding oil prices does not change the direction of the correlation between GDP and health expenditure, but does weaken the magnitude of the relationship. The lower magnitude of the coefficient on GDP suggests that health expenditure and GDP spikes occur at the same period, or that exogenous factors such as oil price or oil reserves are mediating the relationship between health expenditure and GDP.

To determine whether the latter statement is valid, the interaction of oil price change and oil reserves is used as an instrument on GDP growth in a two-stage least squares regression

(TSLS). Oil price change and GDP growth are both given as a whole number percent. Using an instrumental variable on GDP growth will indicate whether increases in income cause increases in the health share of GDP. As global oil prices increase, countries with larger oil reserves should experience income growth. This is tested by the first stage of the TSLS, equation 5. If oil is determined to be a relevant instrument for GDP growth, the second stage of the regression can be used to determine whether exogenous GDP effects drive any changes in health expenditure. The interaction of oil price and oil reserves is an exogenous instrument; it is unlikely that health expenditure will affect either oil prices or oil reserves. For the sake of this study the exclusion restriction is assumed to hold – oil price and oil reserves do not affect health expenditure through any avenue besides GDP. However, the exclusion restriction cannot be guaranteed and thus oil may be an invalid instrument if it affects health expenditure through another factor.

1st stage:

$$gdp\ growth_{it} = \pi_0 + \pi_1 oilpricechange_t * oilreserves_{it} + \pi_2 X_{it} + \varepsilon_{it} \qquad (5)$$

2nd stage

$$healthexp_{it} = \beta_0 + \beta_1 gdp\ growth_{it} + \beta_2 X_{it} + \varepsilon_{it} \qquad (6)$$

Where X_{it} represents all other covariates. The regression results from the first stage are displayed in Table 5.

[Table 5, page 40]

Table 5 shows that the oil interaction variable is just relevant enough to be the instrument for GDP growth and the TSLS may proceed to the second stage. The results of the second stage are displayed in Table 6.

[Table 6, page 40]

The results from Table 6 show that GDP growth is a significant and positive driver of health expenditure. An increase of 1% in per capita income causes the health share of GDP to increase by 0.4 on average. The elderly share of the population is also positively correlated with health expenditure. On average, a 1% increase in the percent of the population over 65 is related to a 0.6 increase in health expenditure as a percent of GDP. When public spending on education as a percent of GDP increases by 1, the average health share of GDP is higher by 0.9. Many countries also see their own significant fixed effects. Germany, the Netherlands, and the United States all spend significantly more on health care than Belgium after accounting for the explained variation from GDP growth, the elderly population, and education spending. On the other hand, Denmark, the UK, Norway, and Sweden all have a significantly smaller share of GDP going to health care relative to Belgium after accounting for variation attributable to other covariates. The United States has the highest level of health expenditure by far – its fixed effects coefficient is over three times the magnitude of any other coefficient. In general, the magnitude of the significant coefficients for country fixed effects are much greater than the other covariate coefficients, particularly GDP growth. Health expenditure is therefore largely associated with certain country-specific factors not included in this study.

3.3 Results: Income Elasticity using Instrumental Variables

To obtain an estimate for the income elasticity of demand for health share of GDP, another TSLS is run using equation 5 as the first stage and equation 7 as the second stage. In equation 7, $\beta_1$represents the central estimate for the income elasticity of demand.

1st stage:

$$gdp\ growth_{it} = \pi_0 + \pi_1 oilpricechange_t * oilreserves_{it} + \pi_2 X_{it} + \varepsilon_{it} \tag{5}$$

2nd stage

$$healthexp\ growth_{it} = \beta_0 + \beta_1 gdp\ growth_{it} + \beta_2 X_{it} + \varepsilon_{it} \tag{7}$$

With oil price change, health expenditure growth, and GDP growth given as a whole number percent. The results from equation 7 are displayed in Table 7.

[Table 7, page 41]

The coefficient on GDP growth shows that a 1% increase in annual GDP causes a 1% decrease in the health share of GDP. This estimate may be due to health expenditure having a lagged response to increases in GDP. Health expenditure is given as a portion of GDP, and if the level of health spending stays constant while GDP grows, then health expenditure as a percent of GDP will decrease. Therefore, a lagged value of GDP growth must be used as the endogenous regressor in order to accurately capture the effects of GDP growth on the growth of health share of GDP. The new TSLS equations using lagged GDP growth and lagged oil interaction are shown in equations 8 and 9.

1st stage:

$$gdp\ growth_{i(t-1)} = \pi_0 + \pi_1 oilpricechange_{t-1} * oilreserves_{it-1} + \pi_2 X_{it} + \varepsilon_{it} \qquad (8)$$

2nd stage

$$healthexp\ growth_{it} = \beta_0 + \beta_1 gdp\ growth_{i(t-1)} + \beta_2 X_{it} + \varepsilon_{it} \qquad (9)$$

The results of equation 8 are shown in Table 8. Oil was again found to be a relevant instrument, and the second stage results are shown in Table 9.

[Table 8, page 42]

[Table 9, page 43]

The central estimate of β_1, the estimated income elasticity of demand for health share of GDP, is found to be 0.373 and significant at the 5% level. As GDP grows, the health share of GDP also grows – a 1% increase in per capita income causes on average a 0.373% increase in the health share of GDP.

There are significant limitations to understand when interpreting these regression results. Firstly, there are considerations for oil prices and oil reserves. The interaction of oil price and oil reserves was relevant, but not a very strong instrument. This may be due to the low oil reserve levels of many countries in this study (Figure 12). Several countries have zero or near zero oil reserves; in these countries oil is not a large part of the national economy and therefore oil price changes do not greatly affect GDP growth. Secondly, the sizes of the country fixed effects coefficients are larger than the estimated effect of GDP growth. Again, this suggest that health expenditure is largely associated with certain country-specific factors not included in this study that may be confounding any of the estimated relationships. Another consideration is the construction of the growth variables – instead of using the natural log, a whole number percent was used to capture growth. Thus, the estimate $\beta_1 \sim 0.4$ may be interpreted as a 1% increase in YoY GDP causes an increase of 0.4% in the YoY health share of GDP.

Unfortunately, due to data constraints the income elasticity of health share could not be calculated separately for the Beveridge, Bismarck, and Private models. With fewer observations in each category the first stage regression was not relevant enough.

3.4 Results: Lasso Regression

An important risk of the above regressions is that the hypothesized models may be overfitting the relationship of GDP and health spending. To discourage an over-fitted model, a penalized regression must be used. A penalized regression minimizes error – the sum of squared residuals – while creating a penalty for model complexity. This is a useful technique to prevent overfitting when the exogenous regressors may be correlated with one another. The Lasso method was determined to be the best type of penalized regression to employ based on the sample constraints. Lasso employs the L_1 norm, given as:

$$L_1 = |\beta_0| + |\beta_1| + |\beta_2| + \cdots + |\beta_n| < c \tag{6}$$

Where β_i is the coefficient on variable i for a regression with n covariates. A lasso regression minimizes the sum of squared residuals subject to the constraint that L_1 is less than some fixed value, c. Lasso shrinks all coefficients in the regression by some amount, lambda, λ.

If a coefficient has a magnitude that is less than λ, it becomes 0. Stricter Lasso regressions use a high value of λ and return few non-zero coefficients. A Lasso regression with $\lambda = 0$ will be indistinguishable from its non-penalized counterpart; all variables and their coefficients will be included in the regression. Figure 13 displays a plot of all coefficients from the regression results of equation 4 by decreasing λ value, for the range $\lambda = [10^0, 10^{-10}]$. The six largest coefficients are labeled to the right.

[Figure 13, page 37]

This figure shows that when all variables considered in this study are employed in an Ordinary Least Squares regression, the country fixed effects for the United States have the greatest effect on health expenditure as a percent of GDP. The United States has a level of health expenditure that is higher than the variation explained by GDP, the elderly population, education spending, oil reserves, etc. Furthermore, it is noteworthy that the next four largest drivers of health spending are also country fixed effects for Germany, Norway, Sweden, and Spain, in order. Germany and Spain have health expenditure exceeding the variation explained by other covariates, including healthcare model. Norway and Sweden spend less on healthcare as a share of GDP than the expected variation due to other factors. These results suggest that deviations in the health share of GDP are explained by some set of country-level factors not included in the above regression. The largest driver of health expenditure excluding all country fixed effects was education spending, whose coefficient was the sixth largest in magnitude. Education spending has a positive relationship with health expenditure, indicating that countries with a higher annual public spending on education as a share of GDP also had higher health expenditure as a share of GDP, on average.

An important limitation of the Lasso method in the context of this study is that it uses a constant shrinkage value, or λ on all coefficients. This method favors variables with large coefficients, which may not necessarily be the most important drivers of health expenditure. A variable that is statistically significant but with a relatively small coefficient value may be discounted even though it is an important factor in explaining variation in health expenditure. For example, GDP has a very small coefficient but is significantly correlated with health expenditure in the OLS regression, yet is not determined to be one of the most important drivers of health expenditure using the Lasso method.

4. Conclusion

This paper finds that national health care expenditure is income elastic. The central estimate for income elasticity of demand for the health share of GDP was approximately 0.4, making health share of GDP income inelastic. An annual income increase of 1% is associated with a 0.4% increase in the health share of GDP, or in other words an increase in health expenditure exceeding the increase the respective increase in income by 40%, on average. This suggests that the share of income going to health will continue rising with increasing global income. The relative value of health increases with GDP and health is therefore a luxury good when considered on a national scale.

However, these study results point to some exogenous, country-level factor as the most significant in determining the national level of health share of GDP, one not captured by the variation in the percent of the population that is elderly, public spending on education, or GDP. This country-level factor appears to be strongest in the United States. These effects may have been overestimated by using a year-over-year national growth percentage instead of the more common natural log of income. Public education share of GDP was also significantly correlated with health share of GDP, but there is uncertainty in the direction of this relationship.

Limitations of this study include the inability to capture such country-level factors, and the lack of countries with health systems falling neatly into the private, Beveridge, and Bismarck categories. The latter factor creates an inability to establish model-level trends that are differentiable from the country-level trends. A possible expansion on this study that may indicate model-level trends in health expenditure would be creating a database of countries that have undergone a change in health care model, and measuring any differences before and after such transition. Other future studies may seek out a stronger instrumental variable for GDP growth, some exogenous measure that is more representative of the national economies.

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6. Appendix

6.1 Figures

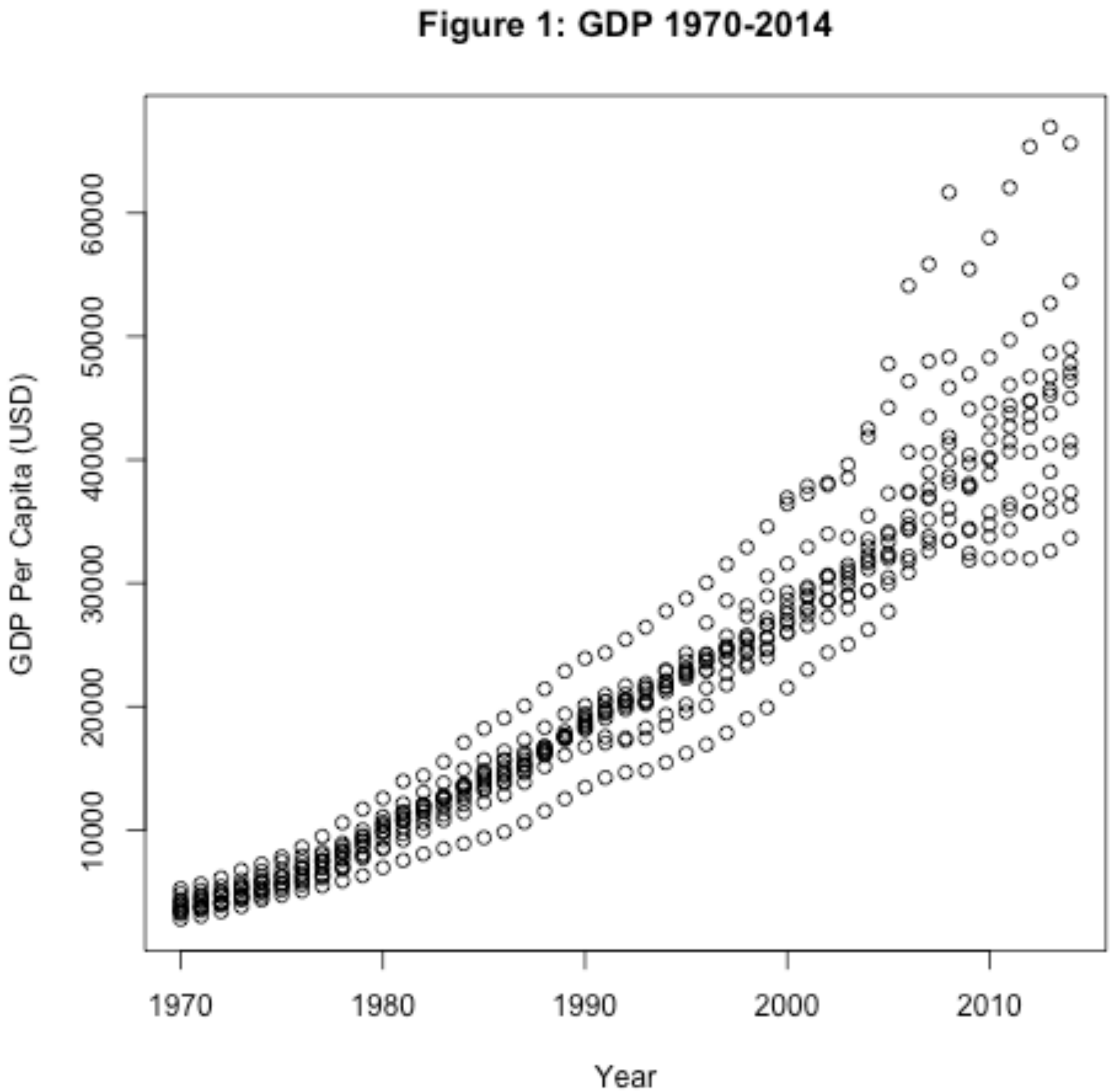


Figure 2: Health Expenditure by GDP

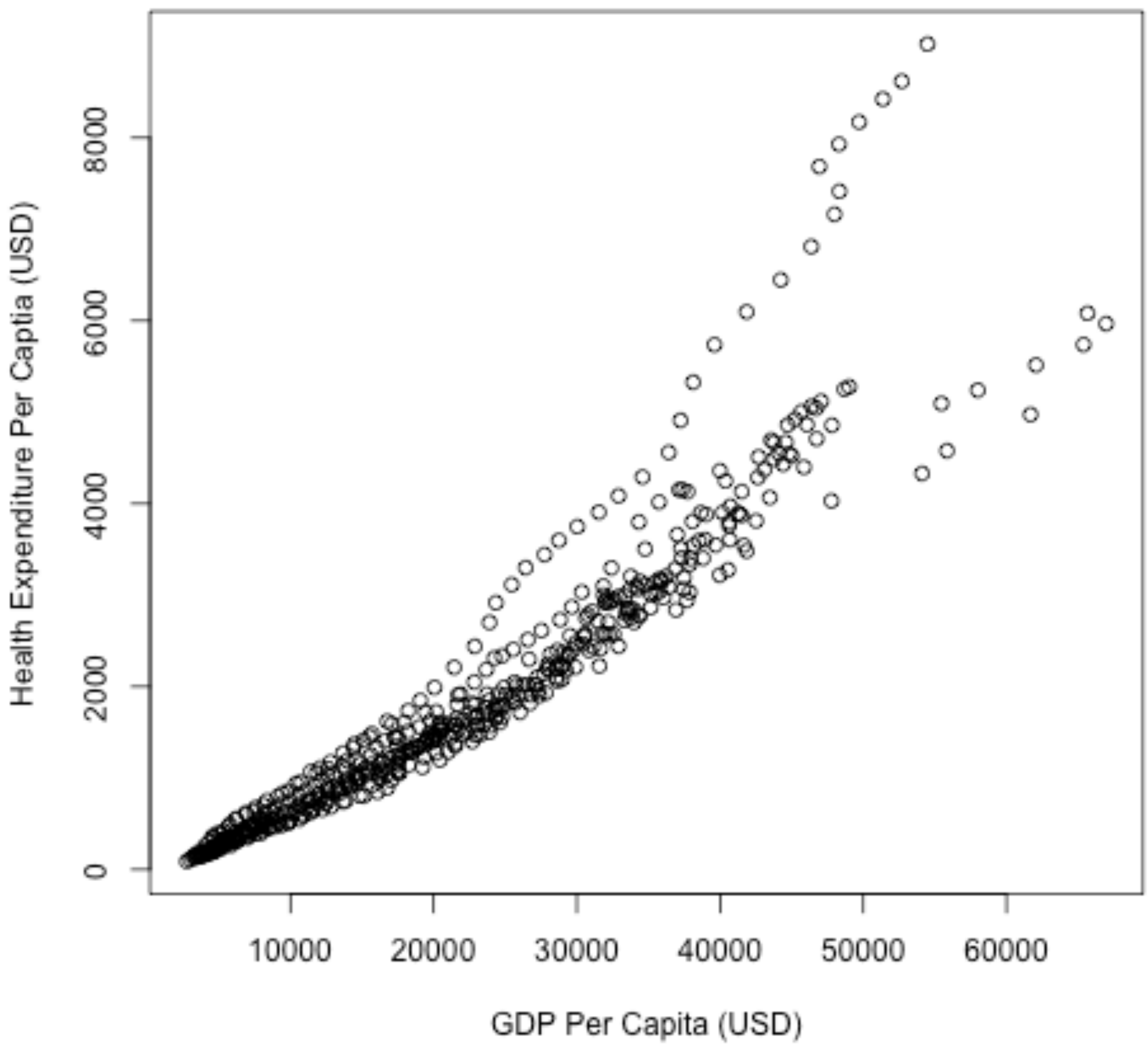


Figure 3: National Health Expenditure by GDP, 2014

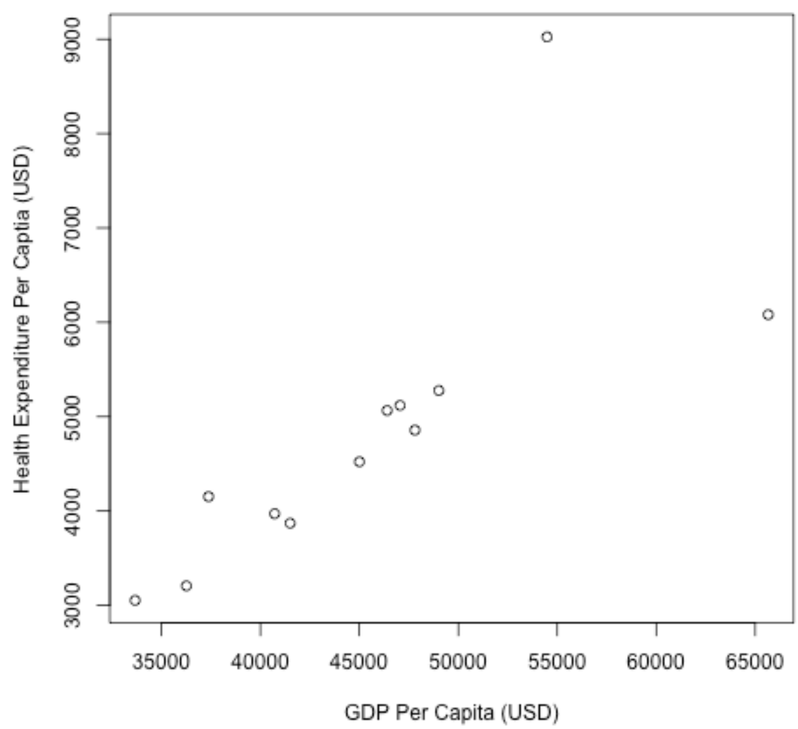


Figure 4: Health Expenditure 1970-2014

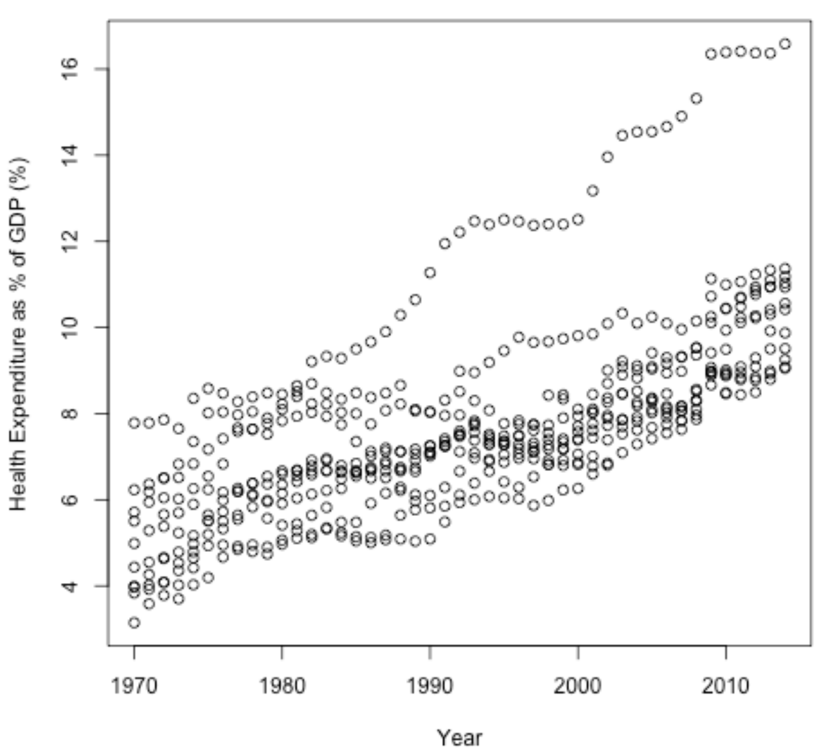


Figure 5: Health Expenditure by Country, 2014

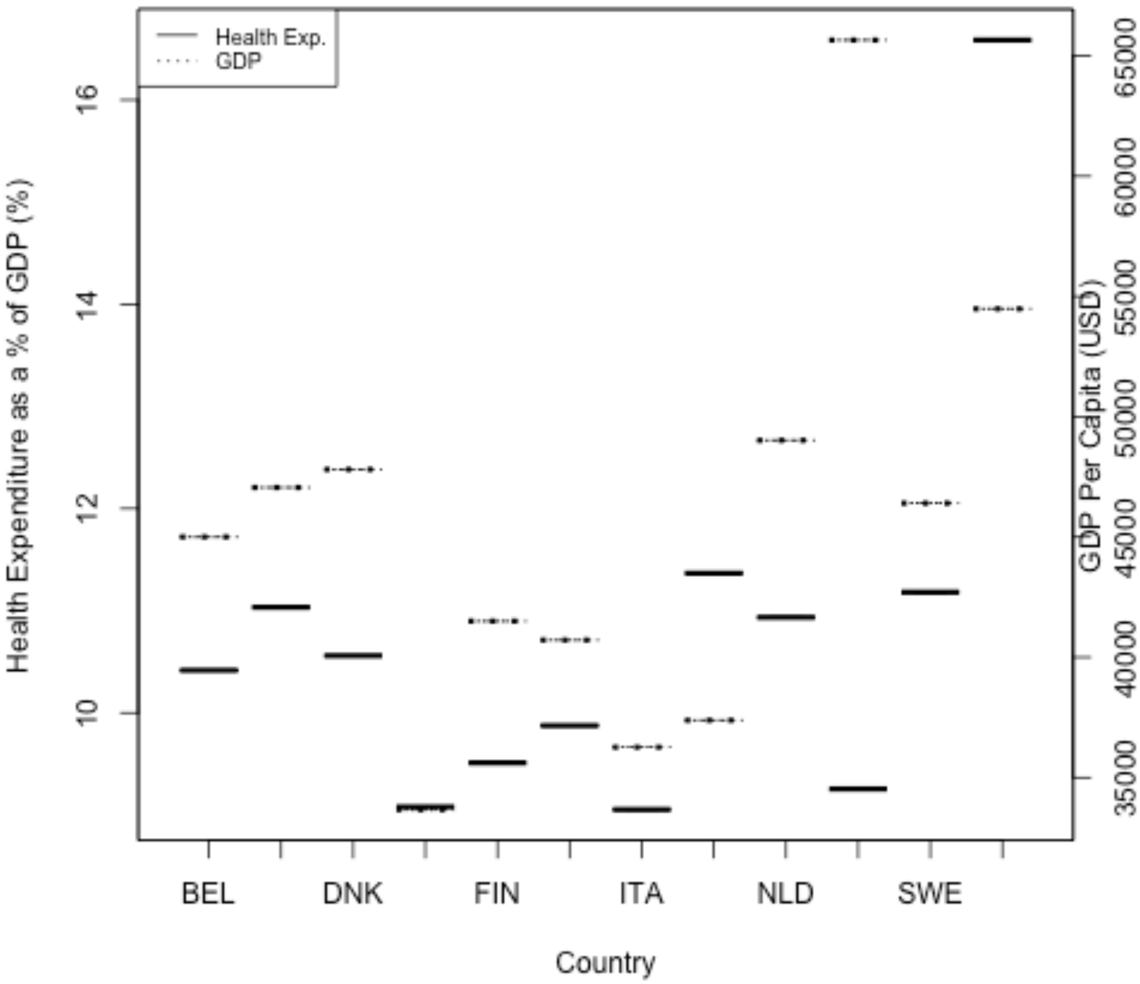


Figure 6: Bismarck and Beveridge Health Expenditure 1970-2014

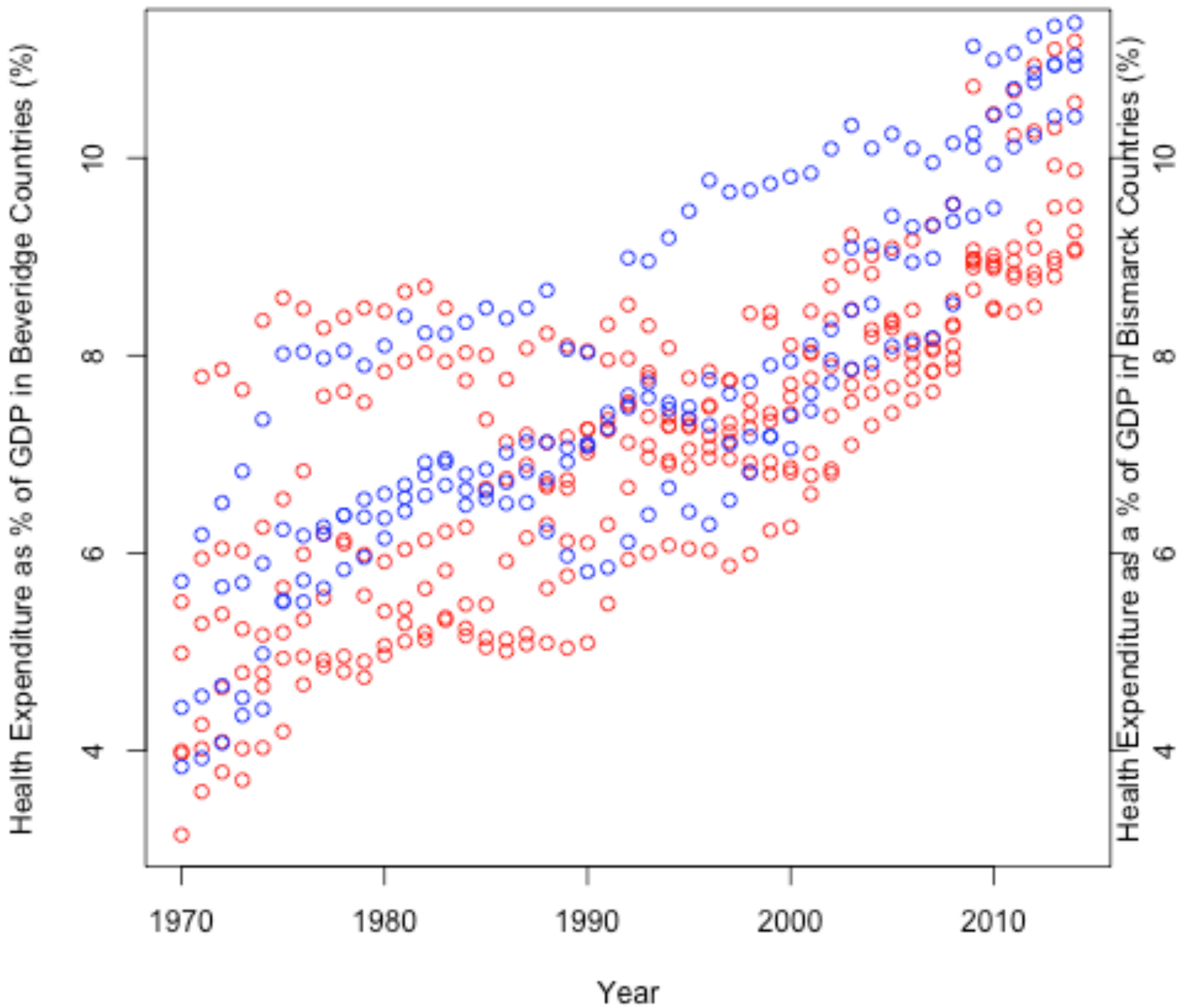


Figure 7a: Elderly Population and Health Expenditure, 1970-2014

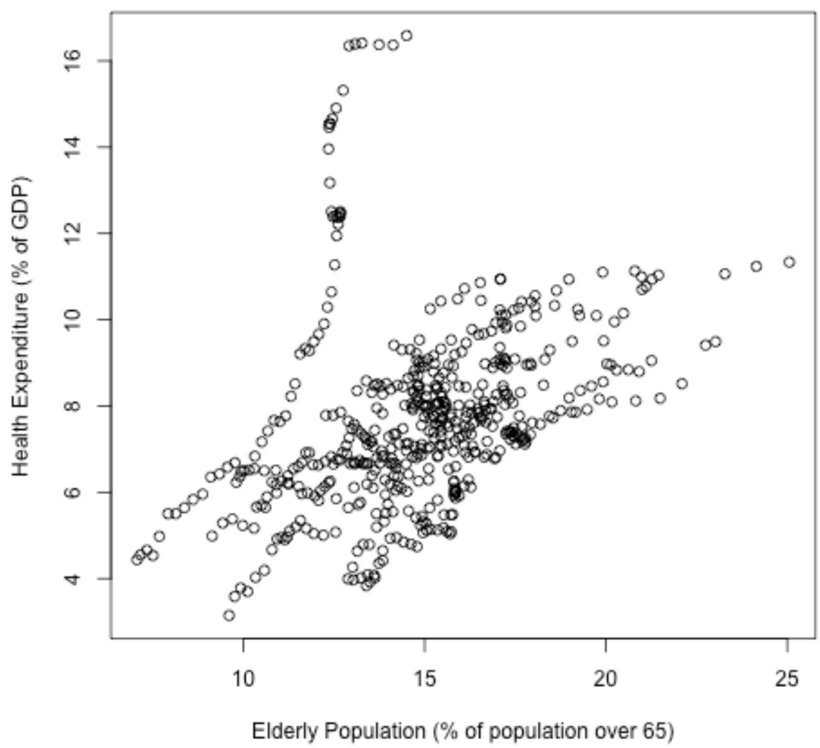


Figure 7b: Elderly Population and GDP, 1970-2014

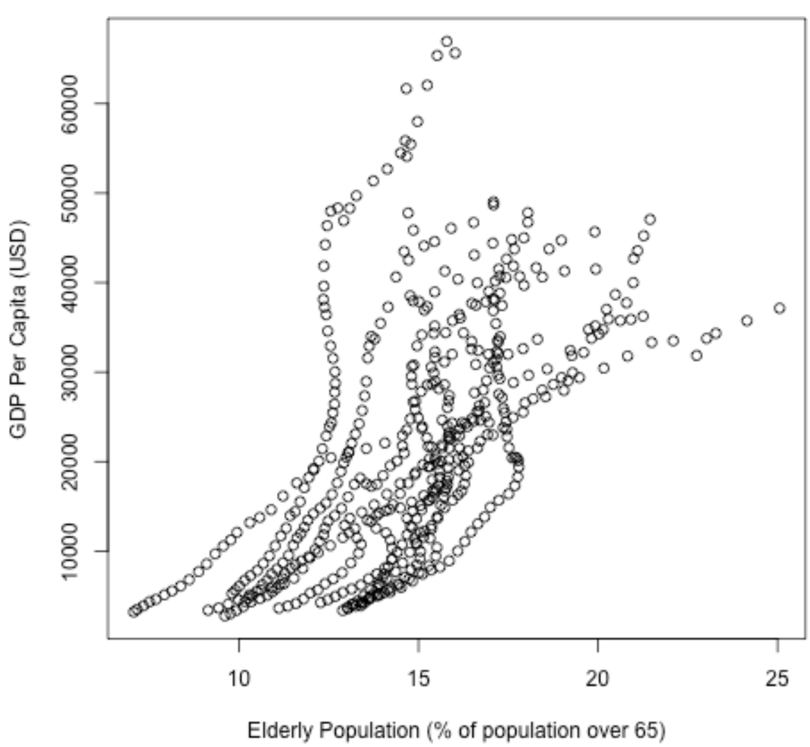


Figure 8: Elderly Population over Time

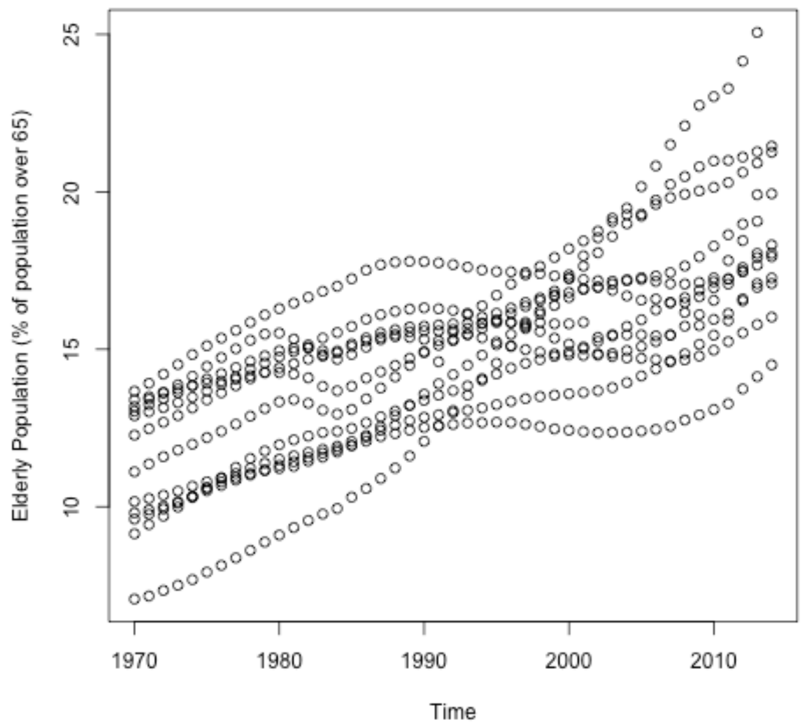


Figure 9a: Education and Health Spending

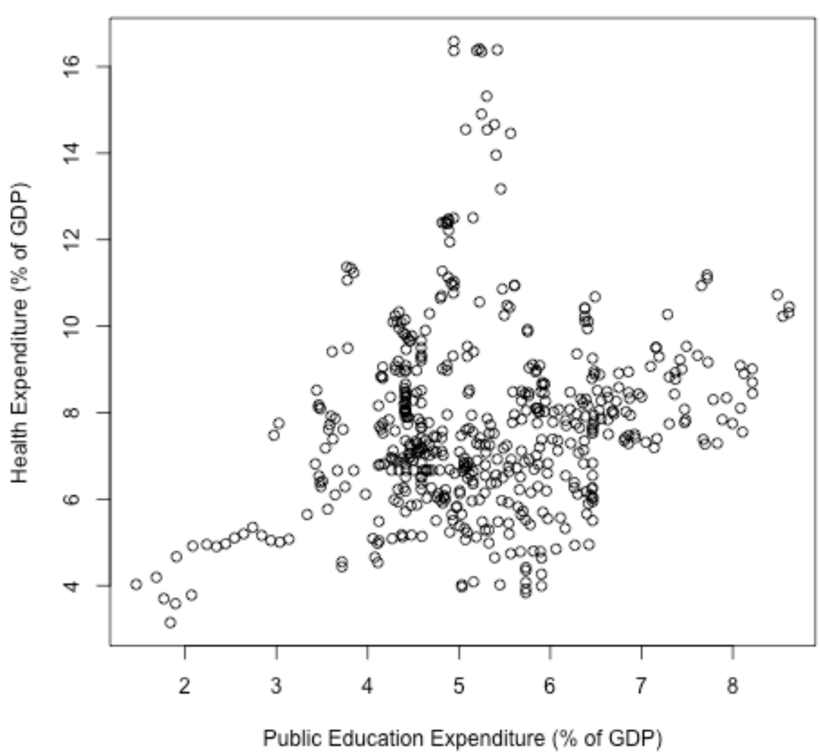


Figure 9b: Education Spending and GDP

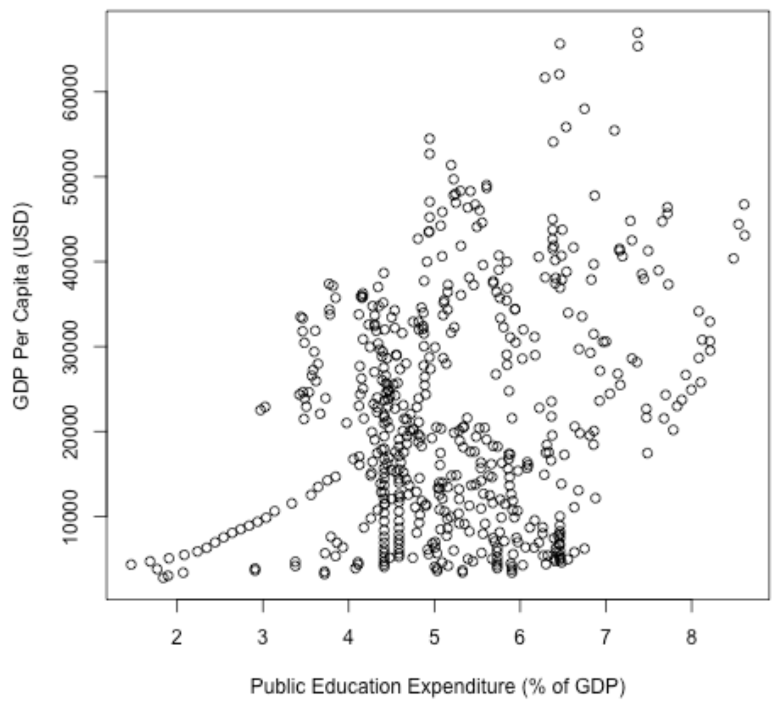


Figure 9c: Education Spending by Country, 1980-2014

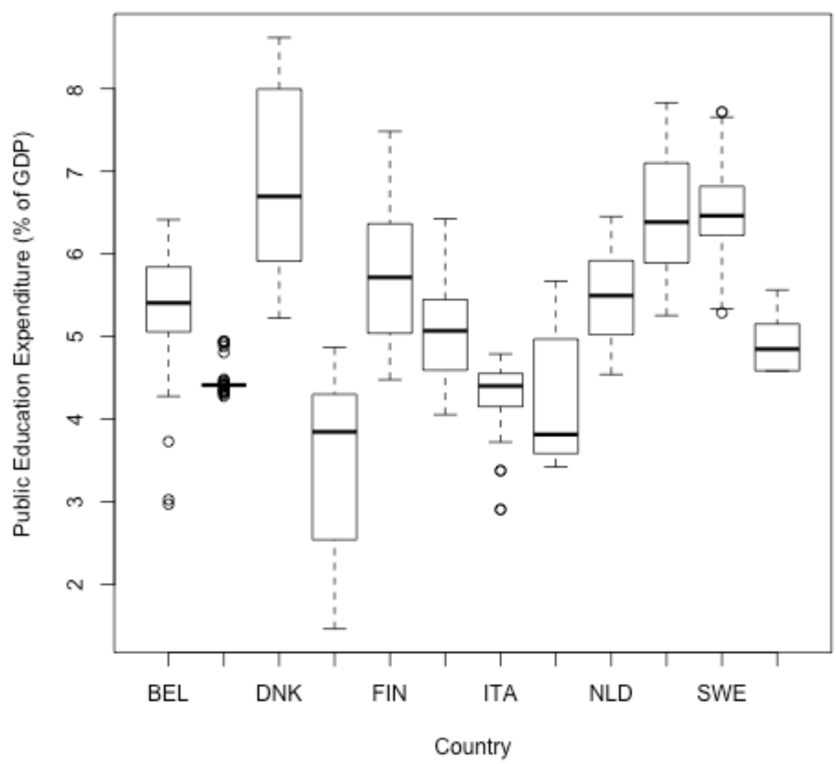


Figure 9d: Education Spending by Healthcare Model, 2014

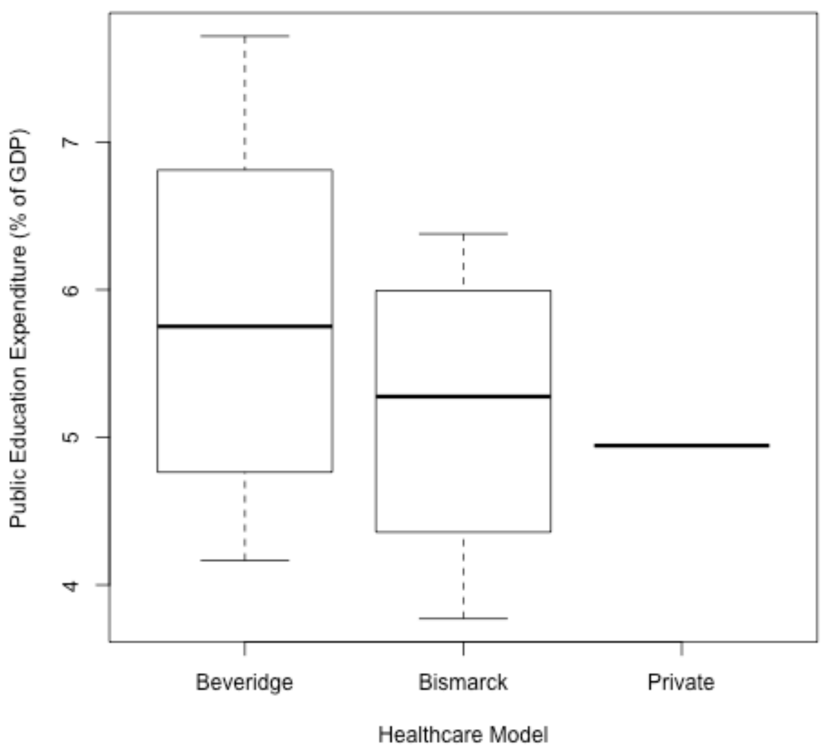


Figure 10: Deficit and Health Expenditure

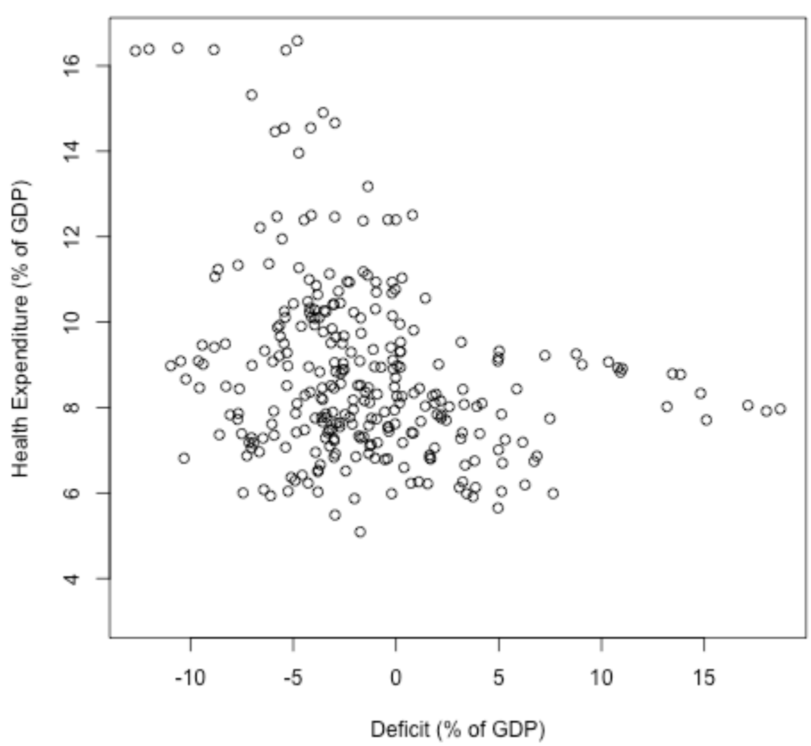


Figure 11: Global Oil Price 1980-2014

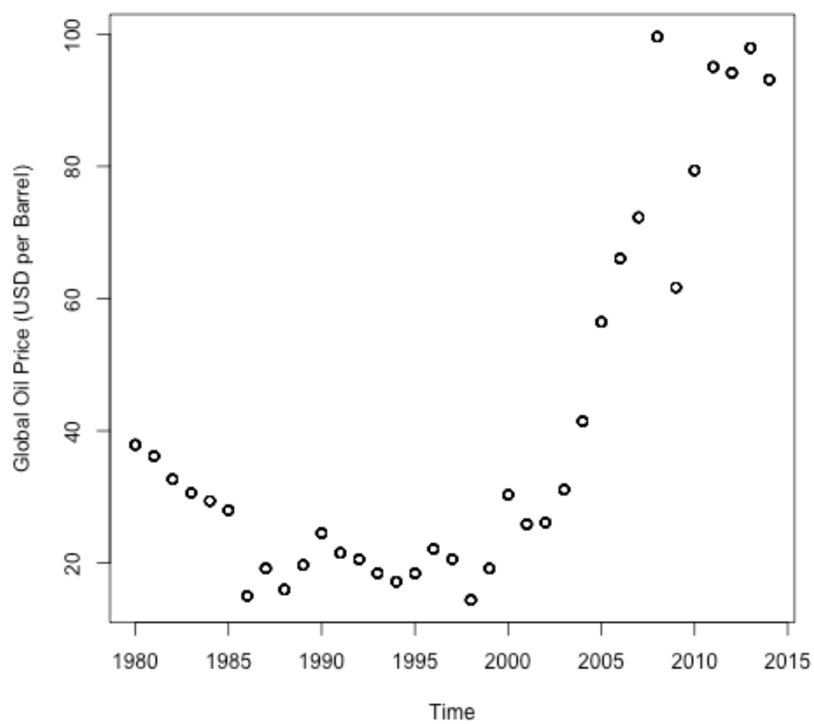


Figure 12: Oil Reserves by Country 1980-2014

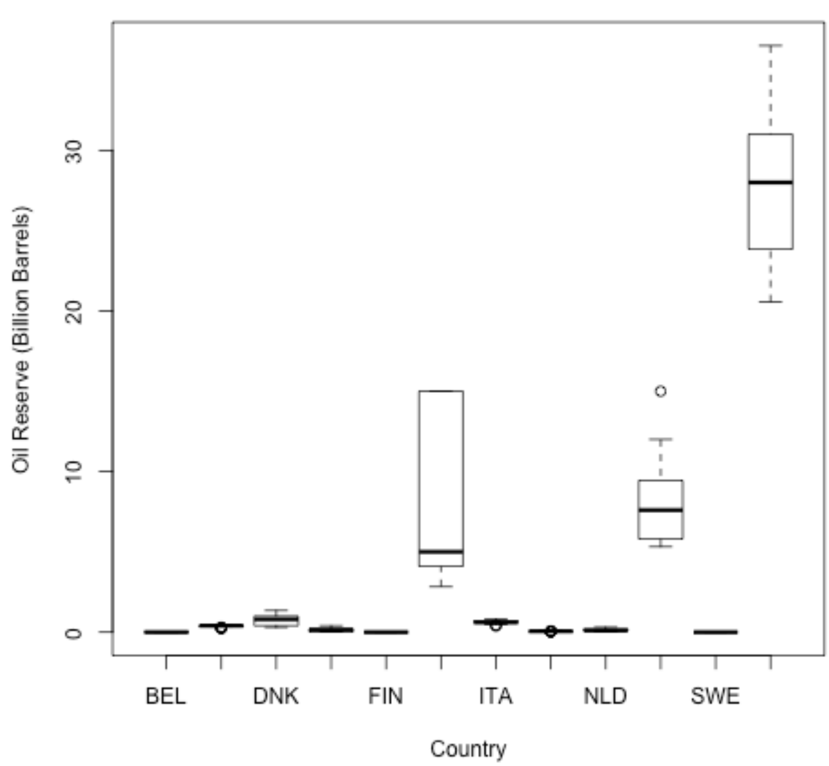
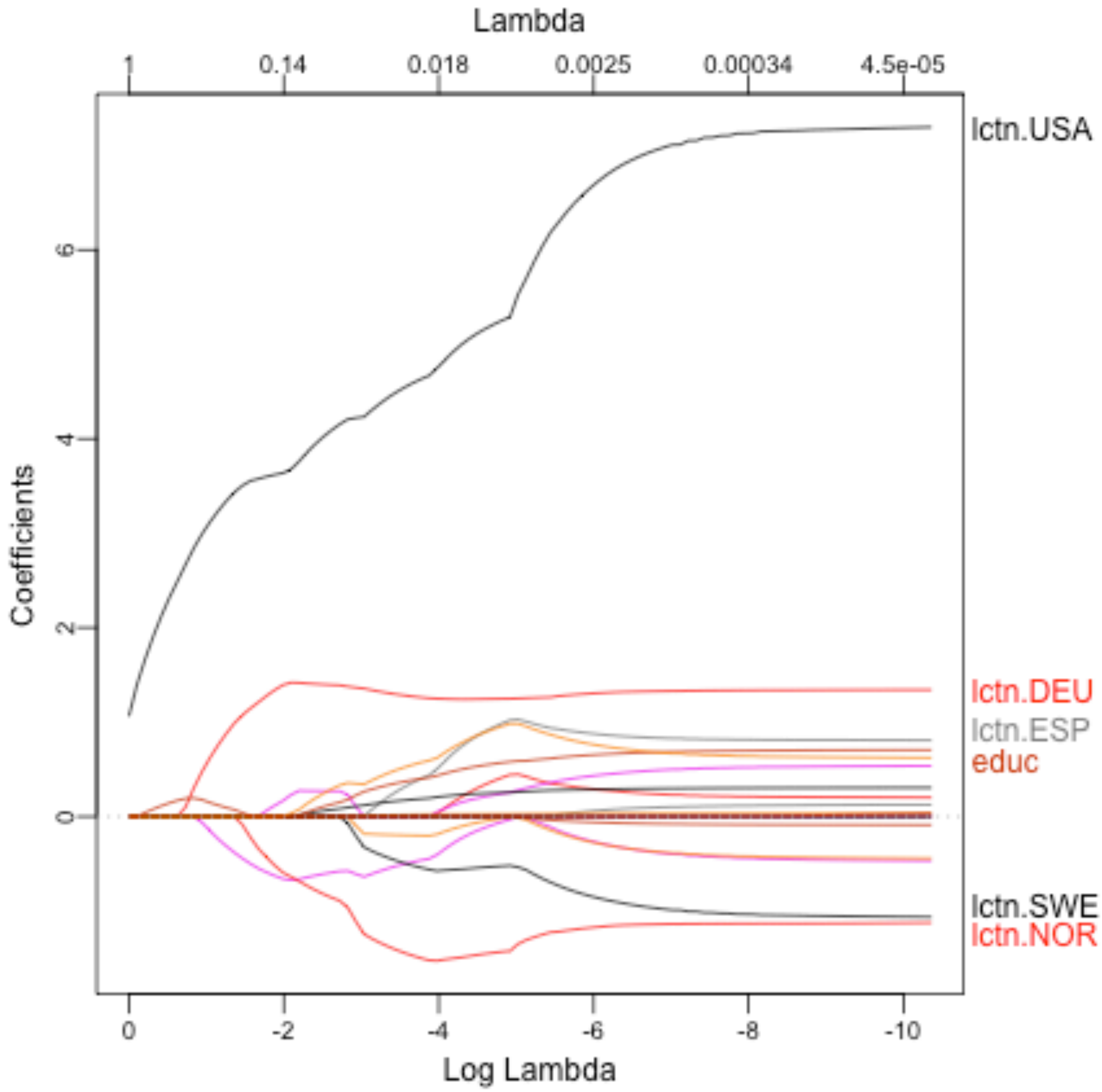


Figure 13: Lasso Regression



6.2 Tables and Regressions

Table 1: GDP on Health Expenditure, 1970-2014

	Dependent variable:		
	Health Expenditure		
	All	Beveridge	Bismarck
	(1)	(2)	(3)
GDP	0.0001^{***}	0.0001^{***}	0.0001^{***}
	(0.00000)	(0.00000)	(0.00001)
Constant	5.139^{***}	5.313^{***}	5.212^{***}
	(0.123)	(0.109)	(0.144)
Observations	527	305	177
Note:	*p<0.1; **p<0.05; ***p<0.01		

Table 2

	Dependent variable:		
	ln(Health Expenditure)		
	All	Beveridge	Bismarck
	(1)	(2)	(3)
ln(GDP)	0.285^{***}	0.248^{***}	0.275^{***}
	(0.010)	(0.011)	(0.014)
Constant	-0.777^{***}	-0.474^{***}	-0.664^{***}
	(0.101)	(0.109)	(0.137)
Observations	527	305	177
Note:	*p<0.1; **p<0.05; ***p<0.01		

Table 3

	Dependent variable:		
	Health Expenditure		
	All	Beveridge	Bismarck
	(1)	(2)	(3)
GDP	0.0001^{***} (0.00000)	0.0001^{***} (0.00000)	0.0001^{***} (0.00001)
Elderly Population	0.125^{***} (0.021)	0.183^{***} (0.025)	0.120^{***} (0.024)
Education Spending	0.216^{***} (0.055)	0.284^{***} (0.053)	0.292^{***} (0.075)
Germany FE	1.541^{***} (0.179)		1.612^{***} (0.140)
Denmark FE	0.797^{***} (0.191)		
Spain FE	-0.113 (0.200)	-0.790^{***} (0.215)	
Finland FE	-0.135 (0.174)	-0.842^{***} (0.140)	
United Kingdom FE	-1.114^{***} (0.171)	-1.881^{***} (0.160)	
Italy FE	-0.128 (0.190)	-0.813^{***} (0.200)	
Japan FE	0.080 (0.184)		0.169 (0.157)
Netherlands FE	0.272 (0.182)		0.245^{*} (0.144)
Norway FE	-1.201^{***} (0.180)	-1.810^{***} (0.131)	
Sweden FE	-0.222 (0.185)	-1.097^{***} (0.139)	
US FE	3.986^{***} (0.197)		
Constant	2.457^{***} (0.432)	2.606^{***} (0.430)	2.029^{***} (0.575)
Observations	525	304	176
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 4

	Dependent variable:		
	Smoothed Health Expenditure		
	All	Beveridge	Bismarck
	(1)	(2)	(3)
GDP	0.00004*** (0.00000)	0.00003*** (0.00001)	0.0001*** (0.00001)
Elderly Population	0.206*** (0.019)	0.113*** (0.024)	0.151*** (0.030)
Education Spending	0.356*** (0.047)	0.384*** (0.047)	0.222** (0.093)
Oil Price	0.007*** (0.002)	0.014*** (0.002)	0.014*** (0.004)
Oil Reserves	-0.160*** (0.019)	-0.044** (0.021)	1.589 (1.016)
Oil Price*Oil Reserves	0.001*** (0.0001)	-0.001* (0.001)	-0.018 (0.012)
Germany FE	1.101*** (0.138)		0.691* (0.379)
Denmark FE	0.046 (0.158)		
Spain FE	-0.288* (0.147)	-0.334* (0.171)	
Finland FE	-0.572*** (0.137)	-0.653*** (0.115)	
United Kingdom FE	-0.628*** (0.171)	-0.849*** (0.178)	
Italy FE	-0.371*** (0.138)	-0.230 (0.161)	
Japan FE	-0.194 (0.142)		-0.346** (0.165)
Netherlands FE	0.328** (0.142)		-0.001 (0.226)
Norway FE	-0.382* (0.211)	-0.646*** (0.184)	
Sweden FE	-0.869*** (0.151)	-0.680*** (0.117)	
US FE	7.774*** (0.498)		
Constant	1.595*** (0.385)	2.810*** (0.436)	2.455*** (0.743)
Observations	418	244	139
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 5: First Stage

	Dependent variable:
	GDP Growth
Oil Price Change*Oil Reserves	0.002*** (0.001)
Elderly Population	-0.562*** (0.070)
Education Spending	-0.291 (0.220)
Germany FE	0.664 (0.727)
Denmark FE	0.640 (0.827)
Spain FE	-0.586 (0.763)
Finland FE	-0.349 (0.723)
United Kingdom FE	0.078 (0.705)
Italy FE	-0.137 (0.724)
Japan FE	-0.245 (0.738)
Netherlands FE	-1.152 (0.720)
Norway FE	1.440* (0.765)
Sweden FE	1.193 (0.758)
US FE	-2.251*** (0.748)
Constant	14.883*** (1.663)
Observations	408
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 6: Second Stage

	Dependent variable:	
	Unsmooth	Smooth
	(1)	(2)
GDP Growth	0.445** (0.201)	0.405** (0.192)
Elderly Population	0.643*** (0.121)	0.626*** (0.114)
Education Spending	0.920*** (0.140)	0.862*** (0.133)
Germany FE	1.093** (0.463)	0.861** (0.433)
Denmark FE	-1.087** (0.505)	-0.965** (0.481)
Spain FE	0.482 (0.466)	0.399 (0.443)
Finland FE	-0.517 (0.437)	-0.492 (0.416)
United Kingdom FE	-1.313*** (0.420)	-1.328*** (0.400)
Italy FE	-0.301 (0.431)	-0.343 (0.410)
Japan FE	0.293 (0.441)	0.224 (0.420)
Netherlands FE	1.362*** (0.487)	1.323*** (0.463)
Norway FE	-2.240*** (0.547)	-2.102*** (0.521)
Sweden FE	-2.171*** (0.506)	-2.082*** (0.481)
US FE	6.931*** (0.596)	6.848*** (0.566)
Constant	-8.940*** (3.118)	-8.185*** (2.956)
Observations	407	408
Note:		*p<0.1; **p<0.05; ***p<0.01

Table 7: Second Stage

	Dependent variable:
	Health Expenditure Growth
GDP Growth	-1.007^{**} (0.416)
Elderly Population	-0.320 (0.244)
Education Spending	-0.792^{***} (0.288)
Germany FE	-1.008 (0.953)
Denmark FE	0.893 (1.044)
Spain FE	-0.771 (0.961)
Finland FE	0.201 (0.902)
United Kingdom FE	0.446 (0.867)
Italy FE	-1.643^{*} (0.978)
Japan FE	-0.586 (0.911)
Netherlands FE	-0.650 (1.000)
Norway FE	2.517^{**} (1.131)
Sweden FE	0.977 (1.040)
US FE	-0.788 (1.217)
Constant	15.289^{**} (6.329)
Observations	398
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 8: First Stage

	Dependent variable:
	Lagged GDP Growth
Lagged Oil Price Change*Oil Reserves	0.002^{***} (0.001)
Elderly Population	-0.556^{***} (0.069)
Education Spending	-0.790^{***} (0.216)
Germany FE	0.303 (0.717)
Denmark FE	1.596^{**} (0.809)
Spain FE	-1.174 (0.748)
Finland FE	0.108 (0.713)
United Kingdom FE	-0.120 (0.694)
Italy FE	-0.478 (0.715)
Japan FE	-0.653 (0.736)
Netherlands FE	-1.154 (0.708)
Norway FE	2.080^{***} (0.752)
Sweden FE	1.804^{**} (0.748)
US FE	-2.390^{***} (0.737)
Constant	17.479^{***} (1.638)
Observations	406
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 9: Second Stage

	Dependent variable:
	Health Expenditure Growth
Lagged GDP Growth	0.373^{**} (0.182)
Elderly Population	0.609^{***} (0.107)
Education Spending	1.079^{***} (0.183)
Germany FE	1.258^{***} (0.405)
Denmark FE	-1.401^{***} (0.531)
Spain FE	0.597 (0.464)
Finland FE	-0.796^{**} (0.397)
United Kingdom FE	-1.190^{***} (0.387)
Italy FE	-0.276 (0.406)
Japan FE	0.336 (0.425)
Netherlands FE	1.313^{***} (0.445)
Norway FE	-2.327^{***} (0.575)
Sweden FE	-2.381^{***} (0.524)
US FE	7.008^{***} (0.558)
Constant	-8.878^{***} (3.261)
Observations	405
Note:	*p<0.1; **p<0.05; ***p<0.01