Measuring Healthcare Value in OECD Countries

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A thesis
submitted in partial fulfillment of the
requirements for the degree of

Master of Public Health

University of Washington
2020

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Program Authorized to Offer Degree:
School of Public Health

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Abstract

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Background

Identifying the most efficient healthcare delivery systems and the characteristics that are associated with them may inform the decisions that governments make regarding the structure and regulation of healthcare. This study sought to estimate the value of healthcare delivery systems for 36 countries of the Organization for Economic Cooperation and Development (OECD) and determine which system features are associated with higher value.

Methods

Disease condition-specific death and incidence data were paired with total health spending per person from each OECD country from 1995 to 2017. A frontier analysis model was used to evaluate condition-specific mortality-incidence ratios for 141 major diseases, adjusting for per capita spending and covariates including smoking rates, age, educational attainment, and obesity to account for differences in the underlying health risks of each country. Inefficiency estimates for each country, year, and disease condition were extracted from the model and combined to

create a single estimate of healthcare delivery system value for each country from 1995 to 2017. Associations between estimated healthcare value and 11 healthcare system characteristics were assessed using linear regression.

Results

The countries with the highest estimated healthcare delivery system value in 2017 were Italy, Estonia, Australia, Spain, and Slovenia. These countries had the lowest mortality-incidence ratios relative to per capita spending and baseline population health. Lithuania, Hungary, Chile, Poland, and Mexico attained the lowest levels of healthcare delivery system value in 2017. Higher insurance coverage rates, more consultations with physicians, and higher physician, nurse and midwife density are associated with higher value systems.

Introduction

Healthcare is one of the largest sectors of spending in countries across the globe and is almost universally increasing, both in absolute terms and as a percent of gross domestic product. In 2003, the average country of the Organization for Economic Cooperation and Development (OECD) spent 7.89% of GDP, or $2,211 per capita. By 2018, the latest data available, that figure has increased to $3,994 per capita, or 8.80% of GDP.[1] Given those high and increasing costs, there is significant interest in designing systems that use resources as efficiently as possible.

Although there is a relationship between health spending and health outcomes at the population level, the association does not explain variations in the value of healthcare – that is to say better health outcomes relative to spending – delivered by high income countries with well-developed healthcare systems.[2] Studying how country-specific measures of healthcare value correlate with health policies and healthcare system characteristics may provide insights useful for health policymaking. Previous international comparisons of healthcare value have not controlled for determinants of health outside of the healthcare delivery system, have employed coarse measures of population health as outcomes, and have been limited in their breadth and timeframe.[3,4] Furthermore, they do not address the confounding factor of disease prevention. The analysis presented here uses an outcome that controls for incidence of disease and thus focuses solely on the efficiency of the health delivery system.

This study seeks to address these gaps in the literature with two major goals: a) use variation in health outcomes and spending across countries in the OECD to estimate healthcare value over a period from 1995 to 2017, controlling for population characteristics and price differences

between countries and b) evaluate which characteristics of healthcare systems are associated with higher healthcare value.

Methods

Data

Health condition-specific, age-specific incidence and mortality rates for 141 causes of death were obtained from the Global Burden of Disease (GBD) 2017 Study.[5] I extracted these data for each of the 36 countries that were member states of the OECD as of 2017, for each year from 1995 to 2017. I selected 141 of 249 causes of death for inclusion in the analysis, dropping health conditions without substantial incidence within high-income countries or whose death or incidence estimates were not available. A full list of countries and health conditions and a description of the selection methods is provided in the Appendix.

Health spending data were obtained from the Financing Global Health 2019 study.[1] These estimates reflect total health expenditure, the combination of government health expenditure, out-of-pocket spending, prepaid private spending, and development assistance for health. All spending estimates were inflation and cost adjusted to reflect 2019 US dollars at purchasing power parity using national price deflation estimates obtained from Financing Global Health. Adjusting for differences in prices between countries allows for the measurement of healthcare value relative to the costs of other goods and services in a given country, mitigating the effects of the higher absolute prices of healthcare delivery in high income countries on our estimates of value.

Several covariates were included in the model to adjust for the underlying health risk of each country's population. Covariates obtained from the Global Burden of Disease study included: percentage of the population over the age of 65 years old, number of cigarettes or cigarette equivalents consumed per adult aged 15 years of older, mean years of education per capita for those 15 years and older, prevalence of obesity, and mean physical activity (minutes per week, lagged 10 years).[5] These covariates were included because of their strong association with health outcomes at a population level.[6–10]

Twelve national health policy or health system characteristics were assessed for their relationship with our estimates of healthcare value. All indicators were obtained from the OECD health statistics database.[11] They fell into three categories: insurance coverage, service utilization, and system access or capacity. A full list of indicators and characteristics, including how they were measured and the years for which they were available can be found in the Appendix.

Estimating healthcare value

This study estimated healthcare value by assessing inefficiency of healthcare delivery systems for each country, year, and health condition using frontier analysis.[12,13] Countries with relatively low mortality-incidence ratio for key health conditions relative to healthcare spending would be expected to be the most efficient. A stochastic frontier meta-analysis model was evaluated for each individual health condition.[14] In order to adjust for different levels of disease severity and drivers of health that vary across states and are determined by factors largely outside of the health sector, the frontier analysis controlled for country- and year-specific educational attainment per person, the fraction of the population greater than 65 years, obesity rate, the

number of cigarettes sold per person, physical activity rate from 10 years prior, and per capita healthcare spending.

Country- and year-specific estimates of healthcare value were constructed by taking the weighted mean of the inverse of the normalized cause-specific inefficiency estimates. Weights were calculated by computing the year-specific proportion of total deaths attributable to each health condition across the countries in the OECD. This process produced a single estimate of healthcare value for each country and year, with more influence on the final estimate of value given to conditions responsible for the greatest mortality across countries.

Estimating the association between healthcare value and health system characteristics

To test the association between healthcare value and health system characteristics and policies, I used cross-sectional linear regression using heteroskedasticity-robust standard errors. Because the data on health system characteristics and policies varied in availability and in some cases was correlated, independent bivariate regressions were assessed.

Quantifying uncertainty

To quantify the impact of data uncertainty, each step of the analysis was conducted on the estimated 1000 draws of the underlying health outcome estimates produced by the GBD study. The mean of the 1000 estimates for healthcare value for each country and year was reported as the point estimate, and the 2.5th and 97.5th percentiles of the 1000 estimates were reported as lower- and upper-bounds of the confidence intervals, respectively. The linear regression analysis was completed separately for each of the 1000 healthcare value estimates, and model and data uncertainty estimates were combined using simulation. Statistical analyses were performed using R version 3.6.0 and Python version 3.6.8.

Results

The countries with the highest estimated healthcare value in 2017 were Italy, Estonia, Australia, Spain, and Slovenia (Figure 1). Across these countries, the median MI ratios of these five countries in 2017 for the six causes responsible for the most deaths across the country sample– ischemic heart disease; tracheal, bronchus, and lung cancer; colon and rectum cancer; chronic obstructive pulmonary disease; breast cancer; and intracerebral hemorrhage– were 0.251, 0.736, 0.293, 0.030, 0.180, and 0.367, respectively. The median per capita healthcare spending of the top five countries in 2017 was $3,526 (2019 USD at purchasing power parity). The countries with the lowest estimated healthcare value in 2017 were Lithuania, Hungary, Chile, Poland, and Mexico. The median MI ratios for ischemic heart disease; tracheal, bronchus, and lung cancer; colon and rectum cancer; chronic obstructive pulmonary disease; breast cancer; and intracerebral hemorrhage across these lowest-value countries were 0.559, 0.972, 0.474, 0.043, 0.271, and 0.519. Their median per capita healthcare spending in 2017 was $2,157 (2019 PPP). Countries with the highest value scores generally had lower MI ratios for the highest-weighted causes and spent slightly less per person on healthcare than the median country in the sample ($4,182). Countries with the lowest value scores tended to have higher MI ratios for the causes with the highest mortality, though they spent significantly less per person on healthcare than both the highest performing countries and the sample at large.

The countries with the most improvement in the rankings of healthcare value between 1995 and 2017 were Estonia, Austria, Germany, and Italy, and Slovenia who increased their ranks by 28, 19, 14, 13, and 13 positions, respectively. The countries with the biggest decline in rank of

healthcare value over the study period were Lithuania, Republic of Korea, Poland, Slovakia, and Mexico, who fell 23, 18, 15, 14, and 13 positions, respectively. Rankings for the complete period of the study can be found in Figure 2.

Figure 3 shows the fitted stochastic frontier curves for the six causes responsible for the most deaths in 2017 across OECD countries (ischemic heart disease; tracheal, bronchus, and lung cancer; colon and rectum cancer; chronic obstructive pulmonary disease; breast cancer; and intracerebral hemorrhage). The slopes of the frontier curves illustrate the negative relationship between increased spending and mortality-incidence ratio after adjusting for characteristics of population health. The position of the curve represents the optimal outcome, or fewest deaths per incident case, at each level of healthcare spending. Inefficiency can be visually interpreted as the vertical distance between each point – representing spending and adjusted cause-specific MI ratio for a given country-year – and the frontier curve.

The results of the regression analyses that evaluates the relationship between estimated healthcare value and characteristics of national healthcare systems are shown in Figure 4. Increases in the rate of total insurance coverage, the rate of private insurance coverage, consultations with physicians, the density of physicians, the density of nurses, and the density of midwives were significantly associated with an increase in value score.

Of the insurance variables, the system characteristic with the largest effect was total insurance coverage, which is significantly associated with value score (p-value < 0.01). A 10% increase in total insurance coverage is associated with a 77-point increase in value score. Private insurance

was also significantly associated with value ($p = 0.01$). A 10% increase in private insurance rate was associated with a 1.8-point increase in value score. Finally, the public insurance rate was weakly and not significantly associated with value score ($p = 0.54$).

Two of the three utilization variables were significantly associated with an increase in value score, physician consultations ($p = 0.05$) and greater length of stay in inpatient facilities ($p = 0.02$). A 10% increase in physician consultations is associated with a 5.2-point increase in value score, while a 10% increase in the average length of stay in inpatient facilities is associated with a 5.4-point increase in value. Inpatient discharges per capita were positively but weakly associated with increased value and were statistically insignificant ($p = 0.43$).

Higher physician, nurse and midwife density were both positively and significantly associated with increases in value (p-values of 0.04, < 0.01 and < 0.01, respectively). An increase in inpatient occupancy rate was negatively associated with value, though its effect is not significant ($p = 0.79$), while hospital bed density was both weakly positive and statistically insignificant in its association with value ($p = 0.90$).

Discussion

This research presents an approach to measuring healthcare value that takes into account a wide range of health conditions over a significant period of time, uses an outcome metric that focuses on the efficiency of the healthcare delivery system, and furthers the application of a modeling approach that evaluates the relationship between health spending and health outcomes more

flexibly and more precisely than efficiency analysis methods of the past. The results show that Italy, Australia, and Estonia achieved the highest measured value in 2017, that is to say the lowest mortality per incident case across a set of 141 health conditions relative to the amount of money that they spend on health, adjusting for the age of their populations, education levels, smoking, obesity, and rates of physical activity. Between 1995 and 2017, Estonia, Austria, and Germany showed the greatest improvement in healthcare value compared to the other countries studied. The countries with the lowest levels of value in 2017 were Chile, Poland, and Mexico.

A regression analysis evaluating the relationship between healthcare value and characteristics of national healthcare systems points to three key conclusions. First, insurance works. Being covered by health insurance not only increases an individual's access to health services and reduces the likelihood of ruinous healthcare costs, but at the national level, systems with higher rates of insurance deliver more health to the population per dollar spent. Second, there is a clear relationship between more non-physician healthcare workers and systems that produce higher value care. Investments in training and retaining nurses and midwives could be an inexpensive and cost-effective way of increasing the efficiency of healthcare systems in countries that have lower health workforce densities like Greece, Mexico, and Latvia. And lastly, systems should not exclusively see time spent in inpatient facilities as an inefficiency that needs to be reduced. The results of this regression analysis suggest that it may be the case that once patients are admitted to an inpatient facility, it is a better use of resources to keep them in that inpatient setting until they are fully recovered than to discharge them earlier in an attempt to keep costs down.

This work presents the most complete and comprehensive evaluation of healthcare value in OECD countries to date. It uses outcomes from a broad set of 141 different health conditions over a 22-year time period, controls for factors that drive health outcomes such as smoking, education, and obesity; and focuses on the healthcare delivery system through its incorporation of disease-specific incidence, which removes some of the effect of societal differences and health interventions outside of the realm of the health delivery sector. The stochastic frontier meta-analysis model has several advantages over a traditional frontier approach or data development analysis methods. Fitting a non-linear model on health spending rather than defining health as a direct result of inputs to an economic production function allows the model to follow the relationship between outcomes and spending as it is shown by the data and removes the arbitrary impact that results from having to select a functional form for the frontier. This approach also incorporates stochastic error, which allows the analysis to differentiate the inefficiency of an observation from the error with which it was measured.

Two sets of trends of healthcare value stood out from the analysis. The first is the significant drop in value of the United States from the mid-1990s to the late 2010s. From 1995 to 2017, the United States' value score fell 29.7% and its relative rank among OECD countries fell from 10th to 22nd. This appears to be driven by both little improvement in health outcomes relative to peer nations and unparalleled health spending (Figure 5). For instance, in 1995, the mean mortality-incidence ratio for ischemic heart disease, the leading cause of death across countries in the sample, was 0.55 and the MI ratio for ischemic heart disease in the United States was 0.39. In 2017 the average OECD country was estimated to have an MI ratio of 0.35, while that of the US was 0.29. Over the study period, the countries of the OECD quite significantly improved

treatment of ischemic heart disease, and while the average country still does not see as good outcomes as the United States, the gap between the OECD average outcome and the US outcome is substantially smaller than it was in the mid-1990s. At the same time, health spending in the US has increased dramatically. Per capita health spending in America grew from $5,472 to $10,243 over the 22-year period studied, an annualized rate of change (AROC) of 2.89%. For comparison, the mean OECD country spent $2,257 per person on health in 1995 and $4,155 in 2017 or an AROC of 2.81%.[1] As the US' health outcomes have stagnated, or in some cases gotten worse in recent years, and its spending continues to grow, its healthcare value has fallen significantly. No longer can good performance on measures of healthcare delivery justify the enormous price that the country pays for those services. Increasing rates of insurance coverage, which are among the lowest in the OECD and have been in decline since 2016, seems like a logical place to start the work of reversing this worrying trend.[15]

The second trend of note is the contrast between the value scores of Estonia and Lithuania. The two countries have much in common. Both are small states situated on the Baltic Sea and were absorbed into the Soviet Union in the mid-twentieth century before regaining independence in the 1990s. They spent approximately the same amount on healthcare per inhabitant throughout the study (Estonia spent $2,164 in 2017, Lithuania $2,171). But in terms of healthcare value, their trends could not be more different. At the beginning of the study period, Estonia ranks 30th out of the 36 OECD countries while Lithuania comes in 9th. In 2017 those positions were flipped: Estonia 2nd and Lithuania 32nd. As they spend about the same amount on health, one would expect that the difference in value is driven by outcomes. And that does seem to be the case – in the late 1990s and early 2000s, MI ratios for key causes in this analysis improved in

Estonia at much faster rates than in Lithuania. For many health conditions, Estonia is around or below the OECD average by the end of the study period while Lithuania remains substantially higher than the mean. Given the cultural and historical similarities between the two countries, there may be policy factors that can help to explain their differences in healthcare value (Figure 6).

Both countries transitioned out of the tax-funded, heavily centralized Soviet healthcare system in the early 1990s with reforms that decentralized the funding and delivery of care. Both looked to reduce the excessive hospital capacity that had been developed under the Soviet Union and prioritize general practitioners and family medicine as the entry point to the healthcare system.[16] A major difference between the reforms was the intensity of the decentralization. While Estonia retained national control over the healthcare system, Lithuania moved the responsibility for organizing and delivering care to municipalities, who may not have the resources or expertise to effectively operate them.[17] The way that the two countries pay for healthcare is quite different as well: a significantly higher proportion of Lithuania's spending comes from out-of-pocket payments than it does in Estonia, where government spending represents around 75% of total health spending.[1] Lastly, while not an explicit policy, an important cultural difference between the two countries is the widespread practice of corruption in the Lithuanian healthcare system. It is common for patients to bribe healthcare workers with envelopes of cash and scandals have emerged in recent years around kickbacks for large contracts.[18,19]

Limitations

There are several key limitations to this analysis. The first is that there is not one established way of measuring healthcare efficiency. Many indicators of population health can be used as an outcome, and the selection of which one to use likely has an impact on the estimation of efficiency. This study only considered mortality, which while more granular than life expectancy, for instance, does not take into consideration the ability of healthcare systems to preserve quality of life. Second, the results are dependent upon the specifications of the model and the factors that it controlled for. I hoped to mitigate this by showing robustness of our efficiency metric across model specifications, but it remains true that the conceptual approach has an impact on the final results.

Next is the challenge of sparse data in the policy variable analysis. This limited the ability to test the associations of policy and value and requires the use of a bivariate model where a multivariate model would be preferable. There may also be associations between systems that report data and systems that function more efficiently. Because there was no effort made to impute values that were missing from the policy variable datasets, the patterns of missingness may impact the associations between policy characteristics and estimated value.

Most importantly, this study restricts its focus to the prevention of death once a disease has been contracted. The highest-functioning health systems should work to prevent disease from occurring in the first place. I intentionally avoided measuring this capacity for prevention, as it is very difficult to do in a rigorous fashion, but it is something that must be taken into consideration.

Conclusion

This study provides novel estimates of healthcare value across countries of the OECD. It identifies variations and changes in value over time using an approach that focuses on the efficiency of healthcare delivery systems. The analysis of system characteristics finds that higher total and private insurance coverage rates, consultations with physicians, and physician, nurse and midwife density are associated with higher value systems. Highlighting the best performing countries and policies that are quantitatively linked to better performance provides a baseline for further investigation into what drives high-value healthcare and may inform agendas for system reform in less efficient countries.

Figures

Figure 1: Summary of highest and lowest value countries in 2017
This figure highlights the countries with the highest and lowest value in 2017, the mortality-incidence ratios for the disease conditions responsible for the most deaths in 2017 and the total healthcare spending.

Figure 2: Healthcare value ranks over time, 1995 - 2017
This figure shows ranks of healthcare value over the study period.

Figure 3: Mortality-incidence frontiers for the six health conditions with the highest mortality
This figure shows the adjusted mortality-incidence frontier for all countries in the study sample, 1995 – 2017 with the effect of key covariates removed. The blue line represents the optimal outcome relative to the level of healthcare spending for each state.

Figure 4: The association between healthcare value and health system characteristics and policies
Estimated elasticities are each from a separate, bivariate, log-linear regression with the 95% confidence interval displayed in the figure. Green font indicates characteristics positively associated with healthcare value.

Figure 5: Trends in US health outcomes and spending
Trends in health outcomes and healthcare spending over time for the United States (red) and the OECD average (black). Panel A shows M-I ratio for ischemic heart disease. Panel B shows healthcare spending over time.

Figure 6: Trends in Estonian and Lithuanian health outcomes and spending
Trends in health outcomes and healthcare spending over time for Estonia (blue), Lithuania (brown), and the OECD average (black). Panel A shows M-I ratio for ischemic heart disease. Panel B shows healthcare spending over time.

Figure 1: Summary of highest and lowest value countries in 2017

			Mortality-incidence ratio						
Rank	Country	Value Score	Ischemic heart disease	Tracheal, bronchus, and lung cancer	Colon and rectum cancer	Chronic obstructive pulmonary disease	Breast cancer	Intracerebral hemorrhage	Personal health spending per person ($ PPP)
1	Italy	74	0.163	0.736	0.280	0.030	0.172	0.431	$ 3,535
2	Estonia	71	0.335	0.861	0.360	0.030	0.254	0.326	$ 2,164
3	Australia	70	0.182	0.653	0.266	0.048	0.170	0.354	$ 5,181
4	Spain	69	0.251	0.707	0.293	0.037	0.180	0.367	$ 3,526
5	Slovenia	67	0.251	0.794	0.369	0.017	0.211	0.548	$ 2,974
	Median of top 5	70	0.251	0.736	0.293	0.030	0.180	0.367	$ 3,526
32	Lithuania	27	0.589	0.828	0.474	0.043	0.290	0.519	$ 2,171
33	Hungary	25	0.559	0.972	0.485	0.053	0.274	0.570	$ 2,157
34	Chile	23	0.254	0.969	0.453	0.032	0.263	0.512	$ 2,365
35	Poland	18	0.462	0.998	0.591	0.029	0.249	0.691	$ 2,003
36	Mexico	12	0.609	0.976	0.441	0.044	0.271	0.477	$ 1,158
	Median of bottom 5	23	0.559	0.972	0.474	0.043	0.271	0.519	$ 2,157

Figure 2: Healthcare value ranks over time, 1995 - 2017

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Country
14	13	11	9	6	7	7	5	6	4	3	3	3	3	3	3	4	3	4	1	1	1	1	Italy
30	25	23	27	22	18	19	16	13	11	11	12	12	9	9	4	2	4	3	4	2	2	2	Estonia
4	5	4	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	2	3	3	3	3	Australia
2	2	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	2	1	2	4	4	4	Spain
18	19	19	19	19	20	20	15	15	12	10	9	8	8	7	8	7	7	7	5	5	5	5	Slovenia
3	3	2	3	3	4	4	3	3	3	4	4	4	4	4	7	8	8	9	10	8	6	6	Japan
13	15	13	8	7	6	5	6	5	6	6	6	7	7	8	9	9	9	8	8	7	7	7	New Zealand
22	23	21	21	20	21	18	18	16	15	12	11	9	11	11	11	10	11	11	11	11	10	8	Germany
8	12	15	13	12	10	8	8	7	7	7	7	6	6	6	5	5	5	5	6	6	8	9	Iceland
5	4	5	4	4	3	3	4	4	5	5	5	5	5	5	6	6	6	6	9	10	11	10	United Kingdom
12	14	16	16	15	15	13	13	14	16	16	16	19	18	17	13	11	10	10	7	9	9	11	Greece
31	32	31	30	25	26	25	21	19	20	18	17	14	13	15	16	14	14	12	12	12	12	12	Austria
1	1	3	6	9	11	12	12	11	10	15	19	18	17	18	20	19	19	18	17	14	14	13	Turkey
11	11	14	14	13	13	10	10	10	13	14	13	13	14	13	15	15	17	16	13	13	13	14	Finland
16	16	12	11	10	9	9	9	9	9	8	8	11	12	12	12	12	15	13	15	16	15	15	Canada
6	7	6	7	8	8	11	11	12	14	13	14	15	15	14	14	17	18	20	21	20	18	16	Sweden
27	30	30	28	28	29	27	26	26	23	23	23	20	20	20	19	20	21	21	20	19	17	17	Netherlands
26	26	27	22	23	23	22	24	22	22	21	22	21	21	22	22	23	22	23	22	22	19	18	Switzerland
21	8	10	17	17	16	23	25	25	28	31	35	31	27	21	21	16	13	14	14	15	16	19	Latvia
24	27	25	24	24	25	24	23	18	18	17	15	16	16	16	17	18	16	17	16	17	20	20	Norway
19	20	20	20	21	22	21	22	23	21	22	20	22	23	23	25	25	25	25	24	25	25	21	Belgium
10	10	8	5	5	5	6	7	8	8	9	10	10	10	10	10	13	12	15	18	21	23	22	United States of America
17	17	17	12	11	12	14	14	20	19	20	18	17	19	19	18	21	23	22	23	23	22	23	Czechia
32	31	34	34	34	34	34	33	31	31	28	28	28	29	28	28	27	27	26	26	26	26	24	Ireland
7	9	9	10	16	17	17	17	17	17	19	21	23	22	24	24	24	24	24	25	24	24	25	Republic of Korea
35	35	32	32	33	33	33	32	32	30	27	27	25	24	25	23	22	20	19	19	18	21	26	Denmark
33	34	35	35	35	35	35	36	36	36	36	34	29	30	30	30	29	31	27	28	27	27	27	Luxembourg
28	29	28	31	31	31	32	31	28	27	26	26	24	25	27	26	26	26	28	27	28	28	28	France
15	18	18	18	18	19	15	20	21	24	29	29	32	33	34	33	30	30	29	29	30	29	29	Slovakia
34	33	33	33	32	32	29	28	27	25	24	25	26	26	26	27	28	29	30	30	29	30	30	Israel
36	36	36	36	36	36	36	35	35	35	33	30	30	32	33	34	34	32	32	32	31	31	31	Portugal
9	6	7	15	14	14	16	19	24	26	30	33	36	35	32	32	32	28	31	31	32	32	32	Lithuania
29	24	22	26	27	24	26	27	33	33	34	32	33	31	31	31	33	34	33	33	35	33	33	Hungary
25	28	29	29	30	30	30	29	29	29	25	24	27	28	29	29	31	33	34	35	33	34	34	Chile
20	22	26	23	29	27	28	30	30	32	32	31	34	34	35	35	35	35	35	34	34	35	35	Poland
23	21	24	25	26	28	31	34	34	34	35	36	35	36	36	36	36	36	36	36	36	36	36	Mexico

Figure 3: Mortality-incidence frontiers for the six health conditions with the highest mortality

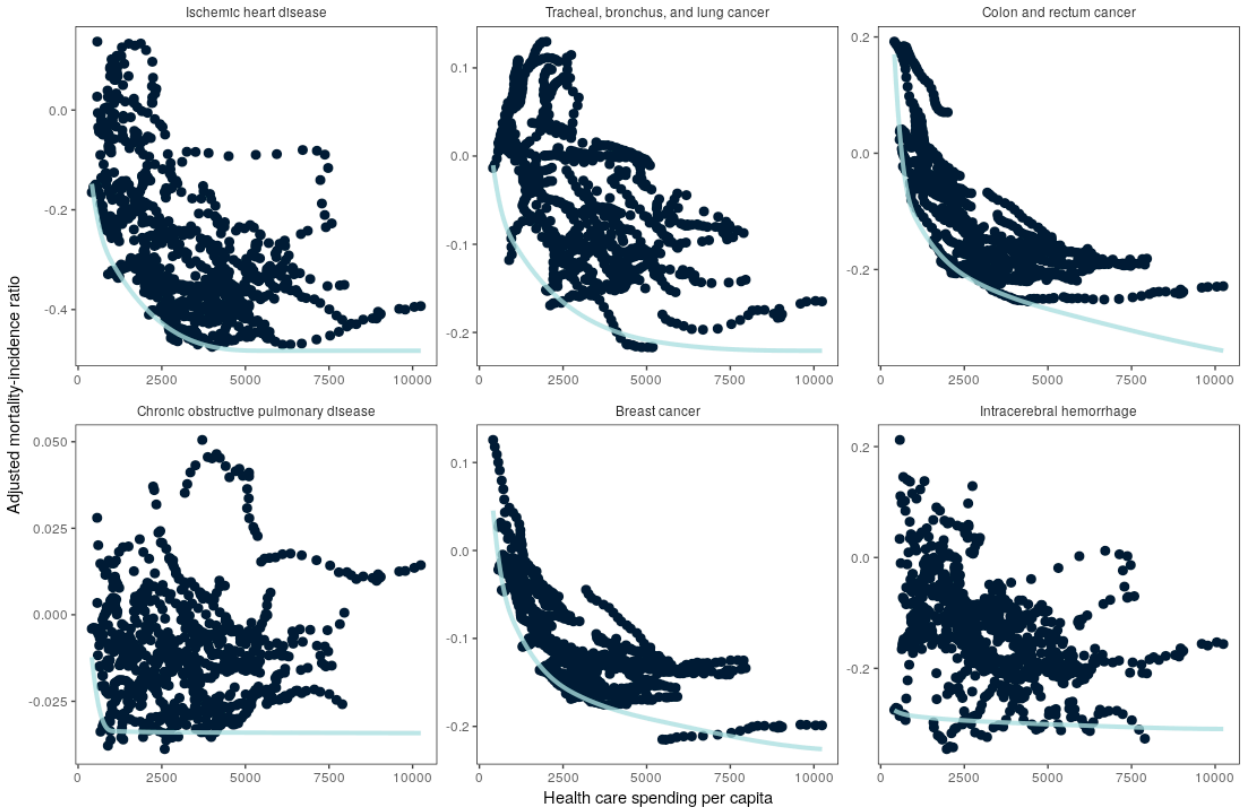


Figure 4: The association between healthcare value and health system characteristics and policies

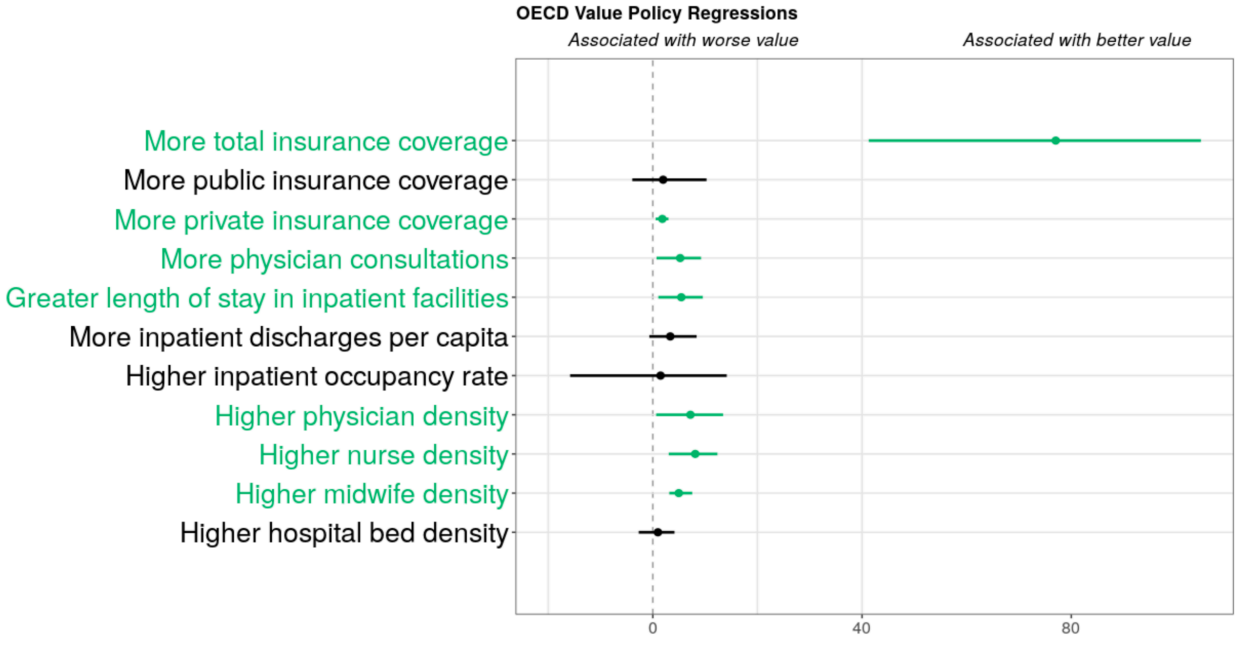
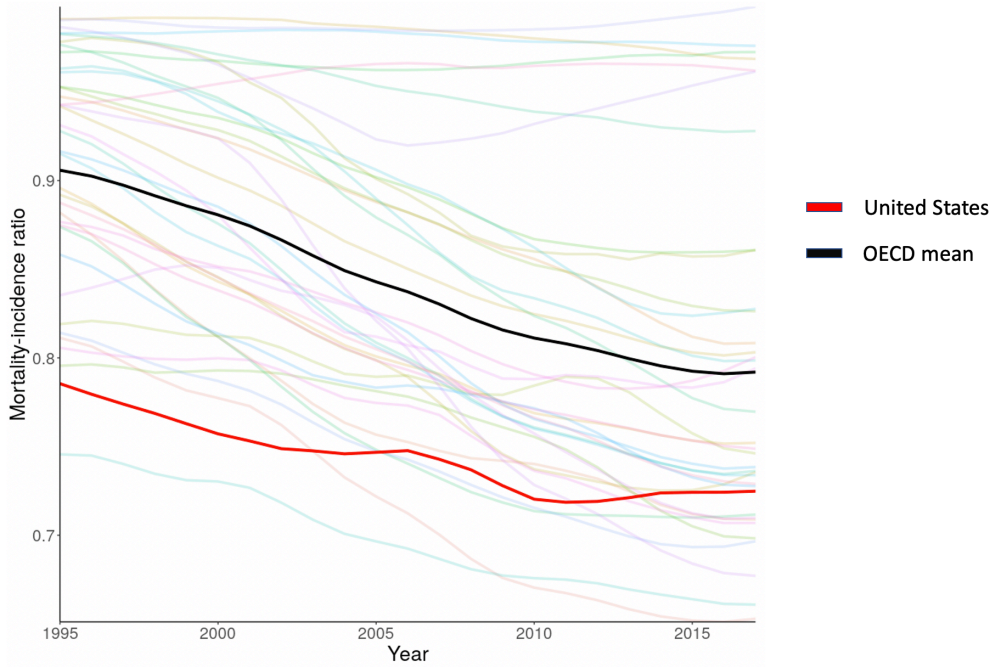


Figure 5: Trends in US health outcomes and spending

(a)



(b)

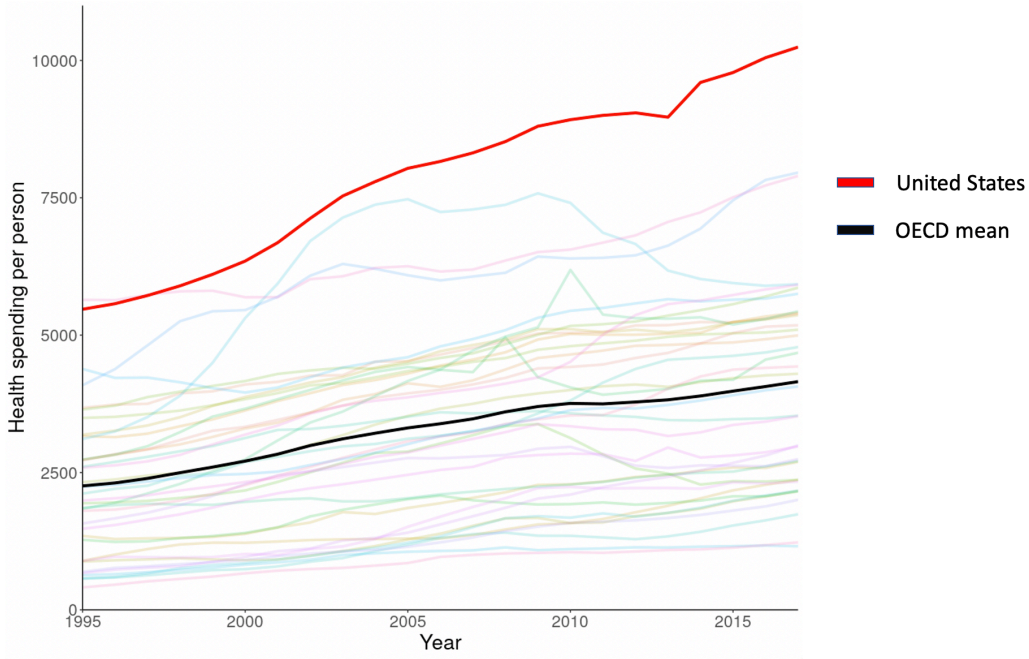
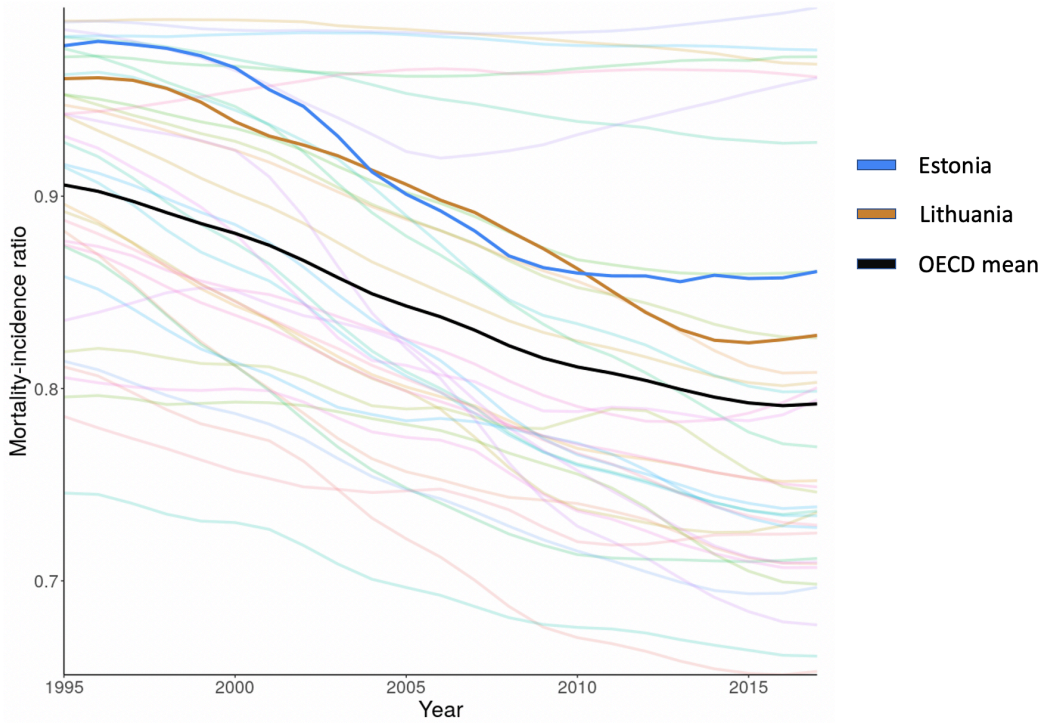
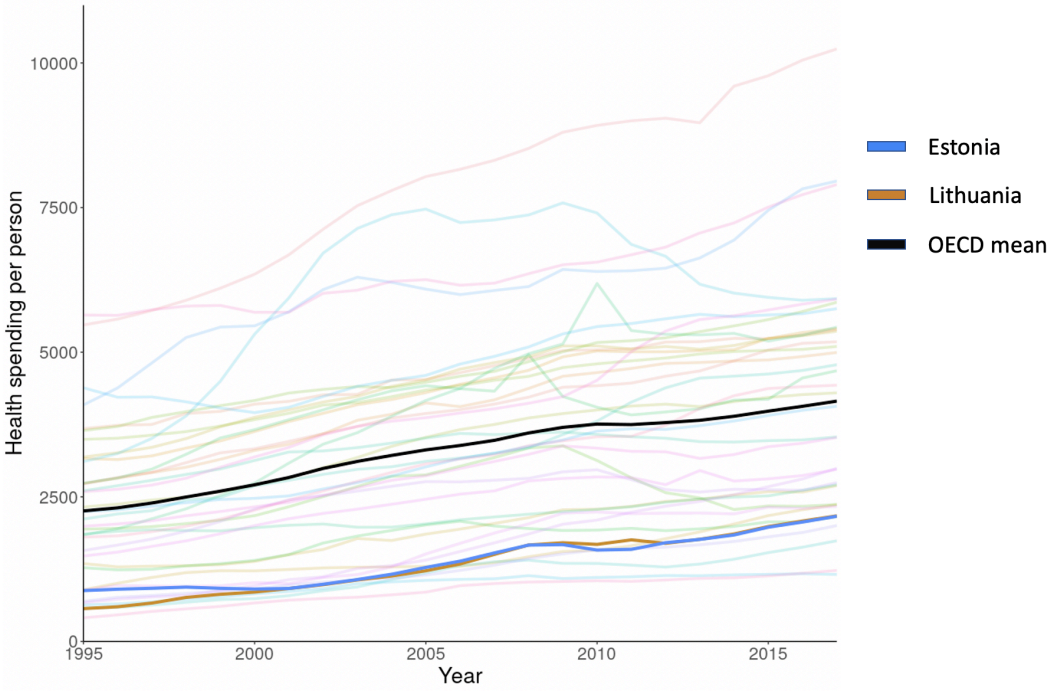


Figure 6: Trends in Estonian and Lithuanian health outcomes and spending

(a)



(b)



References

1. Dieleman J, Campbell M, Chapin A, et al. Evolution and patterns of global health financing 1995-2014: Development assistance for health, and government, prepaid private, and out-of-pocket health spending in 184 countries. *Lancet*. 2017;389(10083):1981-2004. doi:10.1016/S0140-6736(17)30874-7
2. Jaba E, Balan CB, Robu I-B. The Relationship between Life Expectancy at Birth and Health Expenditures Estimated by a Cross-country and Time-series Analysis. *Procedia Econ Financ*. 2014;15:108-114. doi:10.1016/s2212-5671(14)00454-7
3. Wranik D. Healthcare policy tools as determinants of health-system efficiency: Evidence from the OECD. *Heal Econ Policy Law*. 2012;7(2):197-226. doi:10.1017/S1744133111000211
4. Asandului L, Roman M, Fatulescu P. The Efficiency of Healthcare Systems in Europe: A Data Envelopment Analysis Approach. *Procedia Econ Financ*. 2014;10:261-268. doi:10.1016/s2212-5671(14)00301-3
5. Vos T, Allen C, Arora M, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet*. 2016;388(10053):1545-1602. doi:10.1016/S0140-6736(16)31678-6
6. Tobacco: a major international health hazard. Proceedings of an international meeting. Moscow, 4-6 June 1985. *IARC Sci Publ*. 1986.
7. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *J Am Med Assoc*. 1999;282(16):1523-1529. doi:10.1001/jama.282.16.1523
8. Pi-Sunyer FX. Health implications of obesity. In: *American Journal of Clinical Nutrition*. Vol 53. Oxford Academic; 1991:1595S-1603S. doi:10.1093/ajcn/53.6.1595S
9. Meara ER, Richards S, Cutler DM. The gap gets bigger: Changes in mortality and life expectancy, by education, 1981-2000. *Health Aff*. 2008;27(2):350-360. doi:10.1377/hlthaff.27.2.350
10. Wen CP, Wai JPM, Tsai MK, et al. Minimum amount of physical activity for reduced mortality and extended life expectancy: A prospective cohort study. *Lancet*. 2011;378(9798):1244-1253. doi:10.1016/S0140-6736(11)60749-6
11. OECD. OECD Statistics. https://stats.oecd.org/Index.aspx?ThemeTreeId=9#. Accessed June 18, 2020.
12. Hollingsworth B. The measurement of efficiency and productivity of health care delivery. *Health Econ*. 2008;17(10):1107-1128. doi:10.1002/hec.1391
13. Jacobs R, Smith PC, Street A. *Measuring Efficiency in Health Care: Analytic Techniques and Health Policy*. Cambridge University Press; 2006. doi:10.1017/CBO9780511617492
14. Dieleman JL, Kaldjian AS, Sahu M, et al. *Multi-Decade Association of State-Level Value in Caring for Major Illnesses with State Policies and Healthcare System*. Seattle, WA; 2020.
15. Collins SR, Gunja MZ, Doty MM, Bhupal HK. Health Insurance in 2018 Finds ACA Gains Reversing. The Commonwealth Fund. https://www.commonwealthfund.org/blog/2018/first-look-health-insurance-coverage-2018-finds-aca-gains-beginning-

reverse?redirect_source=/publications/blog/2018/apr/health-coverage-erosion. Published 2018. Accessed August 11, 2020.
16. van Ginneken E, Habicht J, Murauskiene L, Behmane D, Mladovsky P. The Baltic states: building on 20 years of health reforms. *BMJ*. 2012;345. doi:10.1136/bmj.e7348
17. Bankauskaite V, O'Connor JS. Health policy in the Baltic countries since the beginning of the 1990s. *Health Policy (New York)*. 2008;88(2-3):155-165. doi:10.1016/j.healthpol.2007.10.017
18. Shah S. Kickback scandal rocks Lithuanian healthcare system - Emerging Europe | Intelligence, Community, News. Emerging Europe. https://emerging-europe.com/news/kickback-scandal-rocks-lithuanian-healthcare-system/. Published 2018. Accessed August 11, 2020.
19. Jurkonis L. How can corruption in the Lithuanian healthcare system be fought? - The BMJ. The BMJ Opinion. https://blogs.bmj.com/bmj/2017/02/01/liudas-jurkonis-how-can-corruption-in-the-lithuanian-healthcare-system-be-fought/. Published 2017. Accessed August 11, 2020.

Acknowledgements

My great thanks to Joe Dieleman and Angela Micah for the support and guidance they provided as members of my thesis committee. This work would not have been possible without them.