Self-affine Characteristics of the Philippine Health Expenditure

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Abstract: The notion of having an efficient health system at a cost–effective value for money, is of most interest to policymakers (Mirella, 2013). Health care financiers including governments, insurers and households are interested in knowing which health system has the largest health benefitsyet spends at a minimal cost (Tulchinsky,2014). Cross-country comparison and benchmarkingare useful tools to assess and compare health systems. However, frail comparisons of health systems may bring inaccurate insights to policy makers (Lopes, 2015). Thus, this study will generate a scale that compare countries accurately by addressing the fractality of the data.The Current health expenditure data is highly fractal with highly unequal distribution of health spending globally. Because of the wide disparity of data, median is the best positional average to use instead of the mean. This will give a more accurate representation of the health spending of all countries. Through fractal analysis we can generate a scale that will place corresponding countries on a continuum with respect to their CHE for cross country comparisons. Through generating a scale that can place countries in a continuum, there will be a fair comparison of the health outcomes.This CHE scale is a better reference because it addresses the fractality of the CHE data. Those belonging to the same cluster are self-affine countries. Self-affine countries are similarly comparable enough to make a fair comparison of health outcomes. Nine scales were created. Countries belonging to the same scale are comparably similar enough to make an inferential finding. In line with the findings of the study, the following conclusions were drawn: (1) That the fractal dimension of current health index of 2015 is 1.003 which means that the extent of self-similarity is low; (2) that the generated scaling may be used for comparison for self-affine countries; (3) the Philippines can benchmark from self-affine countries.

1. Introduction

The notion of having an efficient health system at a cost–effective value for money, is of most interest to policymakers (Thomas, 2016). Health care financiers, including governments, insurers, and households, are interested in knowing which health system has the largest health benefitsyet spends at a minimal cost (Tulchinsky,2014). Although benchmarking are useful tools to assess and compare health systems, if used inaccurately, inconsistencies may arise. Frail comparisons of health systems may bring inaccurate insights to policy makers (Lopes, 2015). For example, a cross-country comparison based on Gross Domestic Product (GDP). A country with per capita income of US$5,000–US$6,000 could compare itself to countries with similar income levels and health outcomes, such as Peru or the Philippines. The two countries have similar child mortality rates (29 per 1,000 for Peru and 34 per 1,000 for the Philippines). Yet public-sector health spending is 2.1 percent of GDP in Peru and only 1.3 percent in the Philippines. Moreover, a comparison is based on good health outcomes, the range of health spending is extensive and rarely gives a clear answer regarding an optimal amount (WHO, 2018).While different studies compare countries according to region, GDP, or health outcomes, this study will come up with a scale that will compare countries based on

their Current Health Expenditure (CHE). This scale will best answer the question, "Which countries are comparably similar enough to make an inferential finding?" Otherwise, assuming normality generates varying estimates that are not borne of data. By generating a scale that can place countries in a continuum, there will be a fair comparison of the health outcomes. This CHE scale is a better reference because it addresses the fractality of the CHE data.

The Current health expenditure data is highly fractal with a highly unequal distribution of health spending globally. To illustrate,in 2016, the world spent US$ 7.5 trillion on health, representing close to 10 percent of global Gross Domestic Product (GDP). Health's share of GDP is greatest in high-income countries, at around 8.2 percent on average. For both low- and middle-income countries, health expenditure is approximately 6.3 percent of GDP. The average per capita health expenditure was US$ 1,000, but half of the world's countries spent less than US$ 350 per person (WHO, 2018). Thus, the distribution of health spending globally remains highly unequal, and this inequity has not shown any signs of significant change since 2000 (Shawiza, 2019). Despite GDP and health spending growing fastest in low- and middle-income countries, a large gap persists between rich and developing countries (WHO, 2018).Because of the wide disparity of data, the median is the best positional average to use instead of the mean. This will give a more accurate representation of the health spending of all countries.

To address the fractal characteristic of the CHE, this study will utilize Fractal Analysis as a methodology. Fractal analysis is used to describe the self-affinity of the data across all scales. Self-affinity and fractional dimensions are vital characteristics of fractal data. If the data, in smaller scales, look the same as on a larger scale, then the data has self-affinity characteristics. The Fractional dimension measures the extent of self-similarity or self-affinity of fractal data. Through fractal analysis, we can generate a scale that will place corresponding countries on a continuum concerning their CHE for cross country comparisons.Those belonging to the same cluster are self-affine countries. Self-affine countries are similarly comparable enough to make a fair comparison of health outcomes. After a scale is generated, this paper will also compare the Philippines to one self-affined country based on the infant mortality rate. Infant mortality rate is an important indicator of health for whole populations, and it has an impact on the mortality rate of infants (Reidpath, 2003).

Comparison to countries with self-affinity to the Philippines will provide the policymakers a clearer benchmark on the successes and failures of health implementation of our policies. Health policy analysis is very important to make health care reform in the Philippines. Through analyzing the health policies, we can maximize the utilization of health budget to the most cost-effective value for the budget.

2. OBJECTIVES OF THE STUDY

This paper sought to investigate current health expenditure worldwide. Specifically, it intends to:
1. Establish the fractal dimension of global Current Health Expenditure per capita in 190 countries.
2. Generate a scale that will place corresponding countries on a continuum concerning their Current Health Expenditure.

3. Make a cross country comparison of the Philippines and its self-affine country on the infant mortality rate.

3. METHODOLOGY

Data Sources

The main source of data was taken from the World Health Organization, last updated in 2018 through data mining. This database contains the Current Health Expenditure in the 190 countries (WHO, 2018). A total of 190 out of 195 countries were included in the study. Countries not included in the study were those who have no data on the WHO datasets. Comparison of the Philippines and a self-affine country is based on the three factors, which are current health expenditure, life expectancy, and infant and under five mortalityrates. The comparison does not analyze conclusions on the total health scenario of both countries.

Data Treatment

This study utilizes a Fractal Analysis. It is used to describe the self-affinity of the data across all scales. Self-affinity and fractional dimensions are vital characteristics of fractal data. If the data, in smaller scales, look the same as on a larger scale, then the data has self-affinity characteristics. The fractional dimension measures the extent of self-similarity or self-affinity of fractal data.

The probability density function (fractal distribution) of a fractal, denoted by f(x), is given by

$$f(x) = \frac{\lambda-1}{\theta}\left(\frac{x}{\theta}\right)^{-\lambda}, \lambda > 1, x > \theta > 0, \qquad (1)$$

$$f(ax) = a^{-\lambda}f(x) \text{ , } a^{-\lambda} \text{ is constant.} \qquad (2)$$

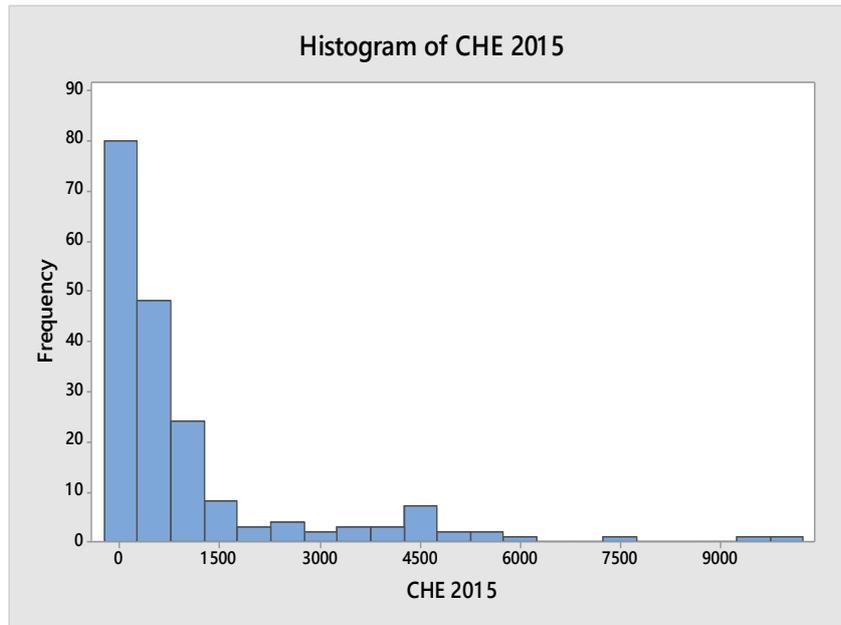By maximum likelihood estimation, the fractal dimension λ is given by

$$\hat{\lambda} = 1 + \frac{1}{\frac{\sum_{i=1}^{n} log\frac{x_i}{\theta}}{n}} \qquad (3)$$

Data Validation

The scale generated was verified by experts in mathematics and statistics.

4. RESULTS AND DISCUSSION

Figure 1 shows the global Current Health Expenditures, 2015 per capita. These are summarized in the form of ahistogram. The graph shows exponential decay.

Figure 1. Histogram of CHE 2015

Figure 2 shows the approximate of the exponential function by polynomial using Taylor's
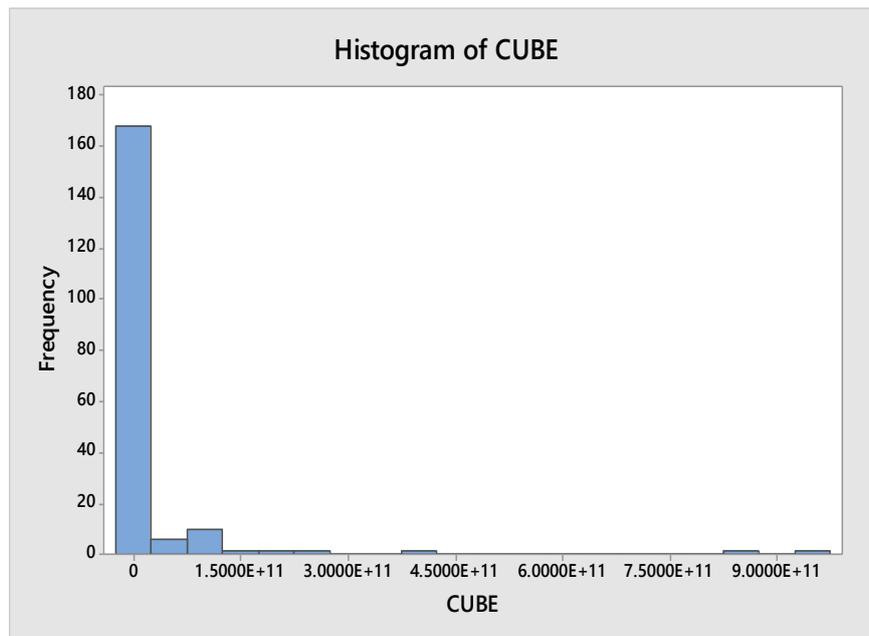
Figure 2. Histogram of Cube of CHE 2015

formula. In this data, polynomial up to degree 3 of the current health expenditure in 2015 was used. The data shows to be fractal, and its fractional dimension is 1.003, which means that the extent of self-similarity is low.

Tabular values show the mean of US$ 1011 and median US$ 366 of the global current health expenditures 2015.The data follows a power-law distribution. This implies that the best positional average is not the mean but the median. 50% (95 out of 190) of the countries have CHE in 2015 lower than or equal to US$ 366.

Descriptive Statistics: CHE 2015										
Variable	N	N*	Mean	SE Mean	St Dev	Minimum	Q1	Median	Q3	Maximum
CHE 2015	190	0	1011	121	1672	17	92	366	979	9818

Table 1. Descriptive Statistics of CHE 2015

Table 2 shows the scale generated through Taylor's formula. Nine scales were created. Countries belonging to the same scale are comparably similar enough to make an inferential finding. For instance, the Philippines is comparable to countries such as Sri Lanka, Sudan, Iraq, Fiji, Indonesia, and Singapore categorized in Scale 4. Furthermore, countries like Thailand and Peru are incomparable to the Philippines because they belong to scale 5. To illustrate the use of the scale, a cross-country analysis between Philippine and Sri Lanka on infant mortality rate is compared.

SCALING OF COUNTRIES								
SCALE 1	SCALE 2	SCALE 3	SCALE 4	SCALE 5	SCALE 6	SCALE 7	SCALE 8	SCALE 9
Central African Republic	Burundi	Lao	Singapore	Thailand	South Africa	Chile	Slovakia	Netherlands
Congo	Ethiopia	Haiti	Kiribati	Tonga	Saint Lucia	Slovenia	Malta	Ireland
Madagascar	Guinea	Mauritania	Angola	San Marino	Seychelles	Estonia	Spain	Australia
	Niger	Rwanda	Indonesia	Guatemala	Sierra Leone	Trinidad and Tobago	Italy	Denmark
	Mozambique	Comoros	Viet Nam	Swaziland	Mauritius	Barbados	Israel	Sweden
	South Sudan	Congo	Sri Lanka	Jordan	Russian Federation	Kuwait	Sao Tome and Principe	Luxembourg
	Benin	Myanmar	Ukraine	Tunisia	Ecuador	Bahrain	Monaco	Norway
	Eritrea	Afghanistan	Philippines	Albania	Mexico	Senegal	New Zealand	USA
	Bangladesh	India	Uzbekistan	Equatorial Guinea	Bulgaria	Uruguay	Japan	Switzerland
	Gambia	Tajikistan	Cabo Verde	Georgia	Suriname	Czechia	Finland	
	Tanzania	Cameroon	Mongolia	El Salvador	Oman	UAE	France	
	Burkina Faso	Liberia	Somalia	Samoa	Lebanon	Palau	Belgium	
	Malawi	Zambia	Sudan	Algeria	Antigua and Barbuda	Greece	Andorra	
	Chad	Cambodia	Iraq	Jamaica	Marshall Islands	Cyprus	United Kingdom	
	Serbia	Kenya	Egypt	Macedonia	Brazil	Bahamas	Iceland	
	Togo	Timor–Leste	Morocco	Belize	Latvia	Portugal	Canada	
	Pakistan	Yemen	Saudi Arabia	Paraguay	Poland	Solomon Islands	Austria	
	Guinea–Bissau	Côte d'Ivoire	Nicaragua	Peru	Brunei Darussalam	Republic of Korea	Germany	
	Mali	Papua New Guinea	Fiji	Belarus	Nauru	Qatar		
	Nepal	Ghana	Honduras	Armenia	Cuba			
	Uganda	Djibouti	Guyana	Iran	Croatia			
		Bhutan	Moldova	Azerbaijan	Niue			
		Lesotho	Bolivia	Colombia	Hungary			
		Kyrgyzstan	Gabon	Kazakhstan	Saint Kitts and Nevis			
		Zimbabwe		Montenegro	Panama			
		Nigeria		Dominica	Lithuania			
		Vanuatu		Malaysia	Costa Rica			
				Botswana	Maldives			
				Micronesia	Venezuela			
				Dominican Republic	Argentina			
				Turkmenistan				
				Namibia				
				China				
				Bosnia and Herzegovina				
				Tuvalu				
				Romania				
				Turkey				
				Grenada				
				Cook Islands				

Table 2. Scaling of Countries

Table 3 shows the comparison of mortality rates (per 1,000 live births) among infants and children under five from countries belonging to scale 4. Sri Lanka, Ukraine, and Saudi Arabia have the lowest incidence of deaths among infants and children under 5. On the other hand, Somalia, Sudan, Guyana, Gabon, and the Philippines and Iraq have the highest incidence of infant mortality rate.

Cross Country Comparison Of Scale 4 On Infant And Child Mortality Rates (UNICEF)		
Countries	Under 5 mortality rate/ 1000 live births (2018)	Infant mortality rate/ 1000 live births
Philippines	28.3718692	22.4568518
Singapore	No data	No data
Indonesia	24.9838841	21.1151951
Vietnam	20.6830167	16.4973136
Sri Lanka	7.44	6.36
Ukraine	8.7346313	7.4788543
Uzbekistan	21.4463869	19.1204735
Cabo Verde	19.5	16.68
Mongolia	16.3241887	14.0368031
Somalia	121.5	76.5722287
Sudan	60.4734228	42.1420328
Iraq	26.7124725	22.4717656
Egypt	21.225325	18.1024784
Morocco	22.4113209	19.2258583
Saudi Arabia	7.0563812	6.0336534
Nicaragua	18.293831	15.6845556
Fiji	25.6209142	21.6197063
Honduras	17.5985716	15.1092552
Guyana	30.1447118	25.1282255
Moldova	15.7913278	13.5831396
Bolivia	26.7950795	21.8392806
Gabon	44.7605326	32.6974635

Table 3. Comparison of Mortality Rates

Sri Lanka VS Philippines: A Comparison
There are several ways of classifying cross-country studies. Cross-country comparison constitutes a diverse inter-disciplinary field of study, which comprises of many factors including 'macro-social units' (Cacace, 2013). Sri-Lanka and Philippines were compared since they both belong to the same scale number 4. Sri Lanka was chosen because it has a low infant mortality rate of 6.36 in contrast to the Philippine's 22.45.

Sri Lanka's expenditure on healthcare is 3.2%of GDP, or US$89 per head, in 2015 (WHO). It's infant mortality rate is 6.36 per 1000 live births. Despite low health expenditure, the country's health care success rivals that of developed countries inregions such as Thailand and Malaysia. Furthermore, despite low expenditure on healthcare Sri Lanka's life expectancy rose from around 60 in 1960 to 74 in 2012 (WHO). The mortality rate for children under five has fallen from 98 per 1,000 live births to 7.44 per 1,000 births in 2018.

A look at Sri Lanka's health care shows universal health coverage provided by the government health system. Primary health care in Sri Lanka is developed as two parallel services: (1)Community health services, focusing mainly on maternal and child health and on communicable diseases and adopting prevention and health promotion strategies, based on the health unit system; (2) Curative services consisting of 496 Divisional hospitals providing both hospitalization and ambulatory services and 474 Primary Medical Care units providing

only ambulatory care which function with non-specialist medical doctors and other staff. (Perera, 2015).

The Philippines, on the other hand has a Current Health Expenditure (CHE) ofUS$3733 or$124 per head.The country also has an infant mortality rate of 22.45. Health has increasingly become more important over the past few decades in the Philippines. Several reform agenda had been implemented to strengthen its health system. In 1991, it had decentralized health governance. In 1995 it introduced PhilHealth, a health insurance program, and in 2010, the Philippines has actively pursued universal health coverage. The national objectives for health (NOH) has well-specified targets, but the progress of local governments towards these targets remains highly uneven. While PhilHealth membership coverage has expanded, its benefits coverage remains mainly for inpatient care, and it provides only limited financial support (WHO, 2018). The limited number of health facilities relative to the growing population contributes to low quality of care. Health outcomes are generally improving, but the stagnant maternal mortality ratio and neonatal rate, and the sluggish degree of improvement in health outcomes compared to neighboring countries. Many Filipinos suffer from diseases that are preventable and treatable with cost-effective interventions. These include HIV, TB, dengue, and VPDs such as measles, and diphtheria. PhilHealth, DOH, and LGU health facilities are spending on the same maternal and child health services. At the same time, the growing cases of Non-communicable disease including the emergency care these conditions often require, are inadequately funded and poorly prioritized (WHO, 2018). The escalating climate change, with the Philippine ranking 3rd in the world in terms of exposure to disaster risks due to strong typhoons, occurring with high regularity, makes a triple burden of disease.

5. CONCLUSION

In line with the findings of the study, the following conclusions were drawn:
1. That the fractal dimension of the current health index of 2015 is 1.003,which means that the extent of self-similarity is low.
2. That the generatedscalingmay be used for comparison for self-affine countries.
3. The Philippines can benchmark from self-affine countries that display low infant and child mortality rates.

6. RECOMMENDATIONS

1. An in-depth study on cross-country comparison of self-affine countries so that best practices may be adapted in the Philippines.
2. A benchmark policy-making tool may be generated based on the findings.

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