Comparing Quality of Life by Human Development Category: Parametric vs. Nonparametric Approaches

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Abstract

Background

As globalism increases across the world, a natural topic of interest is how the world's nations compare with respect to quality of life (QoL). Several organizations monitor global QoL indicators and report single-dimension or aggregate values for indicators of interest. For example, the World Bank reports Gross Domestic Product (GDP), which is a single-dimension indicator often strongly predictive of QoL in a given country (The World Bank (2018)). Additionally, the World Health Organization reports infant mortality rate, life expectancy at birth, and life expectancy at 60 years of age (World Health Organization (2018b), World Health Organization (2018a)).

Other quality of life measures represent compound scores or indices based on several inputs. For example, the United Nations calculates an annual Human Development Index (HDI), representing the developmental level of each country on a scale of zero to one based on several factors, including life expectancy at birth, years of schooling, and per-capita income (The United Nations Development Programme (2018b)). The HDI also categorizes countries into four levels of development (low, medium, high, and very high). Similarly, the Social Progress Imperative publishes the Social Progress Index (SPI), ranging from 0 to 100, and comprising over 50 dimensions in three broad categories: basic human needs (e.g., nutrition, safety), foundations of wellbeing (e.g., basic knowledge, environmental quality), and opportunity (e.g., personal rights, freedoms) (Social Progress Imperative (2018b)). The World Economic Forum's Global Gender Gap Index reports a gender equality index, scaled from 0-1, based on measurements of gender-related gaps in such dimensions as economic participation, level of education, health and survival, and political offices held (World Economic Forum (2016b)). Finally, the World Happiness Report calculates a score from 0-10 by considering per-capita GDP, healthy life expectancy, social support, freedoms, and perception of corruption, among others (Helliwell, Layard, and Sachs (2018)).

The objective of this analysis is to explore the distributions of and relationships between key QoL indicators using both nonparametric and parametric methods, and to assess the appropriateness of each method used.

Methods

A country-level dataset titled `alldata` containing the following variables, all from 2016, was generated for the MAT 8790 course:

Source	Variable Name	Description
`countrycode` package	`country`	Country names
Social Progress Imperative (2018a)	`SPI`	Social Progress Index value (scale of 0:100)
The World Bank (2018)	`GDP_USD_2018`	2016 Gross Domestic Product (valued in $US 2018)
The United Nations Development Programme (2018a)	`HDIrank`	Human Development Index ranking
The United Nations Development Programme (2018a)	`HDIindex`	HDI index value (scale of 0:1)
The United Nations Development Programme (2018a)	`HDI_cat`	HDI index category (5 levels)
Helliwell, Layard, and Sachs (2018)	`happiness`	World Happiness Score (scale of 0:10)
World Economic Forum (2016a)	`genderequality_index`	Gender Equality Index (scale of 0:1)
World Health Organization (2018b)	`infantmort`	Infant mortality rate
World Health Organization (2018a)	`birth_MF`	Life expectancy at birth, males & females
World Health Organization (2018a)	`sixty_MF`	Life expectancy at 60 years, males & females

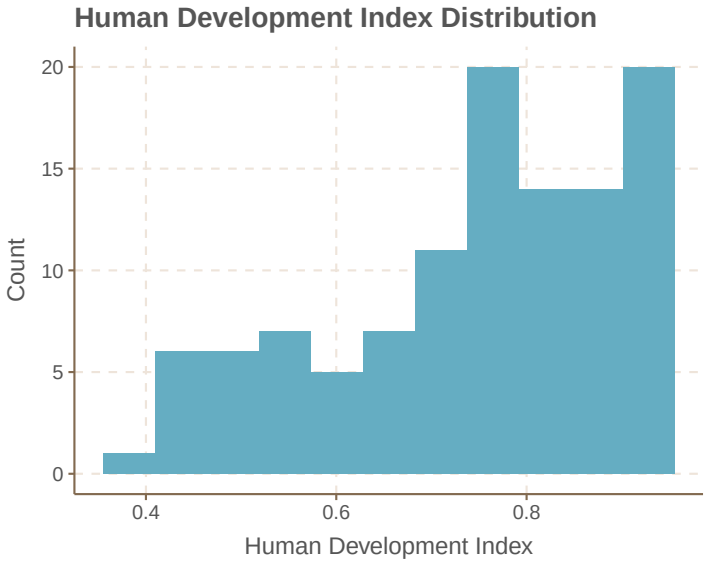
Missing values were omitted from the dataset to ensure that the tests of interest could be performed.

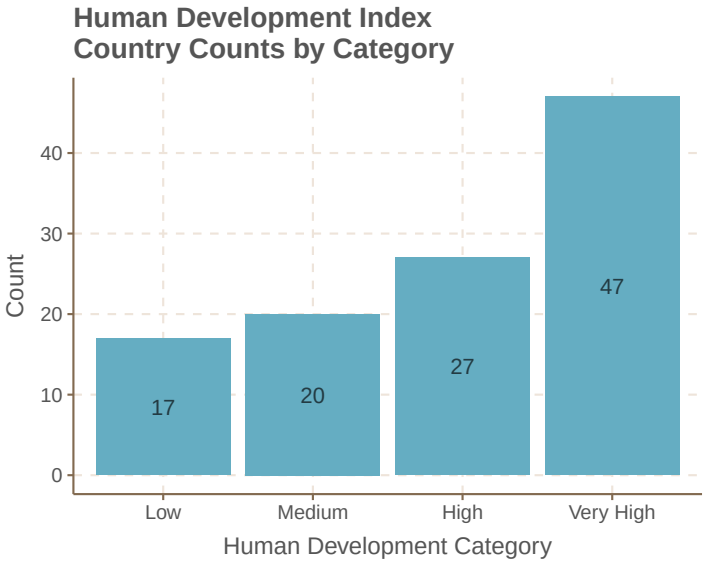
For each variable save `country`, descriptive statistics were run and a sensible visualization was generated, following which a correlation matrix was produced to examine pairwise relationships between continuous variables. Based on these data explorations, several formal hypotheses were generated about the data, and sensible nonparametric tests and their parametric equivalents were performed to assess these hypotheses. Results of these parallel tests were compared in the context of the data and assumptions needed.

Results

Descriptive Statistics and Visualizations

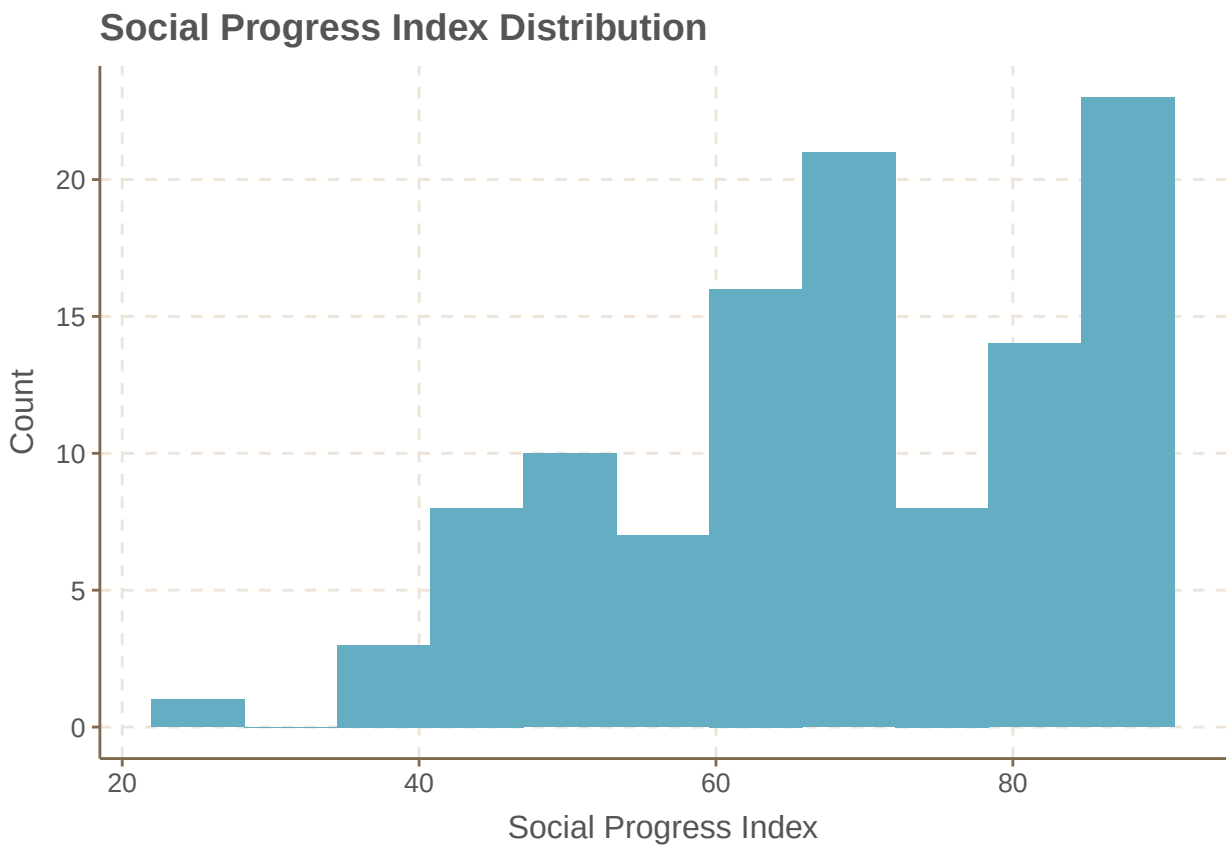
First, exploring the Human Development Index variables:





minimum	q1	median	mean	q3	maximum	sd
0.4053	0.6527	0.7722	0.7446	0.8673	0.9512	0.15

Exploring the Social Progress Index data:

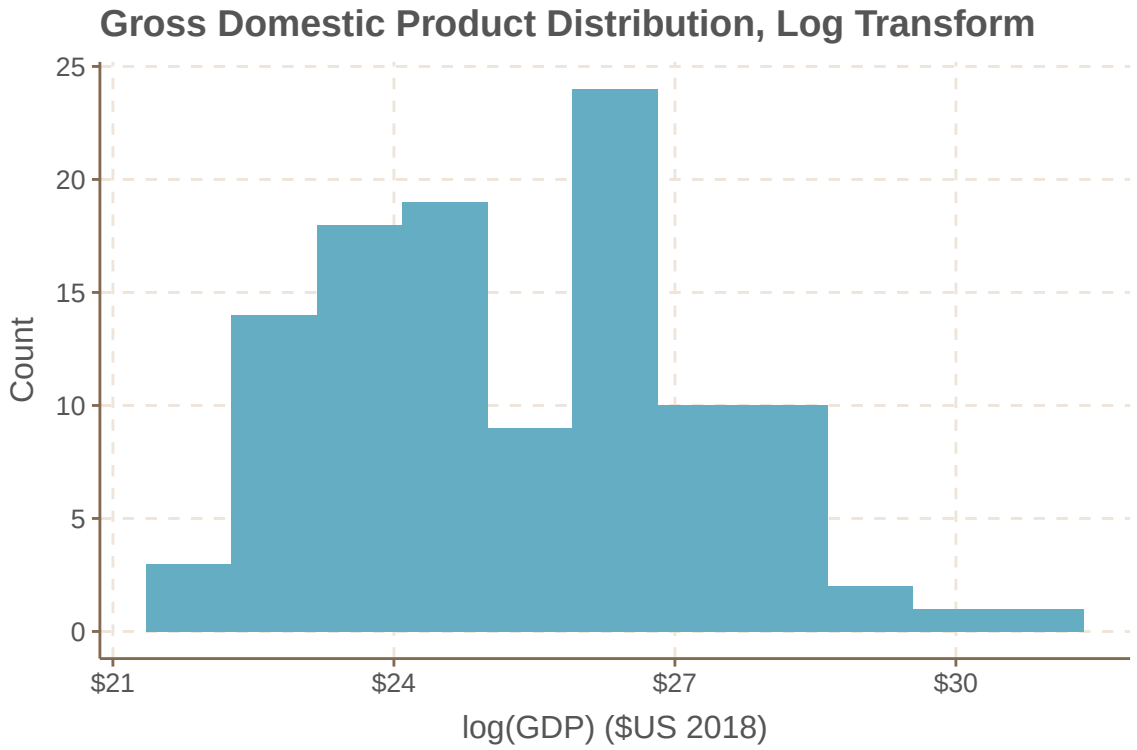


minimum	q1	median	mean	q3	maximum	sd
26.92	58.42	68.94	68.6235	82.37	89.62	15.3807

Next, exploring GDP by summary statistics:

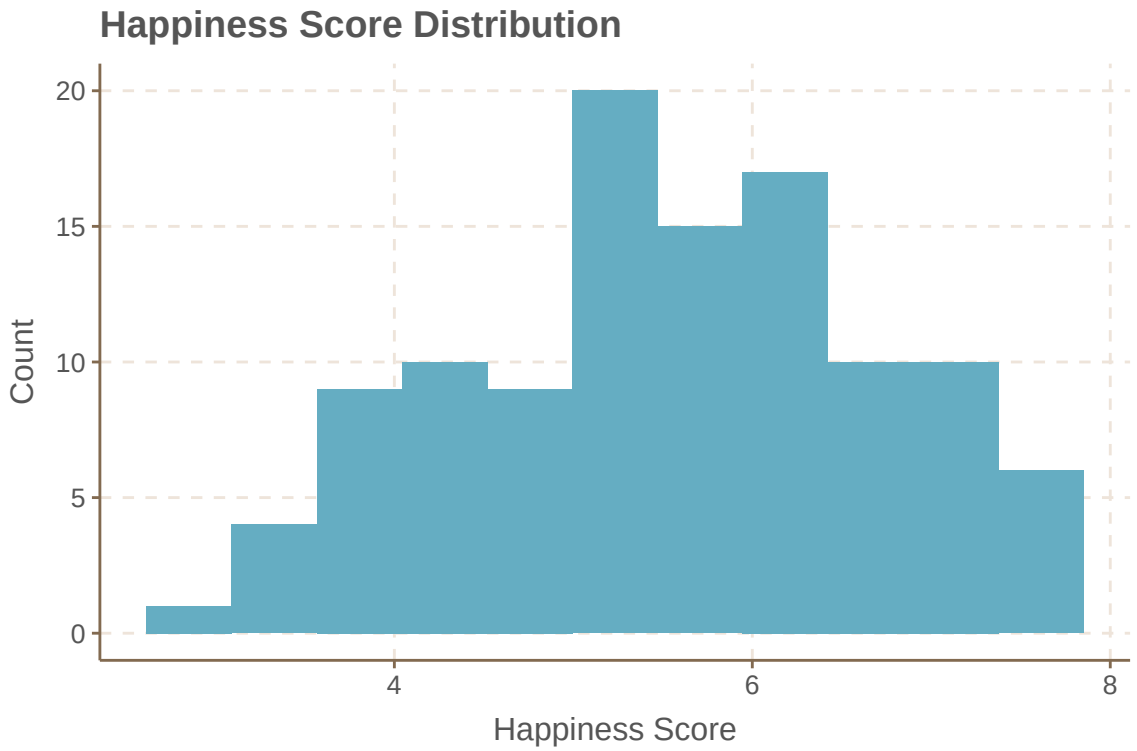
minimum	q1	median	mean	q3	maximum	sd
2101	20228.98	73000.98	650859.6	380937.5	18624500	2138824

Taking the log transform and plotting:



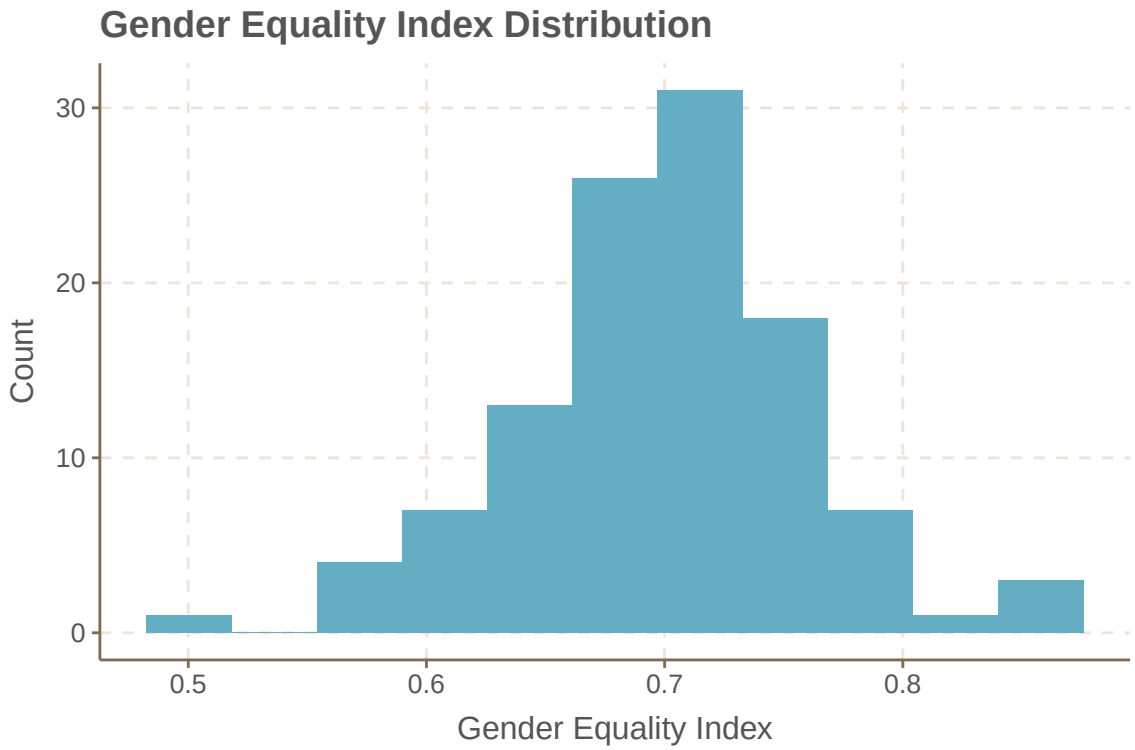
minimum	q1	median	mean	q3	maximum	sd
21.4657	23.7304	25.0137	25.3227	26.6656	30.5555	1.9419

Exploring the World Happiness Report data:



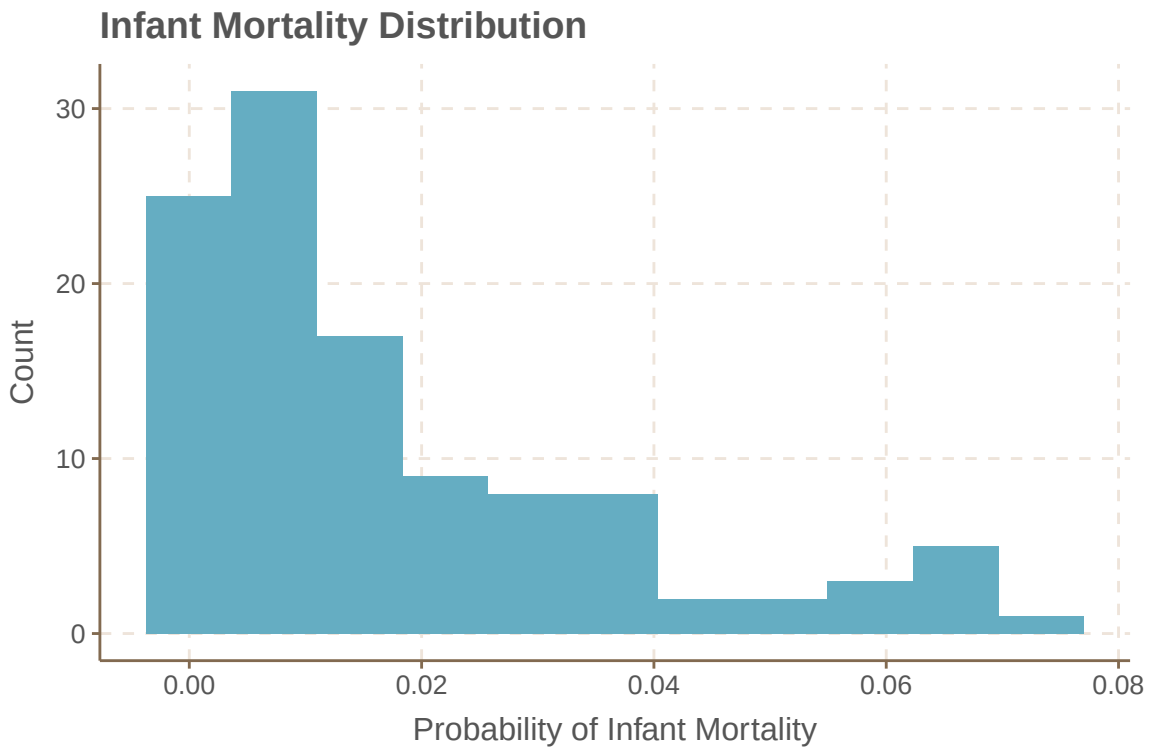
minimum	q1	median	mean	q3	maximum	sd
2.9027	4.6236	5.5778	5.5532	6.3388	7.6598	1.1395

Exploring the gender equality index data:



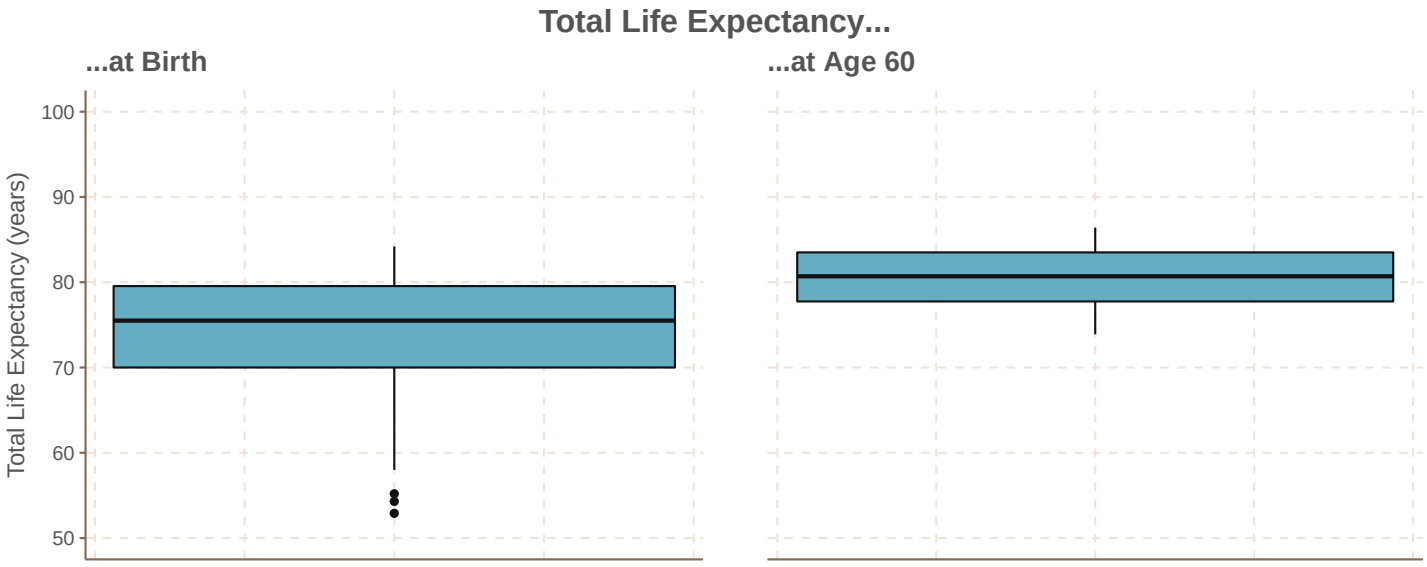
minimum	q1	median	mean	q3	maximum	sd
0.5162	0.6694	0.6999	0.699	0.7347	0.8737	0.0596

Exploring the WHO infant mortality rate data:



minimum	q1	median	mean	q3	maximum	sd
0.0017	0.0038	0.0108	0.0178	0.0273	0.075	0.0185

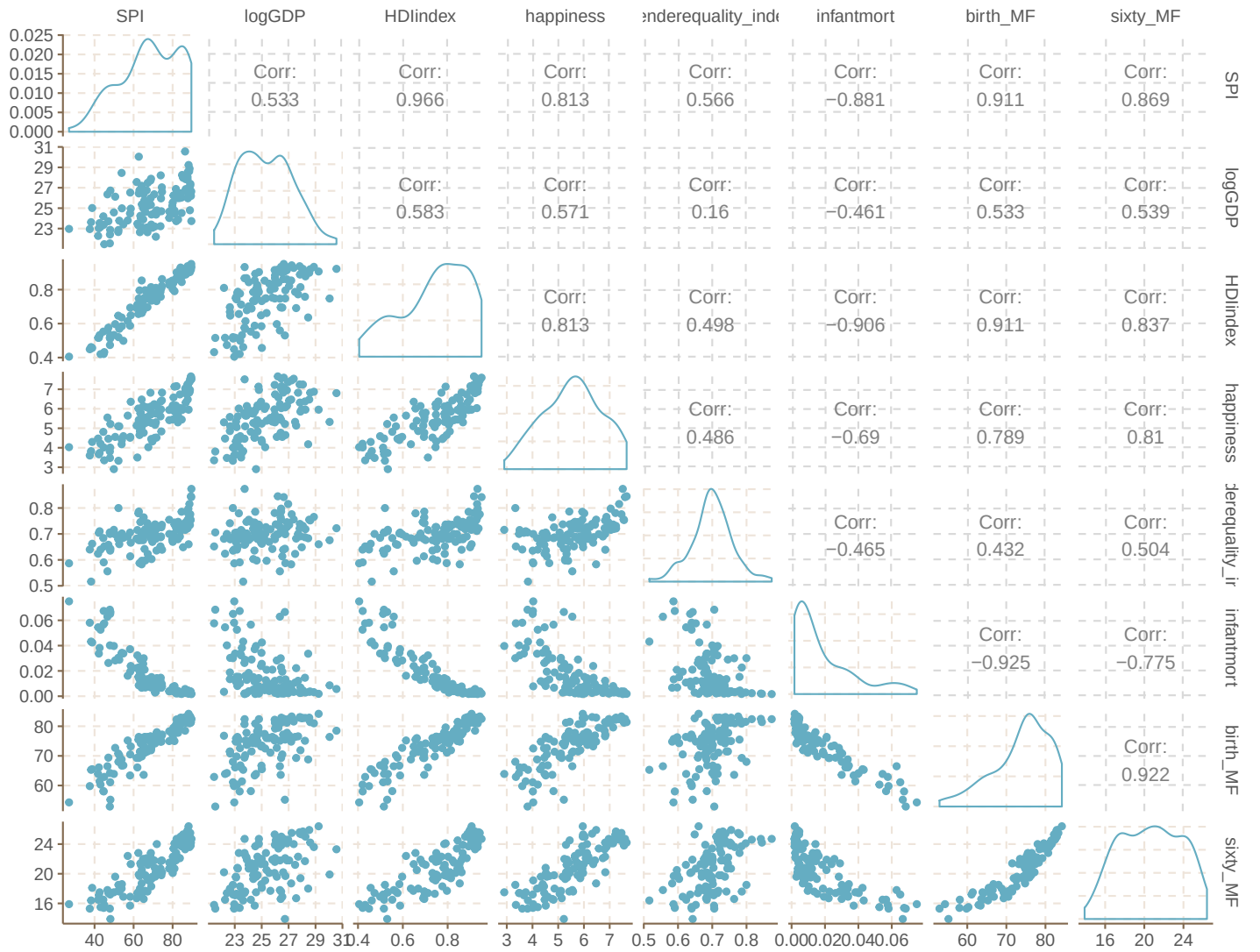
Exploring the WHO life expectancy data:



minimum	q1	median	mean	q3	maximum	sd
52.9	70	75.5	73.9586	79.55	84.2	7.2699

minimum	q1	median	mean	q3	maximum	sd
13.9	17.75	20.7	20.6622	23.5	26.4	3.107

Investigating pairwise relationships between continuous variables:



Strong positive linear relationships are seen between `HDIindex` and `SPI`, `happiness`, and `birth_MF`; between `SPI` and `happiness`, `birth_MF`, and `sixty_MF`; and between `happiness` and `sixty_MF`. Additionally, strong positive relationships that are possibly nonlinear are seen between `HDI_index` and `sixty_MF`, and between `birth_MF` and `sixty_MF`.

Strong negative relationships are seen between `infantmort` and `birth_MF`, between `HDIindex` and `infantmort`, and between `SPI` and `infantmort`, though the latter two of these may not necessarily be linear. A strong negative nonlinear relationship is seen between `infantmort` and `sixty_MF`.

Hypothesis #1:

Helliwell, John F., Richard Layard, and Jeffrey D. Sachs. 2018. "World Happiness Report." http://worldhappiness.report/ed/2018/.

Social Progress Imperative. 2018a. "Social Progress Index." https://www.socialprogress.org/?tab=4.

———. 2018b. "Social Progress Index - Overview." https://www.socialprogress.org/index.

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———. 2018b. "Human Development Reports - Human Development Index (HDI)." http://hdr.undp.org/en/content/human-development-index-hdi.

The World Bank. 2018. "Gross Domestic Product." https://data.worldbank.org/indicator/ny.gdp.mktp.cd?view=map&year_

high_desc=true.

World Economic Forum. 2016a. "Gender Equality." http://reports.weforum.org/global-gender-gap-report-2016/rankings/.

———. 2016b. "Measuring the Global Gender Gap." http://reports.weforum.org/global-gender-gap-report-2016/measuring-the-global-gender-gap/.

World Health Organization. 2018a. "Life Expectancy." http://apps.who.int/gho/data/view.main.SDG2016LEXv?lang=en.

———. 2018b. "Probability of Dying Per 1000 Live Births." http://apps.who.int/gho/data/view.main.182?lang=en.