Replication of: "Comparative Public Health: The Political Economy of Human Misery and Well-Being"

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Abstract:

Ghobarah, Huth and Russett examine spending on health and health outcomes in a cross-sectional analysis. They use a production function approach that explains allocations towards health measured as % of GDP allocated to health as a combination of political variables. They then estimate total spending on health as a function of public and private spending, GDP per capita and educational attainment. Lastly, after having explained total expenditure on health they use total expenditures on health to explain the variation in health adjusted life expectancy (HALE). I explore the scenarios they estimate and demonstrate there there is considerably more uncertainty than their parsimonious models let on. Since their main hypothesis is that health spending is distributed through a democratic process, I concentrate on this explanatory variable throughout my analysis. In my extension of the article, I estimate a variable for quality of governance and find that quality of governance in place of Polity on its own has an impact on health spending that is of a greater magnitude but no effect in Models 2 and 3. The authors attribute causality to increases in education and health spending, failing to understand that there is not a strong correlation between spending on health and health outcomes. I address each model in the same order as Ghobarah, Huth and Russet and providing analysis of methods and results along the way.

Data and Methods

The data for this study consist of statistics compiled from the World Health Organization (WHO), CIA and the Vanhanen Index of the Correlates of War. The main explanatory variables are from 1997 and 1998 as well as the dependent variable in the first model. The last model uses HALE from 2000 and uses lagged variables from

1997 and 1998 to predict HALE in 2000. Public expenditure on health as a % of GDP ranges from a minimum of 0.03 (Democratic Republic of the Congo and Burma) to 8.16 (Germany). The median country allocates 2.78 % of it's GDP to health. In 1998, most countries in Latin America and Africa are allocating this amount to health. As an anchor, WHO estimates that a country cannot provide good health by spending less than 4 % of its GDP on health. [1] The data from WHO is a composite of both domestic spending on health and Development Assistance for Health (DAH). In some cases DAH can be directed at those who are not "spending enough" on health or are faced with a greater burden of disease, leaving the question of whether the explanatory variables in the model actually impact health and well-being or are merely endogenous to the health problems faced by a country.

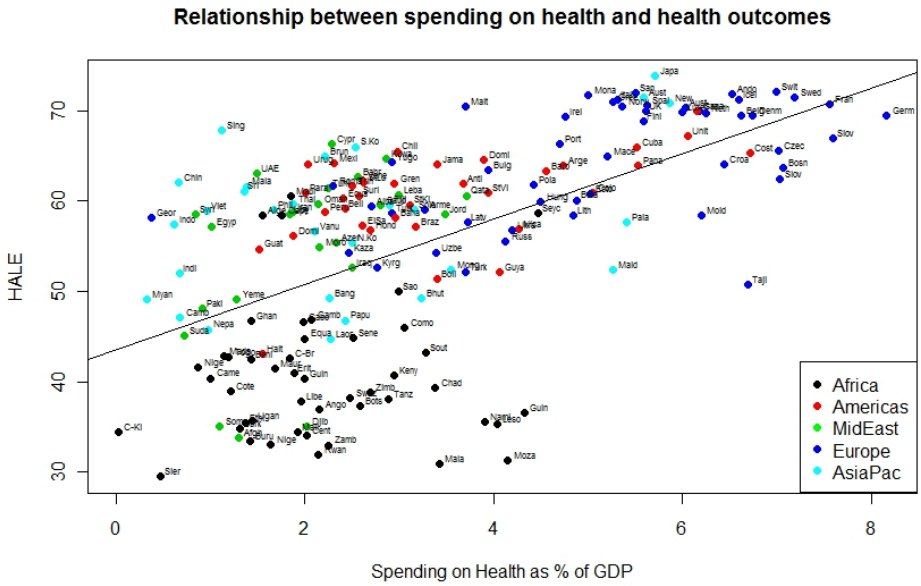


Figure 1: Spending on health as a percent of GDP is positively related to HALE. What should be obvious from the plot, color-coded by region, is that most nations in Africa are spending between 0 and 5% of GDP on health, but have life expectancies much lower than other regions. Of additional note is lower GDP in African nations where % of GDP on health will likely be lower in Cote d'Ivoire than in Singapore though they spend the same percentage of GDP on health. African nations are likely beset with health issues like AIDS or Malaria that make them different than other regions of the world and limit their ability to provide good health at low cost.

[1] Savedoff, W. D. (2007). What should a country spend on health care? Health Affairs, 26(4), 962-970.

Model 1: Predicting health expenditures as a combination of political variables.

The authors work through a set of hypotheses about how political decisions to allocate money to health are made and in each case find data support for their hypotheses in the desired direction.

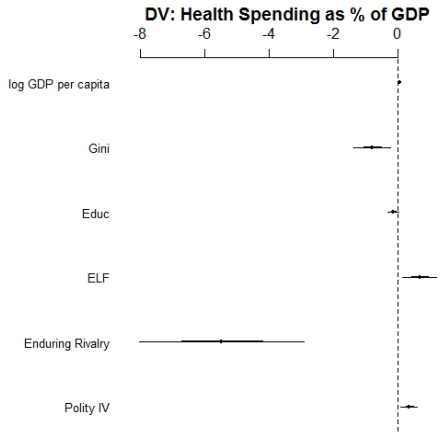


Figure 2: Coefficient plot for Model 1.

Hypotheses: H1: Higher levels of democracy will result in state leaders allocating more expenditures to public health. H2: Higher levels of income inequality in society will result in state leaders allocating fewer expenditures to public health. H3: Higher levels of racial/linguistic/religious diversity in society will result in state leaders allocating fewer expenditures to public health. H4: Involvement in an enduring international rivalry will result in state leaders allocating fewer expenditures to public health. H5: Higher per capita incomes will result in state leaders allocating more expenditures to public health. H6: Higher levels of education in society will result in state leaders allocating more expenditures to public health.

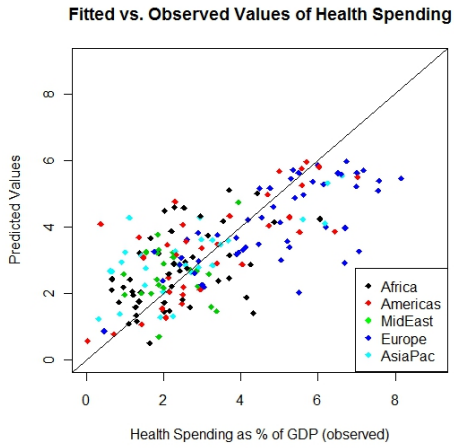


Figure 3: Fitted vs. observed values for Model 1. The model performs poorly in Europe and Asia Pacific countries probably due to high democracy but low spending capabilities in Eastern European countries and some authoritarian countries that do well better on health spending than the model predicts.

Where the authors make a mistake is interpreting their results causally. They claim

that moving from the most autocratic state to the most democratic state produces 49% higher allocations to health as a percentage of GDP. For instance, the Philippines and Suharto-led Indonesia have similar income per capita statistics but more than twice as much was spent on health in the Philippines than in Indonesia.

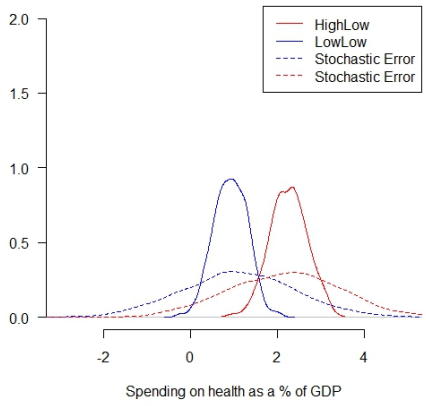


Figure 4: Democracy simulation. The simulated outcomes in this plot show the expected impact of a low income country with high and low levels of democracy. The hypothesis of the paper is that if Suharto-led Indonesia, the scenario represented by the blue curves, could simply be democratic then it could provide twice the amount of health care spending per capita GDP as the democratic Philippines. Looking at the stochastic error representing all the inherent uncertainty in this claim, it makes it hard to advocate for such a democratic upheaval.

They go on to claim that, holding all other variables constant that unequal Nigeria (Gini of .481) spends only 0.9% of GDP on health but in Ghana where society is more equal at .317, 1.4% of GDP is allocated to public health. In examining ethnic heterogeneity, Bangladesh and Ethiopia are compared. Ethnically homogeneous Bangladesh allocates 2.2% of GDP to health but similarly poor and less homogeneous Ethiopia allocates only 1.4% of GDP to health. The authors estimate the effect of an enduring international rivalry that draws resources away from spending on health. The presence of an international rivalry depresses public spending on health by 24% on average. Though, it is not clear if ending a rivalry will lead the defense spending to be allocated to health instead. Since budgets are constrained, policies must compete for priority with one another. Lastly, average educational attainment is shown to have a positive impact on public health through citizens demanding public health systems that meet their needs as they become more educated. Some claim that education changes people's perceptions about the future by changing how much they are willing to discount the future and therefore educational attainment is a cause of more spending on health buy may also be a result of spending on health that allows people to do better in school and therefore stay in school longer. For a 10-fold cross-validation the average RSME was 1.32 which was identical to the full model. Figure 3 shows that the model does not do very well predicting spending in European countries and Asia Pacific countries.

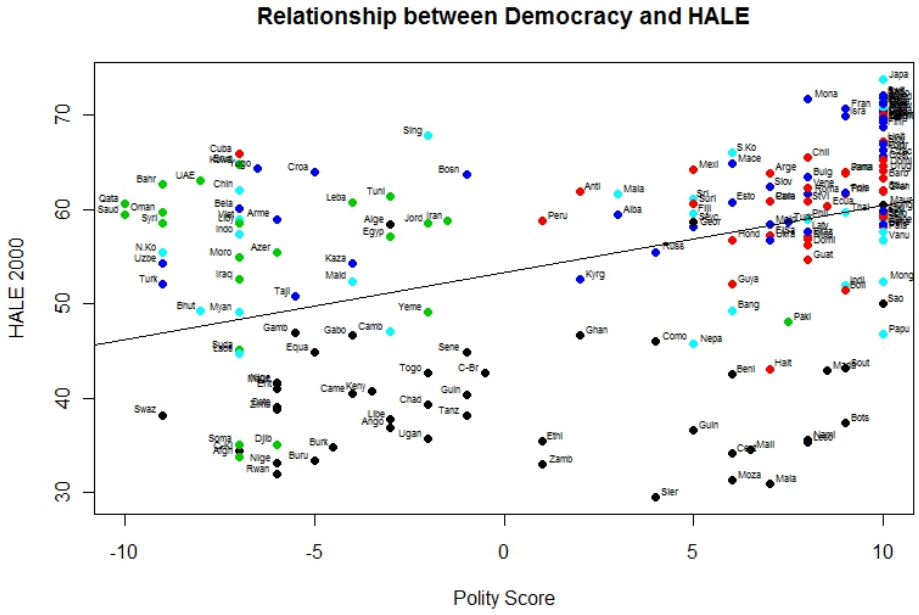


Figure 5: Democracy and HALE. This study examines the way in which spending on health is part of the political process. It seems though that authoritarian governments can expect to have high and if not higher life expectancies than some democracies. Perhaps it is also interesting that the political process might slow down the allocation of spending on health for groups that are of different ethnicities or have lower incomes. Democracy is not the cure for what ales low income countries with constrained budgets because of spending on other policy priorities.

Model 2: Explaining Total Expenditures on Health as a Combination of Economic and Social Factors.

In the second model, total spending on health is a function of economic development, education and public and private resources spent on health. The authors investigate the following hypotheses:

Hypotheses: H7: Higher per capita incomes will result in higher total health expenditures. H8: Higher levels of education in society will result in higher total health expenditures. H9: Higher allocations of private spending to health care will result in higher total health expenditures. H10: Higher allocations of public spending to health care will result in higher total health expenditures.

I am not substantively interested in this model, and the authors only use it to demonstrate that total health expenditures per capita can be explained through this simple model. Total expenditures is then used to explain health outcomes in terms of HALE in the next section.

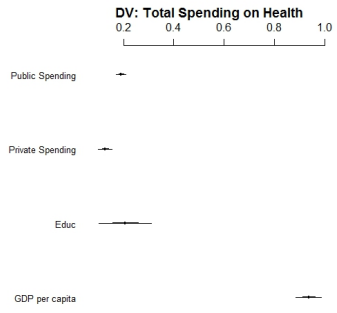


Figure 6: Coefficient plot for Model 2.

Model 3: Explaining Human Misery and Well-Being.

In the third model, the authors examine what explains the outputs from the health sector - Health Adjusted Life Expectancy (HALE) - using the following hypotheses which are proven statistically significant except for the hypothesis about ethnic fractionalization. A 10-fold cross-validation of this model produces an average residual standard error of 5.15 compared with the full model at 4.98.

Hypotheses: H11: The more unequal the distribution of income, the lower will be the HALE. H12: The more ethnically/linguistically/religiously diverse the population, the lower will be the HALE. H13: The faster the pace of urbanization the lower will be the HALE. H14: The occurrence and severity of civil wars will reduce the level of HALE. H15: Civil war in a geographically contiguous country will lower the HALE. H16: The higher the level of total health expenditures per capita the higher will be the HALE. H17: The more educated the population the higher will be the HALE.

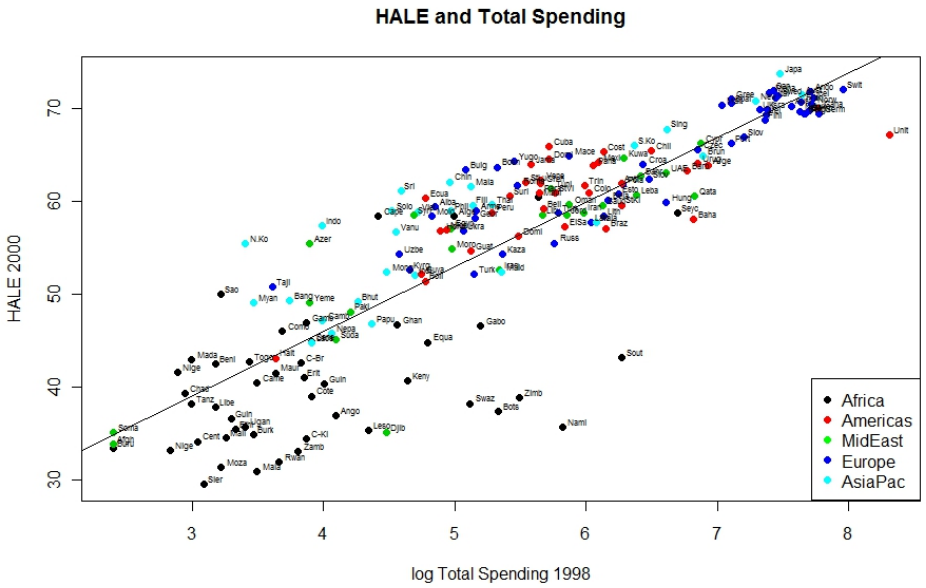


Figure 7: Production function for HALE. This plot shows the bivariate relationship between HALE and logged total spending on health. The relationship is much stronger than the relationship between spending as a percentage of GDP and health. It appears that African countries still lag behind in their ability to produce as much health as their equally wealthy (poor) neighbors. The variation across Africa becomes much more obvious in this diagram. Because of what it is not certain but probably owes to their heavier burden of tropical diseases than other nations. Of particular note is the leveling off of HALE at high expenditures on health. There may be some diminishing returns to increased spending at the point where the United States spends more than other countries but fails to produce as much health. The relationship between high per capita GDP and stress is also reason for contemplation. Some countries live longer with the same level of spending on health and some live even longer by spending much less on health.

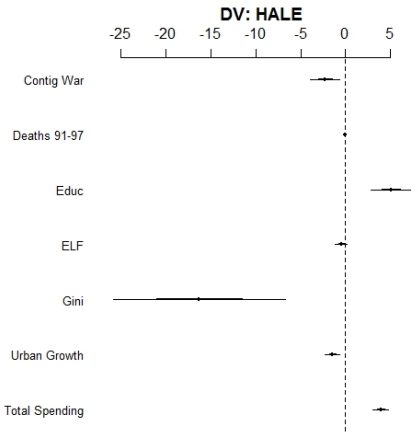


Figure 8: Coefficient plot for Model 3.

The authors find the strongest impact from changes in the level of health spending. However, as mentioned earlier, health policy professionals will contend with those who claim merely doubling health expenditure will produce HALE as the authors of this study seem to claim. Nonetheless, there is a statistical link between health spending and HALE on average. Holding all else constant, moving from the median health spending to the 95th percentile is predicted to bring 10 years of HALE. Ethnic heterogeneity negatively impacts HALE

by reducing health expenditures as seen in the first model. In explaining how income inequality operates to lower HALE, the authors use the United States as an example to argue that 86 countries are more homogeneous and 108 are more equal economically, 27 countries have better HALE even when looking at the fact that the U.S. has one of the highest per capita GDP and spends the most on health care. This also adds to the argument that total spending alone does not help a country achieve health outcomes.

In analyzing the impact of education on HALE, the authors claim that if only Benin, which sits at the 5th percentile for educational attainment, could provide the median level of schooling for its citizens then Benin's citizens could expect to live 6 years longer. One might argue that education spending and health spending compete for space in state budgets so a policymaker would be faced with a tough choice in providing either one. Urbanization is also strongly associated with HALE. Rapidly urbanizing nations have on average 3 years lower life expectancy when controlling for other variables. The last variable they estimate is civil war - both in the country and in a neighboring country. Both depress the estimated HALE. Severe civil wars like in Rwanda and Liberia can depress HALE by up to 10 years. One might question whether HALE then is independently distributed across observations since both disease and war knows no border.

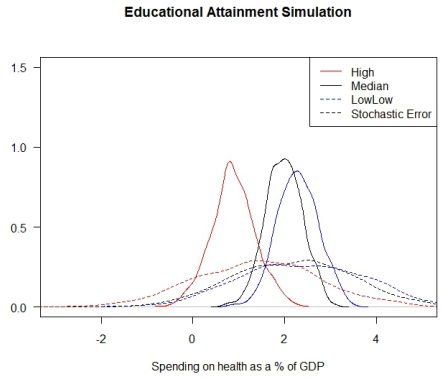


Figure 9: Marginal effects of increasing educational attainment. Smarter societies measured by number of school years completed seem to spend more on health as a percentage of GDP per capita. The graph displays three scenarios for countries with low GDP per capita and the resulting shifts to more years of education. A movement from the bottom quartile of educational attainment to the median produces the largest change with diminishing marginal effects of moving to the top quartile from the median. Adding in the stochastic uncertainty leaves too much variance in the estimate to make any valid policy conclusions about increasing educational attainment.

Where Ghobarah, et al. shine is in pointing out that predicted values of HALE do not match observed values leading us to suspect that the relationship between total spending is more than just a combination of the amount of money allocated but whether that money is allocated in ways that promote health. The models they estimate do not control for regional variation in the spread of contagious diseases such as the prevalence of AIDS in Africa. Citing WHO experts, they claim that it would be wrong to include the spread of AIDS when epidemics are in part due to the government's

inability to control the spread.

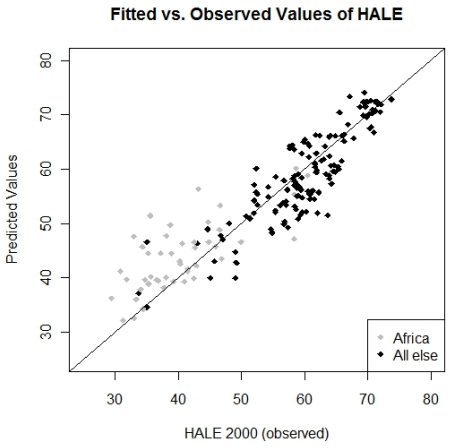


Figure 10: Fitted vs. observed values of HALE.

Expansion

I expand upon the original article by adding the democracy indicator into Models 2 and 3. My reasoning is that if democracy is such a strong predictor of the amount of health spending per capita GDP then it should also be a strong predictor of total spending on health and life expectancy. Some even make the argument that democracy is correlated with life expectancy but as Figure 2 shows, even democracies have trouble providing good health. I find that democracy, while statistically and significantly related to the percentage of GDP that gets allocated to health does not have the same relationship with total spending on health or healthy life expectancy.

Some contend that health spending is a leaky bucket; in the absence of good governance, budgetary allocations earmarked for public health spending do not always reach their intended beneficiaries[2]. In the following models I use a variable I created that the POLITY IV score rescaled to run between 1 and 10 and an average of the Freedom House Political and Civil Liberties measure reversed so that a high score corresponds with high levels of freedom and standardized to run between 1 and 10. I then average the sum of the new POLITY IV score and the average Freedom House score to get a variable I call "quality". This approach is advocated by Charron and Lapuente (2010) [3].

In regards to percent of GDP per capita allocated to health, quality of governance is statistically and significantly related to increased health spending. As quality of governance improves by 1 point on my new scale 10 point scale spending increases by .18 of a percentage point. Alternatively, for democracies that top out the 10 point scale, 1.8 percentage points of the expenditures on health are attributed to quality of governance holding all else constant. Compared to the original model, only .07 of the percentage points of the resulting expenditures on health are found in strong democracies. I find that this does support my original hypothesis that while government matters, governance also is meaningful especially in allocating spending to health. (In the gls

[2]Holmberg, S., Rothstein, B., Nasiritousi, N. (2009). Quality of government. What you get. Annual Review of Political Science, 12, 135-161.

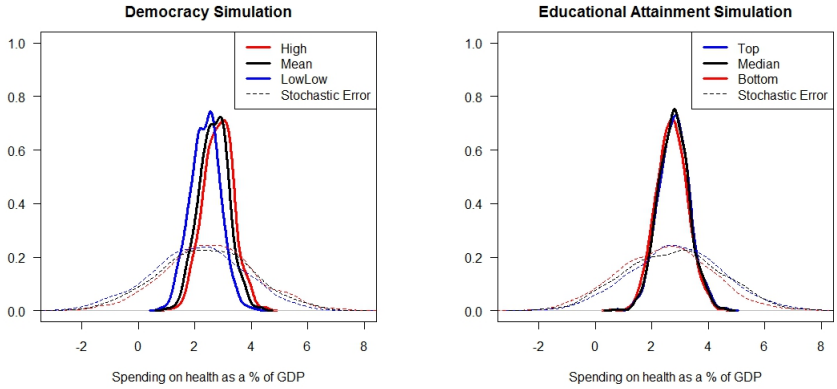
[3]Charron, N., Lapuente, V. (2010). Does democracy produce quality of government? European Journal of Political Research, 49(4), 443-470.

model I estimate later the result is back down to .05.)

I find that in the other two models quality of governance does not matter in any of the models as a statistically significant predictor of either how much money will be allocated to health or how healthy a society is on average. This could either be because of the high correlation between the Polity IV index and the Freedom House Index (.93) or because there are other factors outside of democracy and quality of democracy that determine the amount of spending that gets allocated to health.

The last thing I do is estimate the first model using a normal log likelihood function using the gls function in the nlme R package. The results provide estimates of the joint probability of each event occurring. I get drastically different coefficients which is either owing to the reduction in heteroskedasticy of the errors or the fact that observations of the independent variables are not independently distributed. The authors devote a lot of time explaining how contiguous civil wars can have health consequences that spill over borders. Contagious diseases have also been known to cross borders. I proceed to examine the two scenarios offered earlier. (I'm not sure this is the right approach. I considered a beta distribution but while the DV runs between 0 and 1, the observations are only between 0 and .08 so I abandoned the idea. I would be happy to hear the thoughts of my reviewers on what should be done.)

GDP per capita is strongly and positively related to spending on health as a percentage of GDP likely because when there are more resources a country is able to allocate more to everything including health policies. Democracy is statistically and significantly related to spending on health. I re-estimate the simulations from the first part of the article and find that increasing educational attainment from the bottom to the top quartile in countries with low GDP per capita makes no difference for how much money is allocated to health. Investigating whether democracies are spend more on health than non-democracies provides a similar result. The graphs showing movements from autocracy to the median to most democratic does not provide the same double of health expenditures that the authors claim at first.



(a) Democracy simulation.

(b) Education simulation.

Figure 12: Subfigures (a) and (b) show simulations for the scenarios from the OLS model. The results are even more uncertain than in the first.

Table 1: GLS Estimates for Model 1

(Intercept)	1.341
	(0.725)
GDP per capita	0.250***
	(0.059)
Income inequalty (Gini)	-1.003
	(0.578)
Education	0.041
	(0.118)
Ethnic heterogeneity	0.031
	(0.038)
Enduring international rivalry	-0.057
	(0.126)
Democracy (Polity score)	0.023**
	(0.008)
Phi	0.893
sigma	1.649
AIC	423.467
BIC	452.204
Log-likelihood	-202.734
N	180

Table 2: GLS Estimates for Model 1 with Quality Variable

(Intercept)	1.112
	(0.712)
GDP per capita	0.244***
	(0.061)
Income inequality (Gini)	-0.955
	(0.580)
Education	0.050
	(0.118)
Ethnic heterogeneity	0.030
	(0.038)
Enduring international rivarly	-0.050
	(0.126)
Quality of Governance	0.058**
	(0.020)
Phi	0.892
sigma	1.648
AIC	424.920
BIC	453.656
Log-likelihood	-203.460
N	180

Appendix A. Descriptive statistics.

Table 3: Descriptive Statistics, Model 1

	N	min	max	mean	median	std. dev
Public Expenditures on Health as a % of GDP	180	0.03	8.16	2.79	3.26	1.86
log GDP per capita	182	6.27	10.40	8.16	8.25	1.13
Gini	180	0.19	0.61	0.37	0.38	0.09
log Educational Attainment	182	0.04	2.44	1.79	1.64	0.56
log Vanhanen Index	182	0.00	5.18	3.61	3.24	1.23
Enduring rivalry since 1989	182	1.00	2.00	1.00	1.14	0.35
Polity IV score	182	-10.00	10.00	6.00	2.95	6.92

Table 4: Descriptive Statistics, Model 2

	N	min	max	median	mean	std. dev
log Total Spending on Health, 1998	182	2.40	8.31	5.35	5.35	1.43
log GDP per capita	182	6.27	10.40	8.16	8.25	1.13
log Educational Attainment	182	0.04	2.44	1.79	1.64	0.56
Private Expenditures on Health as % GDP	180	0.00	9.43	1.98	2.23	1.42
Public Expenditures on Health as % GDP	179	0.42	11.01	3.29	3.78	2.36

Table 5: Descriptive Statistics, Model 3

	N	min	max	median	mean	std. dev
HALE, 2000	182	29.50	73.80	58.50	55.37	11.60
log Total spending on health, 1998	182	2.40	8.31	5.35	5.35	1.43
Urban pop. growth, 1991-97	181	-0.41	7.35	0.86	1.23	1.16
Gini	180	0.19	0.61	0.37	0.38	0.09
log Vanhanen Index	182	0.00	5.18	3.61	3.24	1.23
log Educational Attainment	182	0.04	2.44	1.79	1.64	0.56
Deaths from civil war, 1991-97	182	0.00	96.91	0.00	2.12	10.30
Contiguous civil war	182	1.00	2.00	1.00	1.48	0.50

Appendix B. Models

Table 6: Model 1: Explaining Public Expenditures on Health as a Percentage of GDP

	Model 1
(Intercept)	1.72
	(1.19)
GDP per capita	0.35 *
	(0.13)
Income inequality (Gini)	-5.48 *
	(1.28)
Education	0.68 *
	(0.26)
Ethnic heterogeneity	-0.14
	(0.09)
Enduring international rivalry	-0.80 *
	(0.29)
Democracy (Polity score)	0.07 *
	(0.02)
N	180
R^2	0.52
adj. R^2	0.50
Resid. sd	1.32

Standard errors in parentheses

* indicates significance at $p < 0.05$

Table 7: Model 2: Explaining Total Expenditures on Health

	Model 2
(Intercept)	-3.74 *
	(0.17)
GDP per capita	0.94 *
	(0.03)
Education	0.21 *
	(0.05)
Private spending on health as % of GDP	0.13 *
	(0.01)
Public spending on health as % of GDP	0.19 *
	(0.01)
N	179
R^2	0.97
adj. R^2	0.97
Resid. sd	0.26

Standard errors in parentheses

* indicates significance at $p < 0.05$

Table 8: Model 3: Explaining Years of Healthy Life Expectancy (HALE)

	Model 3
(Intercept)	36.98 *
	(3.77)
Total health expenditure	3.92 *
	(0.43)
Rapid Urban Growth	-1.43 *
	(0.41)
Income inequality (Gini)	-16.30 *
	(4.78)
Ethnic heterogeneity	-0.49
	(0.34)
Education	5.04 *
	(1.10)
Civil war deaths 1991-97	-0.08 *
	(0.04)
Contiguous Civil War	-2.31 *
	(0.82)
N	181
R^2	0.82
adj. R^2	0.81
Resid. sd	4.98

Standard errors in parentheses

* indicates significance at $p < 0.05$