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Estimation of the Cost-Effectiveness Threshold: The Case of the Dominican Republic

Álvaro J. Riascos Villegas

Abstract

This study uses quantitative techniques from the health economics literature for evaluating the cost-effectiveness of financing new technologies (including procedures and medications) that result in greater well-being and health for the country. Specifically, a methodology is developed to estimate the cost-effectiveness threshold (CET) for the public healthcare system of the Dominican Republic. Since the CET measures the level of healthcare expenditure estimated to be necessary to gain one quality-adjusted life year (QALY) or some analogous measure of health outcome, this value provides a criterion for determining whether the financing of a new technology is cost-effective. Given a budget constraint, if the cost per QALY of a new technology exceeds the CET, its adoption would yield health benefits inferior to the technologies it displaces. Using econometric techniques, this study estimates the CET for the Dominican Republic at 85,928 Dominican pesos (DOP), with confidence intervals of 40,720 DOP and 131,140 DOP, which is equivalent to 26% of the per capita GDP in 2016 (331,253 Dominican pesos) with a confidence interval of 12.3% to 39.6% of per capita GDP, respectively. These results are robust to various econometric specifications and/or alternative measures of health outcomes.

Keywords: cost-effectiveness, threshold, CET, healthcare system, healthcare expenditure, quality-adjusted life year, QALY, Dominican Republic, economic assessment, Years of life lost, YLL, Standard economics, efficiency, calculate, tools

JEL Codes: H10, H11, H21, H30, H51, H61, I1

ESTIMATION OF THE COST-EFFECTIVENESS THRESHOLD

The case of the Dominican Republic

Alvaro J. Riascos Villegas[1]

SUMMARY

» **This study uses quantitative techniques from the health economics literature for evaluating the cost-effectiveness of financing new technologies (including procedures and medications) that result in greater well-being and health for the country.** Specifically, a methodology is developed to estimate the cost-effectiveness threshold (CET) for the public healthcare system of the Dominican Republic. Since the CET measures the level of healthcare expenditure estimated to be necessary to gain one quality-adjusted life year (QALY) or some analogous measure of health outcome, this value provides a criterion for determining whether the financing of a new technology is cost-effective. Given a budget constraint, if the cost per QALY of a new technology exceeds the CET, its adoption would yield health benefits inferior to the technologies it displaces. Using econometric techniques, this study estimates the CET for the Dominican Republic at 85,928 Dominican pesos (DOP), with confidence intervals of 40,720 DOP and 131,140 DOP, which is equivalent to 26% of the per capita GDP in 2016 (331,253 Dominican pesos) with a confidence interval of 12.3% to 39.6% of per capita GDP, respectively. These results are robust to various econometric specifications and/or alternative measures of health outcomes.

INTRODUCTION

» **Health care systems in all countries are facing increasing health needs and, at the same time, limited health budgets.** This has motivated governments to apply tools that promote the efficient use of resources. Economic Evaluation has become an important factor in the decision-making process regarding financing new health technologies (procedures, medicines, among others), which improve wellbeing and health in the country. One of the tools used is the Cost-Effectiveness Threshold (CET).

» According to Claxton *et al.* (2015), the Cost-Effectiveness Threshold is defined as the level of health expenditure allocated to the health care system which is deemed to be necessary to gain one quality-adjusted life year (QALY) or an equivalent measurement for health outcomes.[2] Therefore, given the budgetary restrictions of health expenditure, it is the opportunity cost – in terms of QALYs – to displace resources allocated initially to the Basic Health Plan (Plan Básico de Salud), towards the financing of new technologies (procedures, medicines, among others). The CET gives us an idea, whether a given health technology can be expensive for society or not. If the value of a new health technology is higher than the CET, its adoption would provide health benefits inferior to the technologies which would be displaced, which would lead to a net-loss in health.

» Specifically, the research question for this study is: **What is the Cost-effectiveness Threshold of the Dominican Republic's health care system?** This paper is a case study, which uses data of life expectancy, mortality and morbidity of the Dominican Republic, together with other sources of information, to estimate the Cost-Effectiveness Threshold of this country.

» The document is structured in the following way: after the introduction, the chapter on data describes the data related to the Dominican Republic used in this study. The following section on methodology outlines the calculation of the result variable in health, the estimation method of the elasticity of demand, as well as the calculation of the Cost-Effectiveness Threshold. The final section presents the results and main conclusions.

1. DATA

The estimation of the Cost-Effectiveness Threshold requires several data sources. The following chapter succinctly describes the main sources' contents and their purpose.

1.1. MORTALITY DATABASE

This database contains 340,198 registered deaths, reported between 2014 and 2019 in the Dominican Republic, constituting the total number of deaths in the country during this period. The registries are derived from the death certificates, which were collected and digitalized by the Ministry of Public Health. From these registries the following data can be obtained: sex, date of birth, date of death, diagnosis and cause of death, amongst other relevant information for each deceased person.

A summary of the data collected can be found in table A.1. This database aims to identify the cause of death and the services provided to each patient before their death. With this information, it will be possible to measure the disease burden that each disease caused to the system to see how different spending levels impact the measurements. Finally, since this study aims to focus on treating diseases, deaths caused by accidents or violence were not included. In addition, it is important to mention that for the purpose of this study the time period was limited to the years 2016-2019, since these are the years when all the additional information was available.

1.2. MEDICAL ATTENTION DATABASE

This database contains 18,605,361 registries between 2016 and 2019, each including records of the medical attention offered to the patient on a specific day. Each health institution passes this information on to the Ministry of Health and Occupational Risks (Superintendencia de Salud y Riesgos Laborales - SISALRIL). SISALRIL then provides this data. In this database each person has an assigned main diagnosis, related to their medical consultation, as well as additional information such as their age, if the person is part of the subsidized health care scheme or a contributory health care scheme, the municipality and the region where the patient was treated, the procedure which was done and the costs incurred by the health care system. The main purpose of this data source is to know the state's cost to treat each disease in each municipality and determine their impact on the treatment of the different diseases.

1.3. NATIONAL LIFE TABLES

National life tables show the number of deaths in each country in a specific year, specified by sex and age. The main purpose of these tables is to estimate life expectancy. They also serve as the principal input for demographic models. In the Dominican Republic, we used all the available mortality tables at the National Office of Statistics (Oficina Nacional de Estadística – ONE) for the period between 1950 and 2020, which offer detailed information per quinquennium. For the purpose of our study, we used the period between 2015 and 2020 as input for the estimations of life expectancy. These tables are shown in table A.2 and table A.3.

1.4. ICD-10

To being able to categorize different diseases systematically and coherently, we use **The International Classification of Diseases** (ICD) and **Related Health Problems 10th Revision** (ICD-10) published by the Pan American Health Organization (2008). The ICD-10 is a system of categories assigned to health problems according to established medical criteria. It comprises 22 categories (numerated from Roman I to XXII) which sum up to 12,610 health conditions. They are organized alphanumerically with one letter and two digits. The different categories can be found in table 1.

TABLE 1 Categories of diseases according to the Pan American Health Organization (2008)

Number	Category	ICD-10 Code
I	Certain infectious and parasitic diseases	A00–B99
II	Neoplasms	C00–D48
III	Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	D50–D89
IV	Endocrine, nutritional, and metabolic diseases	E00–E90
V	Mental and behavioral disorders	F00–F99
VI	Diseases of the nervous system	G00–G99
VII	Diseases of the eye and adnexa	H00–H59
VIII	Diseases of the ear and mastoid process	H60–H95
IX	Diseases of the circulatory system	I00–I99
X	Diseases of the respiratory system	J00–J99
XI	Diseases of the digestive system	K00–K93
XII	Diseases of the skin and subcutaneous tissue	L00–L99
XIII	Diseases of the musculoskeletal system and connective tissue	M00–M99
XIV	Diseases of the genitourinary system	N00–N99
XV	Pregnancy, childbirth and the puerperium	O00–O99
XVI	Certain conditions originating in the perinatal period	P00–P96
XVII	Congenital malformations, deformations and chromosomal abnormalities	Q00–Q99
XVIII	Symptoms, signs, and abnormal clinical and laboratory findings not elsewhere classified	R00–R99
XIX	Injury, poisoning, and certain other consequences of external causes	S00–T98
XX	External causes of morbidity and mortality	V01–Y98
XXI	Factors influencing health status and contact with health services	Z00–Z99
XXII	Codes for special purposes	U00–U99

Source: Clasificación Estadística Internacional de Enfermedades y Problemas Relacionados con la Salud, Décima Revisión (CIE-10). Organización Panamericana de la Salud.

2. METHODOLOGY

> **As guidance for the estimation of the Cost-Effectiveness Threshold, we mainly followed the guidelines and procedures suggested by Claxton *et al.* (2015), since we consider them to be the most complete and precise guidelines on this topic.**

Nevertheless, we used other complementary sources since this source is simply a methodological guide. In particular, the study by Martin *et al.* (2021) conducts a similar evaluation in the United Kingdom between 2003 and 2013 compared to the one this paper tries to provide.

Therefore, the construction of the Cost-Effectiveness Threshold consists of three steps. Each one of these phases will be explained in detail in the following sections: 1) the estimation of the total disease burden, 2) the estimation of the health expenditure elasticity, and 3) the calculation of the Cost-Effectiveness Threshold.

2.1. STEP 1: ESTIMATION OF THE BURDEN OF DISEASE

The objective of the first step is to build a health measurement, which captures the life years of total health lost due to a disease. This is known as the disease burden implied on a health care system. To achieve this, two different dimensions have to be considered: firstly, it is necessary to estimate the years of life lost (YLL) due to premature mortality of the patient, and secondly, to include the quality of life lost due to the disease while the patient is alive.

The first step consists of four intermediate steps: 1) The estimation of the years of life lost due to premature mortality of the patient, 2) adjustments of these years of life lost due to the quality of life which could have been achieved, 3) include the years lost due to the quality of life while the patient suffers from the disease or condition, and 4) add the health measures, which reflect the burden of disease of one particular year and place. Subsequently, each of these steps is explained in detail.

2.1.1. Years of life lost due to premature mortality

The years of life lost due to premature mortality (YLL), are the number of years a person was expected to live if that person hadn't died due to the disease. Therefore, it is necessary to estimate the life expectancy related to the socio-demographic characteristics of each deceased personto know how much more this person would have lived.

To express this more formally, supposing we have N individuals indexed by $i = 1,\cdots,N$. In order to calculate the years of life lost due to premature mortality, we have to think of counterfactual scenarios: one where this individual gets sick and dies, and the other where the person never gets the disease.

$S_i \in \{H,M\}$ is the sex at birth of the individual, i, $M_i \in N_0$ the age at the moment of death, y $E_i \in \{0,I,\cdots,XXI\}$ the disease that this individual has at the time of their death.

For now, we assume that each person can only suffer from one disease. Parting from this information, we find two approaches in the literature to calculate the years of life lost. One possibility is the following:

$$\text{YLL}_i = \text{E}[M_i|S_i] - M_i$$

which simply establishes that the years of life lost is the difference between the expected age of death (due to the sex at birth) and the observed age of death due to the disease. Therefore, the age of expected death is merely the average life expectancy of the Dominican population according to their sex (according to the National Statistics Offices – ONE: 71.81 years for males and 77.15 years for females in 2021).

However, Claxton *et al.* (2015) observe that this is not the ideal way to estimate the life expectancy of individuals since taking the average life expectancy of the entire population as a reference is only viable if every subpopulation, which is affected by a disease, shows the same distribution as the entire population. This is because if a person contracts a disease, it reveals certain characteristics of that person such as their age (e.g. cancer, diseases of the circulatory system or genitourinary diseases), or their place of residence (e.g. diseases transmitted by mosquitoes). This means that depending on this information, a person's life expectancy is different compared to an arbitrary person. It is therefore important to note that this adjustment is necessary since, by observing figures 1 and 2, it can be seen that different diseases affect different age and gender groups in a distinct manner (e.g., category XV affects young women disproportionally).

Therefore, an adequate representation of life expectancy is the one adjusted by the distribution of age and sex of the population at risk for each ICD-10 category. This is the approach chosen by Martin *et al.* (2021) and Claxton *et al.* (2015); consequently, it will also be our strategy. Essentially, we want to calculate the following:

$$\mathrm{YLL}_i = \mathrm{E}[M_i|S_i,E_i] - M_i$$

Hence, based on the law of iterated expectations, the first term of this sum is expressed as:

$$\mathrm{E}[M_i|S_i,E_i] = \sum_{a=0}^{\infty} \mathrm{P}(Ai = a|Si,Ei)\mathrm{E}[Mi|Si,Ei,Ai = a]$$

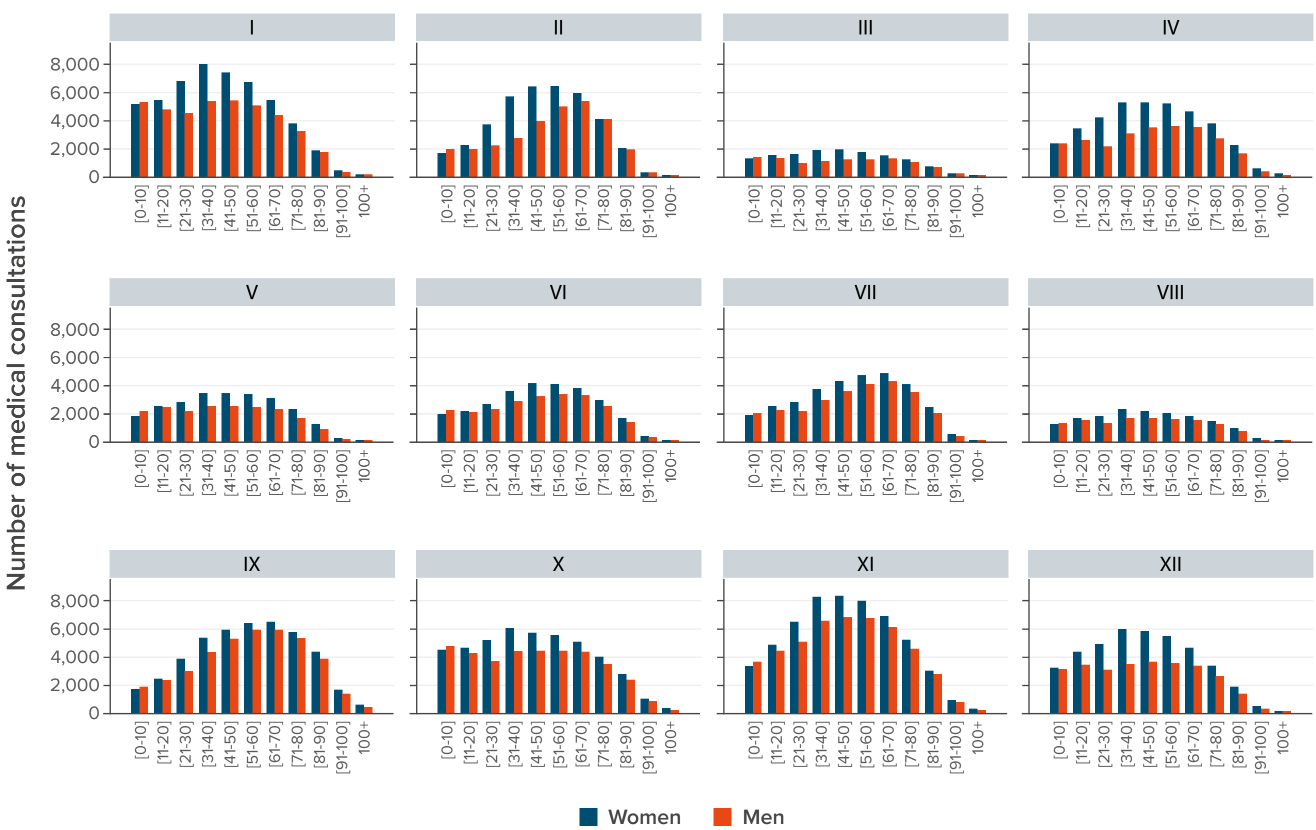
where Ai is the age of the individual i. assuming that the age and sex are sufficient to define the age of death without the disease, then

$$\mathrm{E}[M_i|S_i = s,E_i,A_i = a] = \mathrm{E}[M_i|S_i = s,A_i = a]$$

$$\text{para todo } s \in \{H,M\}, a = 0,1,\cdots$$

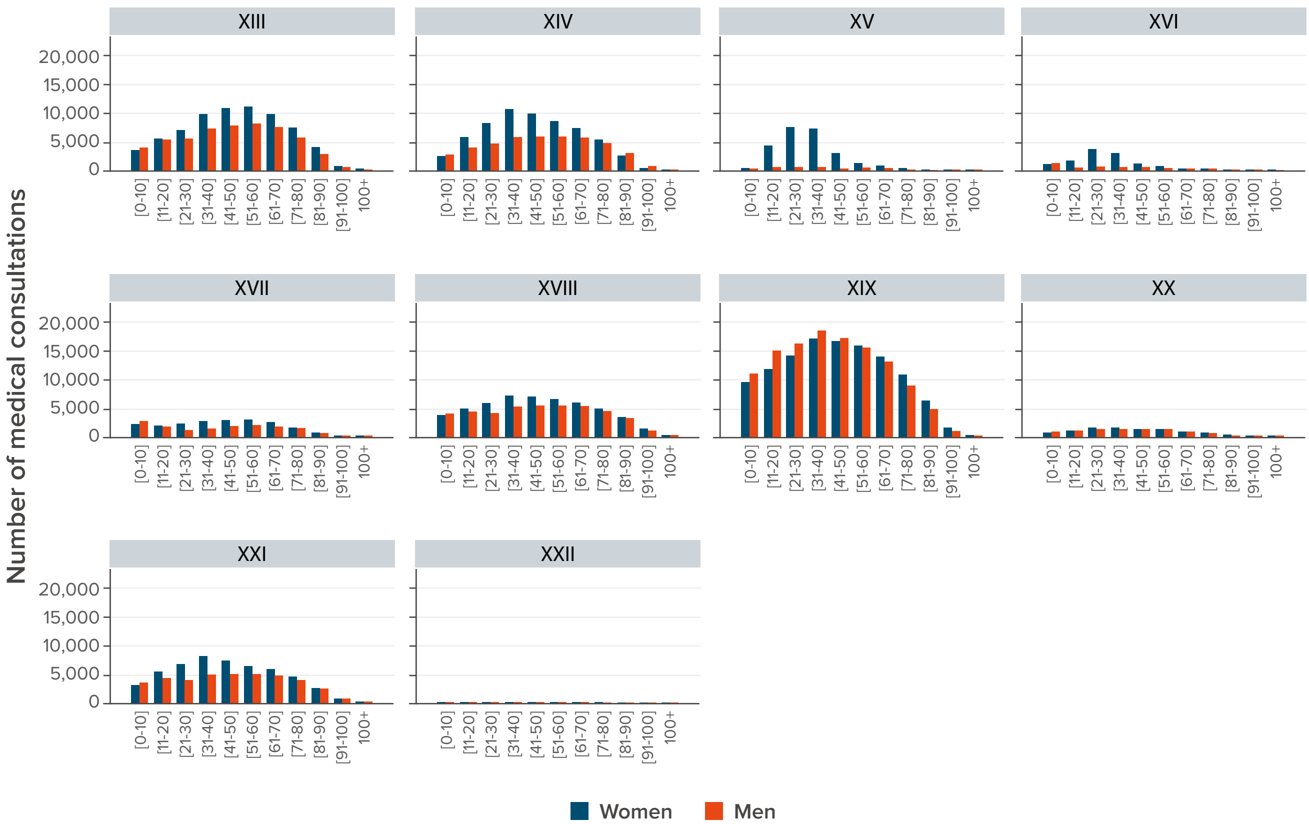
We can then calculate this quantity for each sex since the National Life Tables allow for estimating life expectancy correctly, on the condition that a person's sex is s and their age is a. Even more so, using the total number of medical consultations, we can precisely characterize the age distribution for each disease group per sex, this being $\mathrm{P}(A_i = a|S_i = s,E_i = j)$, while we observe which percentage of individuals of sex s contracted the disease *j* at the age of a.

FIGURE 1 Medical consultations per type of disease and gender, 2016-2019



Source: SISALRIL.
Note: Number of consultancies per group of disease ICD and sex at birth between 2016 and 2019.

FIGURE 2 Medical consultations per type of disease and gender II, 2016-2019



Source: SISALRIL.
Note: Number of consultancies per group of disease ICD and sex at birth between 2016 and 2019.

Thus, the adjusted life expectancies for the population at risk, corresponding to each disease group, are shown in table 2. Although life expectancies are similar between categories, it is important to note that all the estimated life expectancies are slightly higher than the ones of the general population. This is not a minor issue since we would be overestimating the years of life lost without the adjustment. Additionally, there are particular diseases where the adjustment leads to very different results. This is the case, for example, in category IX (diseases of the circulatory system), where the life expectancy is much higher than normal (exceeding 80 years for both sexes) since that disease especially affects older people.

Finally, it is important to mention that all estimated life expectancies are higher than the ones reported for the general population. This is because life expectancies rise as a certain age is reached (e.g., a male's life expectancy at birth is 71,07 years, yet once this individual reaches 50 years, life expectancy is elevated to 77,73).

Yet, an individual can have several diseases reported as a cause of death. In this case we use the lowest life expectancy for each disease the individual suffers from, since we consider the population with the highest risk to best reflect the individual's health conditions.

For the analysis that will be done in the rest of this paper, it is necessary to let go of the individual as an analytical unit to consider the impact of the diseases on health at a more aggregated level, like a municipality or a province. To do so, Claxon *et al.* (2015) suggest using the sum of all life years lost registered at the desired cell[3].

A first attempt to reach the total YLL in a certain cell, would be to consider only premature mortality, hence, those which occur before the estimated life expectancy, since only those represent years of life lost. However, the problem of this way of calculating is that it does not consider that many of the observed deaths at a certain age would have happened before the estimated life

TABLE 2 Estimated life expectancy for each disease, based on the population at risk

ICD category	Estimated life expectancy - Females	Estimated life expectancy - Males
I	81.11	78.00
II	82.09	79.98
III	81.70	79.01
IV	82.20	79.23
V	81.76	78.21
VI	82.27	79.17
VII	82.77	79.93
VIII	81.86	78.81
IX	83.84	81.14
X	82.06	79.01
XI	82.01	79.09
XII	81.55	78.49
XIII	82.26	79.03
XIV	81.57	79.62
XV	79.46	77.54
XVI	79.64	77.08
XVII	81.32	78.30
XVIII	82.49	79.74
XIX	81.78	78.01
XX	81.99	78.55
XXI	81.99	79.33
XXII	80.34	77.28

Source: Author's calculations.

expectancy, even if the disease was not present. In addition, it does not account for the fact that many of the observed deaths at ages higher than the life expectancy wouldn't have happened without the disease. Therefore, a calculation that reflects the burden of disease more accurately, is to focus on those deaths which are a consequence of the disease. We can identify those as excess deaths.

Claxton *et al.* (2015) claim that a simple way to get the excess deaths is to take the net YLL as a reference, which is a result of the sum of the years of life lost due to disease, if the death is premature and the life years gained (LY), in case death occurs after the life expectancy (YLLnet = YLL – LY). In cases where multiple causes are associated with a death, we took the one with a higher mortality rate in the Dominican Republic, according to the mortality data base of the World Health Organization (2022). The calculations of these indicators for the Dominican Republic are represented in table 3.

2.1.2. Quality-adjusted years of life lost

The years of life lost (YLL) due to premature mortality are not an accurate measurement of the burden of a disease on the health care system since they equally weigh each year of life, even though not all years lived are lived with the same quality of life. Therefore, they should not be valued equally. This adjustment is essential, since otherwise, the effect of the health spending would be overestimated, linking improvements in health to it, which are not feasible, given the age or sex of the person.

To solve this problem, it is common practice to switch from YLL to the years of life lost adjusted to quality of life (Quality-adjusted Life Years - QALYs). To achieve this, a score linked to the quality of life associated with the general population's state of health should be estimated. This score is a number between 0 and 1, where 1 reflects the state of perfect health, which diminishes according to age and differs according to the sex (Martin *et al.*, 2021).

To obtain these scores, the health questionnaire EQ-5D is commonly used. Based on it, it is possible to calculate an index which reflects the individual's health state. Nevertheless, this information is not available for the Dominican Republic. It is therefore necessary to make an approximation.

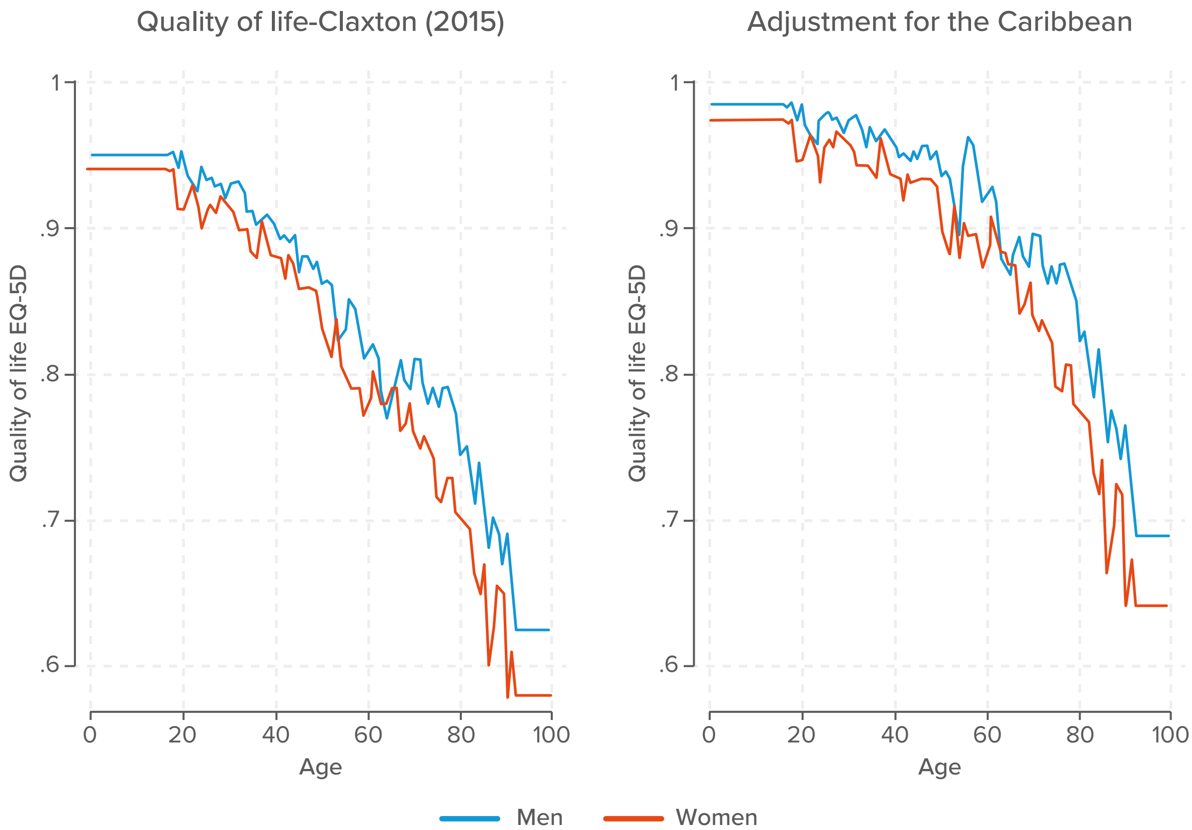
Just as Espinosa *et al.* (2021) and Martin *et al.* (2021), we used the quality scores presented in Claxton *et al.* (2015). However, since those were calculated using the United Kingdom as a sample and are over a decade old, we decided to adjust the weighting to better reflect the actual conditions in the country. Hence, we referred to the study of Bailey *et al.* 2022, which calculates the quality of life weights for five Caribbean countries: Barbados, Belize, Colombia, Jamaica, and Trinidad and Tobago. Nonetheless, the level of aggregation of the resulting weighting was too high in order to make good adjustments. Consequently, the series proposed by Claxton *et al.* (2015) was adjusted to reflect the average scores for each age group and both sexes out of the average scores collected in the Caribbean countries. The result of this correction can be seen in figure 3.

TABLE 3 Total of years of life lost and excess deaths per disease, 2016-2019

Category ICD-10	Type of disease	YLL	LY	Net YLL	YLL Per observed death	Excess deaths	Total deaths	Percentage excess
I	Infections	188,884	9,052	179,831	24.47	7,350	8,553	85.93
II	Cancers	252,701	17,470	235,230	18.88	12,461	14,956	83.32
III	Blood	15,451	1,006	14,444	24.82	582	677	85.97
IV	Endocrine	92,695	4,505	88,190	17.24	5,115	5,822	87.86
V	Mental	1,499	116	1,383	23.44	59	75	78.67
VI	Nervous system	19,616	1,609	18,006	22.82	789	986	80.02
VII	Ocular	0	0	0	0	0	0	0
VIII	Ear diseases	0	0	0	0	0	0	0
IX	Circulatory	751,786	125,076	626,710	13.21	47,457	65,229	72.75
X	Respiratory	190,671	29,312	161,359	16.61	9,717	13,469	72.14
XI	Digestive	45,047	3,878	41,169	17.42	2,363	2,876	82.16
XII	Dermatological	616	109	507	16.37	31	36	86.11
XIII	Musculoskeletal	2,606	258	2,348	27.63	85	112	75.89
XIV	Genitourinary	62,247	3,408	58,839	22.63	2,600	3,016	86.21
XV	Pregnancy and child birth	7,454	76	7,377	49.52	149	151	98.68
XVI	Perinatal	14,060	1,532	12,527	70.38	178	223	79.82
XVII	Malformations	2,674	376	2,297	45.06	51	64	79.69
XVIII	Other	153,318	20,436	132,881	18.57	7,154	9,416	75.98
XX	External causes	3,067	1,183	1,884	22.98	82	123	66.67

Source: Author's calculations.
Note: YLL, LY, net YLL per ICD disease category between 2016 and 2019. This table also shows the average YLL per death, which are the average life years lost for each premature death. The column showing excess deaths includes the individuals who die before the expected age according to their disease in the mortality database. The average years for each premature mortality are calculated by dividing these two (column 3 by column 5). By dividing column 5 by column 6, we obtain the last column representing the percentage of total deaths attributed to the disease.

FIGURE 3 Quality of life scores per age group and sex at birth



Source: Claxton (2015) and author's calculations.
Note: The weightings of the panel on the left-hand side correspond with those foreseen by Claxton et al. (2015). In the panel on the right-hand side, the weights are adjusted to replicate the average observed in each age group for the case of the Caribbean described in Bailey et al. (2022).

To describe this more formally, the previous methodologies allow us to calculate the weighting that each year of life has per age and per sex, which we will identify as $Q_{a,s} \in [0,1]$.

Therefore, we can calculate the QALYs in the following way:

$$\text{QALY}_i = \sum_{a=M_i}^{L_i} Q_{a,S_i}$$

where $L_i = \mathrm{E}[M_i | S_i = s, E_i = j]$ is the life expectancy calculated in table 2.

Naturally, by introducing quality of life, the 'quantity' of life lost is less than when all years are weighted equally. At the same time, the life years gained, meaning the occasions when the individual exceeds the life expectation, will be diminished since these years won´t be lived in a perfect health state. As a result, the net years of life lost, adjusted by quality of life, will be less than their counterparts which are not weighted. A comparison of these measurements in the case of the Dominican Republic is shown in table 4.

TABLE 4 Years of life lost versus quality-adjusted years of life lost, 2016-2019

Category ICD-10	Type of disease	No adjustment			Quality-adjusted		
		YLL	LY	Net YLL	YLL	LY	Net YLL
I	Infections	188,884	9,052	179,831	166,353	6,953	159,399
II	Cancer	252,701	17,470	235,230	213,957	14,604	199,353
III	Blood	15,451	1,006	14,444	13,475	778	12,698
IV	Endocrine	92,695	4,505	88,190	79,062	3,478	75,584
V	Mental	1,499	116	1,383	1,324	97	1,227
VI	Nervous system	19,616	1,609	18,006	17,249	1,222	16,027
VII	Ocular	0	0	0	0	0	0
VIII	Ear diseases	0	0	0	0	0	0
IX	Circulatory	751,786	125,076	626,710	633,209	97,811	535,398
X	Respiratory	190,671	29,312	161,359	165,885	22,324	143,561
XI	Digestive	45,047	3,878	41,169	39,119	2,978	36,141
XII	Dermatological	616	109	507	521	77	443
XIII	Musculoskeletal	2,606	258	2,348	2,276	192	2,084
XIV	Genitourinary	62,247	3,408	58,839	54,205	2,707	51,498
XV	Pregnancy and childbirth	7,454	76	7,377	6,583	52	6,532
XVI	Perinatal	14,060	1,532	12,527	12,812	1,046	11,766
XVII	Malformations	2,674	376	2,297	2,442	265	2,178
XVIII	Other	153,318	20,436	132,881	131,524	15,807	115,717
XX	External causes	3,067	1,183	1,884	2,764	856	1,908

Source: Author's calculations.
Note: Comparison between the years of life lost versus those of life lost adjusted by quality of life for each category ICD-10.

2.1.3. Disability-adjusted life years

A disease does not only cause a person's death, but it also reduces their quality of life even if they are still alive. Therefore, it is necessary to make an additional adjustment according to the disease's burden to better reflect the incidence of a particular disease. To address this matter a final adjustment is usually made corresponding to the QALYs, known as the disability-adjusted life years (DALYs). Intuitively, a disability-adjusted life year corresponds to the number of years **in perfect health** lost due to a disease.

In order to calculate the DALYs, the years of life lost to due to premature mortality have to be summed up with the years of life lost due to the disease *j* while alive (which we identify as $YLD_{i,j}$[4]):

$$\text{DALY}_i = \text{QALY}_i + \text{YLD}_{i,Ei}$$

To calculate ($YLD_{i,j}$), we used the Dominican Republic estimations, available at the Global Burden of Disease Collaborative Network (2019). As Claxton *et al.* (2015) indicate, there are two main limiting factors of this source of information. The first one is that the codes used to categorize the diseases differ from those of the ICD-10. Therefore, it is necessary to convert the data between those two systems. Fortunately, the network itself provides a conversion table, allowing for the conversion between both categories.

The second factor is that those years of life are not measured with the same scale as the QALYs, meaning they are not deducted from the health questionnaire EQ-5D. Hence, the authors recommend taking this into account at the time of interpreting the results. In the case of an individual who suffers from different diseases, the years of life lost due to the disease are added for each disease.

Claxon *et al.* (2015) indicates that, in addition to being a direct measurement of the burden of a particular disease on the health care system, DALYs are also helpful to understanding *in which way* the disease generates problems in society. Therefore, they suggest calculating the ratio as follows:

$$R_i = \frac{DALY_i}{AVP_i} = \frac{QUALY_i}{AVP_i} + \frac{YLD_i}{AVP_i}$$

It has to be noted that due to the construction, $0 < \frac{QALY}{AVP} < 1$,

but that $\frac{YLD}{AVP}$ can have an arbitrary magnitude.

If $R_i = 1$, this means that each year lost due to mortality would have been lived in perfect health. Therefore, if $R_i < 1$, the ratio suggests that the majority of the burden imposed on the individual is due to their premature death. On the contrary, if $Ri > 1$, this implies that the burden the disease imposed on the individual is due to the loss of quality of life, whilst alive and suffering from the disease. The distribution of these ratios in the Dominican case for each category can be found in table 5.

2.1.4. Standard expected years of life lost (SEYLL)

Finally, the last step consists of aggregating DALYs in a quantity that captures the impact of a disease in a certain place and a certain year. For this purpose, Marshall (2010) and Claxton *et al.* (2015) underline that it is important to consider two aspects: 1) that the measurement can be interpreted as years of life lost in a specific year (so it makes sense to compare the spending in a specific year) and 2) for it to reflect the population structure of a place.

In the previous steps, we have described how to calculate the disability-adjusted life years of a person i, who dies at the age a due to a disease j, in the municipality m, in the year t, and which we describe as $DALY_i = DALY_{i,a,j,m,t}$. Next, we have to calculate the Standard Expected Years of Life Lost $SEYLL_{j,m,t}$, including the information we have related to each individual. **We defined specific quantities of interest:**

- » $DALY_{a,j,m,t}$:= The total number of healthy life years lost in the population with age *a*, in the municipality *m*, due to the disease *j* in the year *t*. This is the sum of all the net DALYs lost in this population.
- » $P_{a,j,m,t}$:= The quantity of deaths of individuals at age a, in the municipality *m*, due to the disease *j* in the year *t*.
- » $P^*_{a,m}$:= The number of individuals at age *a*, included in the population of municipality *m*. This information is available at National Statistics Office (Oficina Nacional de Estadística - ONE). Therefore, the total number of people in the municipality is:

$$P^*_m = \sum_a P^*_{ma}$$

Therefore:

$$\text{SEYLL}_{j,m,t} = \sum_a \frac{QALY_{a,j,m,t}}{P_{a,j,m,t}} \frac{P_{a,m}}{P_m}$$

Simply put, the first parenthesis stands for the healthy years of life lost due to death in an age group. The second parenthesis represents this group's weight in the municipality's population. Based on this, SEYLLj,m,t is interpreted as the number of life years in perfect health lost due to a disease, per person in a particular year.

TABLE 5 Ratios of burden of disease per type of disease, 2016-2019

Categories ICD-10	Type of disease	Median [Percentile 5, Percentile 95]		
		Burden whilst alive	Burden due to premature death	Total burden
I	Infections	0.02 [0.00, 1.08]	0.88 [0.77, 0.92]	0.91 [0.81, 1.92]
II	Cancers	0.02 [0.00, 0.47]	0.84 [0.66, 0.89]	0.87 [0.74, 1.26]
III	Blood	0.01 [0.00, 0.85]	0.87 [0.66, 0.92]	0.89 [0.75, 1.74]
IV	Endocrine	0.46 [0.13, 3.73]	0.85 [0.71, 0.90]	1.30 [1.01, 4.59]
V	Mental	0.02 [0.00, 1.45]	0.89 [0.57, 0.92]	0.91 [0.75, 2.36]
VI	Nervous system	0.06 [0.00, 1.00]	0.87 [0.71, 0.92]	0.93 [0.84, 1.77]
IX	Circulatory	0.09 [0.00, 2.30]	0.83 [0.50, 0.90]	0.93 [0.77, 3.03]
X	Respiratory	0.04 [0.00, 1.83]	0.87 [0.71, 0.92]	0.91 [0.80, 2.63]
XI	Digestive	0.75 [0.00, 9.68]	0.87 [0.73, 0.91]	1.62 [0.81, 10.52]
XII	Dermatological	0.01 [0.00, 0.31]	0.80 [0.00, 0.89]	0.85 [0.50, 0.97]
XIII	Musculoskeletal	0.03 [0.01, 0.48]	0.87 [0.76, 0.91]	0.91 [0.82, 1.35]
XIV	Genitourinary	0.08 [0.00, 0.97]	0.87 [0.73, 0.92]	0.96 [0.83, 1.81]
XV	Pregnancy and childbirth	0.29 [0.00, 1.27]	0.88 [0.87, 0.90]	1.17 [0.89, 2.14]
XVI	Perinatal	0.64 [0.16, 0.80]	0.91 [0.91, 0.91]	1.56 [1.07, 1.72]
XVII	Malformations	0.01 [0.00, 0.31]	0.91 [0.00, 0.94]	0.92 [0.84, 1.21]
XVIII	Other	0.01 [0.00, 0.99]	0.84 [0.62, 0.91]	0.87 [0.70, 1.77]
XX	External causes	0.01 [0.00, 0.03]	0.91 [0.74, 0.93]	0.91 [0.82, 0.95]

Source: Author's calculations.

2.2. STEP 2: ESTIMATING ELASTICITY

A crucial step in calculating the Cost-Effectiveness Threshold is to relate how effective health spending is when trying to diminish the disease burden. Traditionally, this relationship is represented by an elasticity which relates to how percentage changes in health spending per capita translate to percentage changes in the burden of disease on the health care system. Econometrically speaking, this elasticity can be estimated through a model of linear regression defined as:

$$sinh^{-1}(\mathrm{SEYLL}_{j,m,t}) = \beta \sinh^{-1}(G_{j,m,t}) + \delta_j + \lambda_{m,t} + \epsilon_{j,m,t}$$

where $G_{j,m,t}$ is the spending per patient (at constant prices 2016) destined to attend the disease *j* in the municipality *m* in the year *t*. δ_j are fixed effects of the disease, while $\lambda_{m,t}$ model differential tendencies in time of a municipality (e.g., its population, its public spending, etc.).

The target parameter is β, which can be interpreted as the health spending elasticity after a minor adjustment. Nevertheless, estimating this quantity is difficult since the model shows a clear endogeneity problem. As an example, an increased spending generates less results to combat adverse health, while at the same time, historically, increased health problems or mortality generated a higher spending level. Therefore, the estimation based on the least squares method would result in inconsistent estimators of the target parameter.

To solve the endogeneity problem, we opted we chose the instrumental variables estimation model. It is important to mention that this solution is commonly used in the literature in order to solve the endogeneity problem (Claxton *et al.* 2015, Espinosa *et al.* 2021; Martin *et al.* 2021). Nevertheless, we suggest a new instrumental variable based on an exclusion principle like in Benson *et al.* (2019).

For each municipality m ϵ M = {1,⋯,*M*}, we define as N(*m*) $\subseteq$ M the total of geographical neighbors of m. Furthermore, we consider that the relation defined by geographical vicinity is not reflexive, i.e., m/ϵ N(*m*). We define the average spending of the neighbors of *m*, in the position *j* and in the year *t* as

$$Z_{m,j,t} = \begin{cases} \frac{1}{\#|\mathcal{N}(m)|} \sum_{n \in \mathcal{N}(m)} G_{n,j,t} \\ \mathbf{0} \end{cases}$$

si $\mathbf{N}(m) \neq \emptyset$, otherwise.

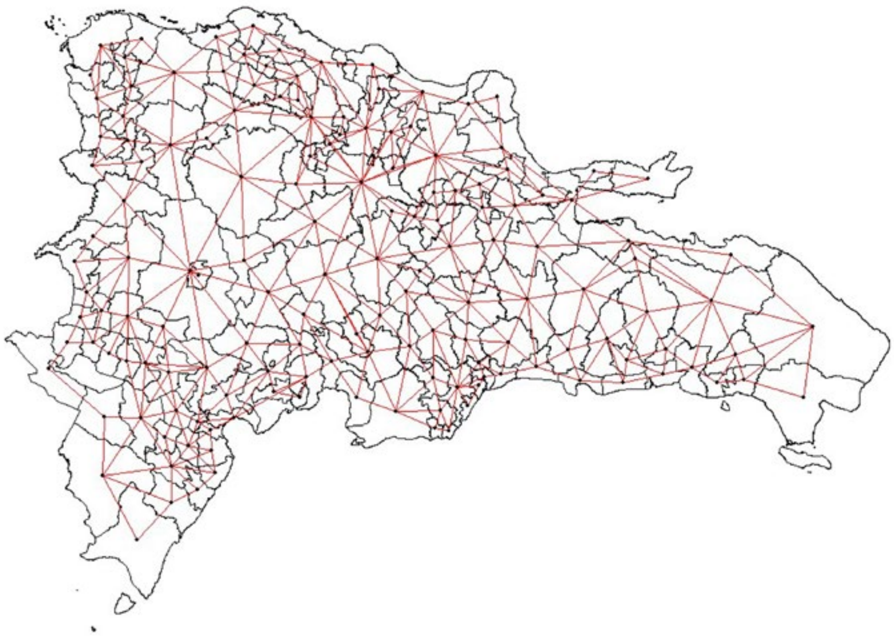
The idea is that $Z_{m,j,t}$ is the instrument of $G_{m,j,t}$. Therefore, using this instrument solves the endogeneity problem any time that two conditions are met: relevance and exogeneity.

In order to guarantee relevance it is necessary that $\mathrm{Cov}(Z_{m,j,t}\epsilon_{m,j,t}|\delta_j,\lambda_{m,t})$/= 0, which means that the observed spending in a municipality correlates, to some extent, to the observed spending of the neighboring municipalities. This is reasonable since the increases in the budget and the budget cuts are generally done at a national level, as well as the governmental initiatives which aim at a particular disease *j*.

To comply with the second condition, exogeneity, the following criteria have to be met: Cov($Z_{m,j,t}\epsilon_{m,j,t}|\delta_j,\lambda_{m,t}$) = 0. Briefly, what this assumption implies is that, given the characteristics of a disease *j* (for example for it to be very contagious or mortal, etc.) and the natural development of a municipality m over time (for example its population, municipal budget, etc.), the health expenditure of the neighbors does not have an impact on the health results observed within the municipality m. Given the fact that the municipality is not part of its neighboring communities, $Z_{m,j,t}$ does not contain spending on health benefits. Therefore, it is not feasible to think that the spending on health of other municipalities will positively impact the health services provided in the municipality of interest. This is less plausible due to the flexibility of the fixed effects, where we are looking at the reassignments of health expenditure to a specific disease, given a certain level of spending and spending tendency.

Finally, it is important to note that this is not the only way to define the instrument since it is possible to pair neighboring municipalities differently. Other methods, which are common in spatial econometrics, are to take the closest neighbors *k* (not depending on whether they share borders or not) or to consider all the municipalities simultaneously but by weighting their importance by the reciprocal value of the distance to the county seat (cabecera municipal). For this reason, we show that our strategy is robust to these different ways of formulating the instrument.

FIGURE 4 Network of geographical vicinity - Dominican Republic



Source: Author's calculations.
Note: Network of municipalities which share borders.

2.3. STEP 3: CALCULATION OF THE COST-EFFECTIVENESS THRESHOLD

As a final step, we will use the results of the previous model to estimate the Cost-Effectiveness Threshold, as suggested by Claxton *et al.* (2015). The Cost-Effectiveness Threshold consists of:

$$k = \frac{\Delta G}{\Delta \mathrm{SEYLL}} = \frac{\bar{G}}{\bar{\hat{\xi}}\mathrm{SEYLL}} = \frac{\sqrt{1+\bar{G}^2}}{\beta\sqrt{1+\mathrm{SEYLL}^2}}$$

where k represents the health spending necessary to reduce one unit of SEYLL. This is equivalent to the average health spending (G) and the proportion of average health. which changes according to changes in the spending ($\hat{\xi}$ SEYLL). $\hat{\beta}$ is the parameter of the estimation model using the least squares method in two steps.

3. RESULTS

Based on the strategy described in section 2, we calculated the Cost-Effectiveness Threshold for the Dominican Republic. The results of the main strategy can be found in table 6.

Each column is the result of implementing the methodology described in section 2.2., with different combinations of fixed effects. Panel A shows the estimation of parameter $\hat{\beta}$, which is a result of the method of least squares in two steps, while panel B shows the elasticity. Finally, Panel C offers the estimation of the Cost-Effectiveness Threshold, together with its standard error and corresponding confidence interval at a 95% confidence level. It has to be noted that the instrument used is relevant and very strong regarding all specifications, since it exceeds the threshold of 104.7 of the statistic F proposed by Lee *et al.* (2022), which is necessary to avoid significant distortions which could be the result of a possible correlation of the instrument with the variable of interest. Therefore, the method of instrumental variables is a reliable option for estimating the interest elasticity.

The Cost-Effectiveness Threshold for the Dominican Republic, according to the preferred specifications (column 3) is 85,928 Dominican pesos, with a confidence interval of [40, 720, 131, 140], which corresponds to 26% [12,3%, 39,6 %] of GDP per capita in 2016 (331,253 Dominican pesos). This value is relatively stable when it comes to other specifications of fixed effects (columns 1 and 2), which is a good indicator.

Likewise, in table 7 we verify the robustness of our estimation to different instruments. We thereby observe that the CET is of a relatively similar magnitude applying all the other instruments (between 85,928 and 106,480 Dominican pesos), providing additional evidence that our estimation is not sensitive to the instrument chosen. Finally, we see that using the contiguous neighbors seems to be the best specification, since it provides the strongest instrument out of the ones considered, leading to a more precise standard error. This number does not change much if alternatively, QALYs are used instead of DALYs as health measurement, as shown in table 8. In this case, the estimated threshold is 107,476 Dominican pesos. Finally, given the variety of plausible estimators, we follow the approach from Lavancier & Rochet (2016) to produce the best estimand possible of the threshold by averaging 2SLS in table 9 so as to minimize finite-sample bias and improve precision. These are our preferred estimates.

Furthermore, we explored how stable this value is over time when estimating the CET for each year in the sample. The results of this exercise can be found in table 10. We can observe much more variability in this exercise, where CETs are estimated from 49,041 to 199,291, which can be attributed to the reduced sample used in this estimation. Nevertheless, in all cases, the yearly confidence intervals intersect with those of the combined sample, which is a good indicator that these quantities don't differ statistically. However, the estimate of the sample is much more precise.

TABLE 6 Cost-Effectiveness Threshold, 2016-2019

	(1)	(2)	(3)
Panel A. *Estimation of the model*			
Model parameter	-0.329	-0.315	-0.354
	(0.108)	(0.112)	(0.113)
Panel B. *Expenditure elasticity*			
Elasticity	-0.333	-0.319	-0.358
	(0.110)	(0.113)	(0.115)
Panel C. *Cost-Effectiveness Threshold*			
Threshold [Miles DOP]	92.515	96.633	85.928
	(30.536)	(34.357)	(27.488)
	[42.289,142.742]	[40.12,153.15]	[40.72,131.14]
Observations	10.630	10.630	10.626
Kleibergen-Paap F	146.41	188.10	158.20
Fixed effects			
Type of disease	✓	✓	✓
Municipality	✓	✓	
Year		✓	
Municipality × Year			✓

Source: Author's calculations.
Note: Standard errors are in parenthesis and intervals at 95% in square brackets. In Panel A, the errors are cluster-type errors grouped by municipality. The standard errors in panels B and C are calculated using the Delta method based on the errors found in Panel A. The regression is weighted by using the municipal population of 2016.

TABLE 7 Cost-Effectiveness Threshold, all IV strategies

	(1) Contiguous Municipalities	(2) Five closest neighbors	(3) Ten closest neighbors	(4) Pesos as Reciprocal value to distance
Panel A. *Estimation of the model*				
Model parameter	-0.354	-0.322	-0.319	-0.286
	(0.113)	(0.121)	(0.131)	(0.117)
Panel B. *Expenditure elasticity*				
Elasticity	-0.358	-0.326	-0.323	-0,289
	(0.115)	(0,122)	(0.133)	(0.119)
Panel C. *Cost-Effectiveness Threshold*				
Threshold [Miles DOP]	85.928	94.488	95.215	106.480
	(27.488)	(35.510)	(39.177)	(43.775)
	[40.715,131.142]	[36.079,152.898]	[30.774,159.655]	[34.477,178.483]
Observations	10.626	10.626	10.626	10.626
Kleibergen-Paap F	158.20	54.89	18.50	26.60
Fixed effects				
Type of disease	✓	✓	✓	✓
Municipality × Year	✓	✓	✓	✓

Source: Author's calculations.
Note: Standard errors are in parenthesis and intervals at 95% in square brackets. In Panel A the errors are cluster-type errors grouped by municipality. The standard errors in panels B and C are calculated using the Delta method based on the errors found in Panel A. The regression is weighted by using the municipal population of 2016. Column 1 is the preferred specification. In columns 1 and 2 the average expenditure per capita is used as an instrument among the five and ten closest neighbors, respectively (according to geographical distance). Column 4 is the average expenditure per capita weighted by the reciprocal value of the distance between each pair of municipalities.

TABLE 8 Cost-Effectiveness Threshold, QALYs 2016-2019

	(1)	(2)	(3)
Panel A. *Estimation of the model*			
Model parameter	-0.297	-0.283	-0.316
	(0.107)	(0.110)	(0.111)
Panel B. *Expenditure elasticity*			
Elasticity	-0.302	-0.288	-0.321
	(0.109)	(0.112)	(0.113)
Panel C. *Cost-Effectiveness Threshold*			
Threshold [Miles DOP]	114.471	120.063	107.476
	(41.217)	(46.679)	(37.715)
	[46.675,182.267]	[43.28,196.84]	[45.44,169.51]
Observations	10.630	10.630	10.626
Kleibergen-Paap F	146.41	188.10	158.20
Fixed effects			
Type of disease	✓	✓	✓
Municipality	✓	✓	
Year		✓	
Municipality × Year			✓

Source: Author's calculations.
Note: Standard errors are in parenthesis and intervals at 95% in square brackets. In Panel A, the errors are cluster-type errors grouped by municipality. The standard errors in panels B and C are calculated using the Delta method based on the errors found in Panel A. The regression is weighted by using the municipal population of 2016.

TABLE 9 Cost-Effectiveness Threshold, all IV strategies

	(1) DALY standardized	(2) QALY standardized
Panel A. *Preferred Cost-Effectiveness Threshold*		
Threshold [Miles DOP]	92.242	119.505
	(11.547)	(18.272)
	[73.249,111.235]	[89.450,149.560]
The proportion of GDP per capita (2016)	0.28	0.36
Panel B. *Weight assigned*		
Contiguous municipalities	0.43	0.17
Five neighbors	0.09	0.55
Ten neighbors	0.39	0.14
Reciprocal value to distance	0.09	0.14

Source: Author's calculations.
Note: Average estimator resulting from all IV strategies in Table 7 following Lavancier & Rochet (2016). Variance-covariance matrix of estimated using municipality-clustered bootstrap. Standard errors are in parenthesis and intervals at 95% in square brackets. Column 1 indicates the preferred threshold using as health outcome standardized DALYs. Column 2 indicates the preferred threshold using as health outcome standardized DALYs.

TABLE 10 Cost-Effectiveness Threshold per year, 2016-2019

	(1) Combined sample	(2) 2016	(3) 2017	(4) 2018	(5) 2019
Panel A. *Estimation of the model*					
Model parameter	-0.354	-0.573	-0.124	-0.573	-0.275
	(0.113)	(0.203)	(0.118)	(0.115)	(0.288)
Panel B. *Elasticidad del gasto*					
Elasticity	-0.358	-0.580	-0.125	-0.579	-0.280
	(0.115)	(0.205)	(0.120)	(0.116)	(0.293)
Panel C. *Cost-Effectiveness Threshold*					
Threshold [Miles DOP]	85.928	49.041	199.291	53.619	144.262
	(27.488)	(17.324)	(190.384)	(10.730)	(151.221)
	[40.715,131.142]	[20.546,77.537]	[-113.862,512.445]	[35.970,71.269]	[-104.47,392.998]
Observations	10.626	2.281	2.782	2.794	2.769
Kleibergen-Paap F	158.20	14.24	45.01	30.01	9.71
Fixed effects					
Type of disease	✓	✓	✓	✓	✓
Municipality		✓	✓	✓	✓
Municipality × Year	✓				

Source: Author's calculations.
Note: Standard errors are in parenthesis and intervals at 95% in square brackets. In Panel A the errors are cluster-type errors grouped by municipality. The standard errors in panels B and C are calculated using the Delta method based on the errors found in Panel A. The regression is weighted by using the municipal population of 2016.

A.1. APPENDIX

TABLE A.1 Descriptive statistics for mortality data

Variable	Media	Standard Deviation	Minimum	Median	Maximum
Panel A. Main variables					
Age of death	57.800	28.295	0	65	119
Women	0.410	0.492	0	0	1
Year of birth	1959.311	28.374	1899	1952	2019
Age of death	2017.569	1.121	2016	2018	2019
Panel B. Type of death					
Non-violent	0.846	0.361	0	1	1
Homicide	0.034	0.181	0	0	1
Suicide	0.014	0.118	0	0	1
Work-related accident	0.003	0.050	0	0	1
Traffic accident	0.061	0.239	0	0	1
Other types of accidents	0.020	0.140	0	0	1
Undetermined	0.014	0.118	0	0	1
Panel C. Number of death causes registered with ICD codes per deceased person					
0 causes	0.029	0.167	0	0	1
1 cause	0.209	0.406	0	0	1
2 causes	0.275	0.447	0	0	1
3 causes	0.256	0.436	0	0	1
4 causes	0.161	0.367	0	0	1
5 causes	0.050	0.219	0	0	1
6 causes	0.020	0.140	0	0	1

Source: Author's calculations.
Note: Number of observations: 179,852.

TABLE A.2 National Life Table I, 2015-2020 (Men - Women)

Age	Probability of death	Number of persons alive (per 100k)	Additional life expectancy conditional on having reached the indicated years of life	Probability of death	Number of persons alive (per 100k)	Additional life expectancy conditional on having reached the indicated years of life
0	0.02450	100,000	71.07	0.01845	100,000	76.17
1	0.00199	97,550	71.86	0.00170	98,183	76.58
2	0.00135	97,356	71.00	0.00109	98,016	75.71
3	0.00114	97,225	70.09	0.00072	97,909	74.79
4	0.00049	97.114	69.17	0.00044	97,838	73.84
5	0.00035	97,066	68.21	0.00032	97,795	72.87
6	0.00032	97,032	67.23	0.00028	97,764	71.90
7	0.00029	97,002	66.25	0.00025	97,737	70.92
8	0.00028	96,973	65.27	0.00023	97,712	69.93
9	0.00027	96,946	64.29	0.00023	97,690	68.95
10	0.00027	96,921	63.31	0.00023	97,667	67.97
11	0.00030	96,894	62.32	0.00024	97,645	66.98
12	0.00037	96,865	61.34	0.00026	97,622	66.00
13	0.00050	96,829	60.36	0.00029	97,596	65.01
14	0.00066	96,781	59.39	0.00034	97,567	64.03
15	0.00084	96,717	58.43	0.00038	97,535	63.05
16	0.00102	96,636	57.48	0.00043	97,498	62.08
17	0.00122	96,538	56,54	0.00049	97,456	61.10
18	0.00144	96,420	55.61	0.00056	97,408	60.13
19	0.00168	96,280	54.69	0.00064	97,353	59.17
20	0.00192	96,119	53,78	0.00072	97,291	58.21
21	0.00215	95,935	52.88	0.00080	97,221	57.25
22	0.00233	95,728	51.99	0.00088	97,144	56.29
23	0.00244	95,505	51.11	0.00095	97,059	55.34
24	0.00249	95,272	50.24	0.00101	96,967	54.39
25	0.00253	95,034	49.36	0.00108	96,869	53.45
26	0.00257	94,794	48.49	0.00115	96,764	52.50
27	0.00261	94,550	47.61	0.00121	96,653	51.56
28	0.00266	94,303	46.73	0.00128	96,536	50.63
29	0.00271	94,052	45.86	0.00134	96,413	49.69
30	0.00276	93,797	44.98	0.00140	96,284	48.76
31	0.00281	93.538	14.10	0.00147	96,149	17.82
32	0.00286	93.276	43.23	0.00154	96,008	46.89
33	0.00293	93,009	42.35	0.00161	95,861	45.97
34	0.00302	92,736	41.47	0.00168	95,707	45.04
35	0.00311	92.456	40.60	0.00176	95,546	44.11
36	0.00321	92,168	39.72	0.00185	95,377	43.19
37	0.00332	91,872	38.85	0.00195	95,201	42.27
38	0.00343	91.567	37.97	0.00206	95,016	41.35
39	0.00355	91,253	37.10	0.00218	94,820	40.43
40	0.00369	90,929	36.23	0.00232	94,614	39.52
41	0.00385	90,594	35.37	0.00248	94,394	38.01
42	0.00403	90.245	34.50	0.00263	94,160	37.71
43	0.00422	89,882	33.64	0.00277	93,913	36.81
44	0.00444	89,503	32.78	0.00290	93,654	38.61
45	0.00467	89.106	31.92	0.00305	93,382	35.01
46	0.00495	88,689	31.07	0.00323	93,098	34.11
47	0.00531	88,250	30.22	0.00349	92,797	33.22
48	0.00578	87,782	29.38	0.00384	92,474	32.34
49	0.00634	87,274	28.55	0.00426	92,120	31.46
50	0.00695	86,721	27.73	0.00472	91,729	30.59

Source: Oficina Nacional de Estadística (ONE). República Dominicana.
Note: National Life Table for the Dominican Republic. The column `probability of death' is the mortality rate between the age x y (x + 1), meaning, the probability that a person of exact age x dies before reaching the age of (x + 1). The column `number of persons alive (per 100k)' is the number of survivors up to the exact age x out of 100,000 born alive with the same sex. Finally, the column 'Additional life expectancy conditional on having reached the indicated years of life' refers to the life expectancy of the average period reaching the age of x, meaning the average number of life years those of the exact age of x are going to live afterwards.

TABLE A.3 National Life Table II, 2015-2020 (Men - Woman)

Age	Probability of death	Number of persons alive (per 100k)	Additional life expectancy conditional on having reached the indicated years of life	Probability of death	Number of persons alive (per 100k)	Additional life expectancy conditional on having reached the indicated years of life
51	0.00759	86,118	26.92	0.00521	91,297	29.73
52	0.00824	85.465	26.12	0.00571	90,822	28.89
53	0.00888	84,761	25.33	0.00621	90,306	28.05
54	0.00953	84,008	24.56	0.00673	89,746	27.22
55	0.01023	83,208	23.79	0.00730	89,145	26.40
56	0.01100	82,357	23.03	0.00792	88,496	25.59
57	0.01179	81,451	22.28	0.00853	87,798	24.79
58	0.01262	80,490	21.54	0.00911	87,053	24.00
59	0.01350	79,474	20.81	0.00970	86,263	23.21
60	0.01441	78,402	20.08	0.01031	85,431	22.44
61	0.01542	77,272	19.37	0.01101	84,555	21.66
62	0.01661	76,081	18.67	0.01190	83,629	20.90
63	0.01806	74,817	17.97	0.01302	82,640	20.14
64	0.01971	73,406	17,29	0.01434	81,571	19.40
65	0.02158	72,018	16.63	0.01587	80,409	18.67
66	0.02353	70,464	15.99	0.01750	79,143	17.96
67	0.02544	68,806	15.36	0.01907	77,770	17.27
68	0.02723	67,055	14.75	0.02049	76,301	16.59
69	0.02901	65,229	14.15	0.02189	74,753	15.93
70	0.03069	63,337	13.56	0.02314	73,134	15.27
71	0.03265	61,394	12.97	0.02469	71,462	14.61
72	0.03547	59.389	12.39	0.02732	69,719	13.97
73	0.03954	57,283	11.83	0.03148	67,840	13.34
74	0.04463	55,018	11.29	0.03688	65,737	12.75
75	0.05047	52,562	10.80	0.04318	63,357	12.21
76	0.05633	49,910	10.35	0.04939	60,678	11.73
77	0.06159	47,098	9.93	0.05462	57,754	11.30
78	0.06565	44,198	9.55	0.05805	54,683	10.90
79	0.06876	41,296	9.19	0.06002	51,599	10.52
80	0.07164	38,456	8.83	0.06147	48,592	10.14
81	0.07500	35,702	8.47	0.06343	45,694	9.76
82	0.07887	33,024	8.12	0.06613	42,885	9.36
83	0.08362	30.419	7.77	0.07022	40,139	8.97
84	0.08922	27,876	7.43	0.07557	37,416	8.58
85	0.09544	25,389	7.11	0.08160	34,692	8.22
86	0.10190	22,966	6.81	0.08767	31,972	7.88
87	0.10845	20,626	6.53	0.09384	29,286	7.55
88	0.11470	18.389	6.26	0.09976	26,661	7.25
89	0.12069	16,280	6.01	0.10551	24,128	6.96
90	0.12673	14,315	5.76	0.11140	21,710	6.67
91	0.13325	12,501	5.53	0.11782	19,419	6.40
92	0.14064	10,835	5.30	0.12509	17,258	6.14
93	0.14916	9,311	5.09	0.13339	15,227	5.89
94	0.15873	7,922	4.89	0.14257	13,322	5.67
95	0.16882	6,665	1.72	0.15215	11,549	5.46
96	0.17807	5,540	4.57	0.16114	9,916	5.28
97	0.18380	4,553	4.46	0.16774	8,438	511
98	0.18147	3,716	1.35	0.16897	7,132	1.96
99	0.16505	3,042	4.20	0.16026	6,021	4.78
100+	1.00000	2,540	3.93	0.22098	5,127	4.53

Source: Oficina Nacional de Estadística (ONE). República Dominicana.
Note: National Life Table for the Dominican Republic. The column `probability of death' is the mortality rate between the age x y (x + 1), meaning, the probability that a person of exact age x dies before reaching the age of (x + 1). The column `number of persons alive (per 100k)' is the number of survivors up to the exact age x out of 100,000 born alive with the same sex. Finally, the column 'Additional life expectancy conditional on having reached the indicated years of life' refers to the life expectancy of the average period reaching the age of x, meaning the average number of life years those of the exact age of x are going to live afterwards.

A.2. APPENDIX

The following table shows CET biased estimators using ordinary Least Squares without instrumental variables. None of the estimators is statistically significant.

TABLE A.4 Cost-Effectiveness Threshold, Ordinary Least Squares

	(1)	(2)	(3)
Panel A. *Estimation of the model*			
Model parameter	-0.003	0.006	-0.011
	(0.010)	(0.009)	(0.010)
Panel B. *Expenditure elasticity*			
Elasticity	-0.003	0.006	-0.011
	(0.010)	(0.009)	(0.010)
Panel C. *Cost-Effectiveness Threshold*			
Threshold [Miles DOP]	9484.010	-5324.343	2737.981
	(30560.843)	(8383.620)	(2459.151)
	[-40784.103, 59752.123]	[-19100, 8465.485]	[-1306.963, 6782.925]
Observations	10714	10714	10710
Fixed effects			
Type of disease	✓	✓	✓
Municipality	✓	✓	
Year		✓	
Municipality × Year			✓

Source: Author's calculations.
Note: Standard errors in parenthesis and 95% confidence intervals in squared brackets. In panel A, errors are clustered at the municipality level. The standard errors in panel B and Panel C are calculated using the delta method, using those found in panel A as reference. The regression was weighted by the total population in each municipality in 2016.

ENDNOTES

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[2] YLL - Years of life lost, DALYs - disability-adjusted life year, SEYLL - Standard expected years of life lost.

[3] We refer to a cell as a particular level of aggregation, for example, this could be at the level of municipality-disease-age, municipality-age, year, etc.

[4] YLD (Years of healthy life lost due to disability). One YLD represents the equivalent of one full year of healthy life lost due to disability or ill-health.

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