

# \*Solutions Problem Set Global Indicators and Perceptions

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## Exercise I

Answer the questions below

i) What are the new directions for measures of the evolution of social welfare?

**Solution** New measures of social welfare should consider broader dimensions than income, incorporating measures of education, longevity, housing, as well as other dimensions both in objective and subjective terms, including flows and stocks (see the directions in Stiglitz, Sen and Fitoussi, 2010). These new directions can be organized under four headings: prosperity, sustainability, equality and sensibility.

ii) a. Explain the methodology to construct the Human Development Index (HDI). How are the variables normalized and how each component is weighted? What criticism can be made of this methodology? What are its advantages? b. Do the same for the Inequality-adjusted HDI (IHDI). What distinguishes algebraically the two indicators? c. Do the same for the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs).

**Solution** a. The HDI is calculated from data of health (life expectancy at birth), education (used to be literacy rate and enrollment ratio; now is completed years of schooling for the adult population and expected years of schooling for those in school age) and income (per capita GDP PPP adjusted) at national level. The normalization of the variables occurs as follows:

$$y_i = \frac{x_i - \min(x)}{\max(x) - \min(x)}$$

where  $y_i$  is the normalized variable,  $x_i$  is the original variable and  $\max(x)$  and  $\min(x)$  are the maximum and minimum values of the distribution of  $x$ . In the case of income, we take logs and the highest value is US\$ 75,000 per year, which according to Kahneman and Deaton is the point where income does not affect happiness anymore. Note that when  $x_i = \min(x)$ , we have that  $y_i = 0$ , while when  $x_i = \max(x)$ , then  $y_i = 1$ . Using the normalized variables, a

normalized index for each component is constructed. The HDI is the geometric mean of the three normalized indices. We have that

$$HDI = (I_{health} \cdot I_{educ} \cdot I_{income})^{1/3}$$

Therefore, each component of the HDI has equal weight,  $1/3$ .

One criticism of the methodology is that it doesn't take into account inequalities in the distributions of the components. In addition, it weights its three components quite arbitrarily assuming equal weights.

One advantage of the HDI over other common welfare measures is recognizing the influence of factors other than income on social welfare. Besides that, it is very easy to calculate and interpret because of the normalization.

b. The Inequality-adjusted HDI (IHDI) combines a country's average achievements in health, education and income with how those achievements are distributed among country's population by "discounting" each dimension's average value according to its level of inequality. Thus, the IHDI is distribution-sensitive. Two countries with different distributions of achievements can have the same average HDI value but different IHDI.

The difference between the IHDI and HDI is the human development cost of inequality, that is, the loss to human development due to inequality. A recent measure of inequality in the HDI, the Coefficient of human inequality, is calculated as an average inequality across three dimensions. Algebraically, we have that

$$IHDI = (I_{health}^* \cdot I_{educ}^* \cdot I_{income}^*)^{1/3}$$

where  $I_x^* = (1 - A_x) \cdot I_x$  is the inequality adjusted index for each component and  $A_x = 1 - \frac{\sqrt{x_1 \dots x_n}}{\bar{x}}$  is a measure of inequality for each component, following Atkinson (1970) family of inequality measures setting the parameter  $\epsilon$  equal to 1. Therefore, we have that

$$IHDI = [(1 - A_{health}) \cdot (1 - A_{educ}) \cdot (1 - A_{income})]^{1/3} \cdot HDI$$

c. The MDGs encompass diverse dimensions such as poverty, hunger, education, gender equality, child mortality, health, sustainability and global agreements. Like the HDI, it shows concern about factors other than income that impact the level of social welfare.

One criticism of the goals is to set targets for and end date without setting intermediate goals, which as we have seen provides incentives for policy makers to postpone the efforts to meet the targets.

The SDGs update some of the MDGs previous goals (for example, there is a goal for overcoming extreme poverty) and also include some goals directly related to the environment, such as combating climate change, conserve, protect and sustainably use terrestrial and marine ecosystems, combat desertification and reverse land degradation.

iii) What does the Perceived Human Development Index (PHDI) try to measure and what is its conceptual difference in relation to the HDI?

**Solution** The PHDI seeks to measure the level of human development perceived by the society. Therefore, the measures that compose it are subjective,

which is the main difference in relation to the HDI as the last makes use of objective measures. In addition, the broader version of the PHDI considers perceptions about working conditions, not captured by the HDI.

iv) How do inner and outer perception components behave with changes in variables such as income and age?

**Solution** Inner components tend to have more information content than the outer components since individuals are talking about themselves and not about the outside world. In the selection of principal components, the first ones to appear are inner components. Inner components (income, health and work) are positively correlated with income (objectively measured), while outer components present a more diversified behavior (positive for the outer income component, null for the others). The correlation with age is also more pronounced for inner than for outer components. The greatest negative correlations are found between age and the inner health component, while the relation is even positive when considering the outer health component. The relationship between age and the inner work component is quite peculiar: the latter measure increases substantially at the beginning of the life cycle, remaining high up to 50 years of age, when an uninterrupted fall begins. The outer measure of work, however, is stable throughout life. The income components are quite erratic, but it is possible to identify the highest values for the inner component occurring at the beginning and end of the life cycle.

v) Explain briefly the idea behind the methodology of Principal Components Analysis.

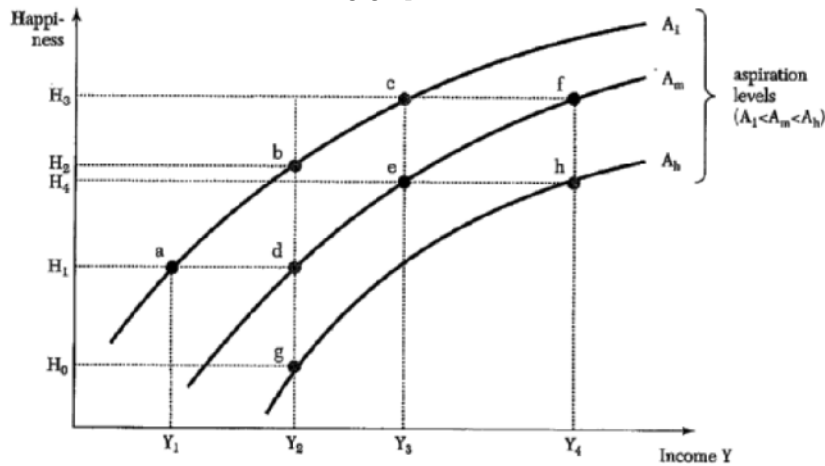
**Solution** Principal Component Analysis (PCA) is a useful methodology when we have data about a certain number of variables and we suspect redundancy between them, that is, that some variables are correlated with others. The problem is that these variables could be essentially measuring the same dimensions. The PCA procedure convert this set of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. A principal component is a linear combination of the observed variables defined in such a way that the first principal component has the largest possible variance (that is, accounts for as much of the variability in the data as possible), and each succeeding component in turn has the highest variance possible under the constraint that it is orthogonal to the preceding components.

vi) Based on the analysis of data from Gallup for 2006 and 2007, tell which component of the PHDI is more important to life satisfaction in general and how does its importance change across the life cycle.

**Solution** The most important component of the PHDI to life satisfaction is the inner component of income. We have that it is positively correlated with the life cycle.

vii) Represent graphically the dynamic relation between Income, Happiness and Aspirations. How the concepts of present and future hapines in a given moment of time, as well as the measurement of present hapiness in different moments, can be used to assess this relation?

**Solution** Consider the following graph



Suppose that, given a present level of happiness and a present level of aspirations (point a), the individual expects a higher level of future utility, anticipating access to a higher level of consumption (point b). The problem is that in the future, when this level of consumption is achieved, the individual's level of aspiration is adjusted, and his level of happiness is lower than that predicted (point d).

\*\* viii) Describe the main conclusions of the Stiglitz-Sen-Fitoussi commission.

**Solution** Based on the original report of the comission, there is a list of 12 recommendations

1. When evaluating material well-being, look at income and consumption rather than production
2. Emphasise the household perspective
3. Consider income and consumption jointly with wealth
4. Give more prominence to the distribution of income, consumption and wealth

5. Broaden income measures to non-market activities
6. Quality of life depends on people's objective conditions and capabilities. Steps should be taken to improve measures of people's health, education, personal activities and environmental conditions. In particular, substantial effort should be devoted to developing and implementing robust, reliable measures of social connections, political voice, and insecurity that can be shown to predict life satisfaction.
7. Quality-of-life indicators in all the dimensions covered should assess inequalities in a comprehensive way
8. Surveys should be designed to assess the links between various quality-of-life domains for each person, and this information should be used when designing policies in various fields
9. Statistical offices should provide the information needed to aggregate across quality-of-life dimensions, allowing the construction of different indexes.
10. Measures of both objective and subjective well-being provide key information about people's quality of life. Statistical offices should incorporate questions to capture people's life evaluations, hedonic experiences and priorities in their own survey.
11. Sustainability assessment requires a well-identified dashboard of indicators. The distinctive feature of the components of this dashboard should be that they are interpretable as variations of some underlying "stocks". A monetary index of sustainability has its place in such a dashboard but, under the current state of the art, it should remain essentially focused on economic aspects of sustainability.
12. The environmental aspects of sustainability deserve a separate followup based on a well-chosen set of physical indicators. In particular there is a need for a clear indicator of our proximity to dangerous levels of environmental damage (such as associated with climate change or the depletion of fishing stocks.)

**ix)** What are the priorities of young Brazilians in relation to the main Sustainable Development Goals (SDGs)? What is the difference between importance, satisfaction and weight in happiness? What is the difference between perceived and measured quality? Apply to the case of education in Brazil.

**Solution** The five top priorities of young Brazilians are quality of education, improvement of health services, access to quality food, honest and active government and protection against crime violence. Note that in comparison with not young Brazilians, the young give much more priority to quality of education, better job opportunities and elimination of prejudice and discrimination, as well as political freedom and access to telephone and internet.

Importance refers to direct questions on main priorities in public policies or main problems faced by the individuals (like the 6 main priorities related to the SDGs captured by the My World Survey). Satisfaction refers to direct questions asking about some specific issue, for example asking an individual to give a grade to his own health or to the quality of the health services offered by the public sector. Weight in happiness is an indirect way to measure the relevance of different components in overall life satisfaction. We can measure the weight of each component by running a regression of life satisfaction on the different objective dimensions like education, health and income (note that one should not run a regression of subjective measures like life satisfaction on subjective measures because of the potential bias).

The difference between perceived and measured quality is that the first capture the subjective evaluation of the quality of some component while the other tries to measure it objectively. The perceived quality is captured by asking individuals to give a grade for inner and outer components of the HDI, for example.

In the case of education in Brazil, we have that the quality of education is the first priority for the youth and the second to the population as a whole. When we regress life satisfaction (happiness) on the HDI components, we have that education has a weight of only 3% against 66% for income and 31% for health. While the perceived quality is captured by the grades individuals give to their own education and for the educational system in the country as a whole, the measured quality would be the average grades in unified exams like Prova Brasil (used to construct the Ideb index) and Enem, as well as the Ideb at the national level, and PISA for international comparisons.

For more details, see the slides on "Global Social Indicators: Human Development Index (HDI)" in the Global Social Indicators' section on the website of the course.

**x)** Explain the methodology for constructing the Multidimensional Poverty Index (MPI). What are its advantages?

**Solution** Each person is assigned a deprivation score according to the household's deprivations in each of 10 components indicators. The maximum deprivation score is 100 percent, with each dimension (education, health and standard of living) equally weighted. The education and health dimensions have two indicators each, so each indicator is worth  $\frac{33.3}{2} = 16.7$  percent. The standard of living dimension has six indicators, so each indicator is worth  $\frac{33.3}{6} = 5.6$  percent. The deprivation scores for each indicator are summed to obtain the household deprivation score. A cutoff of 33.3 percent is used to distinguish between the poor and nonpoor. If the score is 33.3 percent or higher, the household is multidimensionally poor.

Let's define the headcount ratio as  $H = \frac{q}{n}$ , where  $q$  is the number of people who are multidimensionally poor and  $n$  is the total population. Let's also define the intensity of poverty as  $A = \frac{\sum_{i=1}^q c_i}{q}$ , where  $c_i$  is the deprivation score that individual  $i$  (multidimensionally poor) experience.

The Multidimensional Poverty Index is  $MPI = H \cdot A$ .

For an example and more details, see the handout on Multidimensional Poverty (in Global Social Indicators).

## Exercise II

To think beyond the material given in class...

- \*\* i)** Studies show that unemployment affects more negatively the subjective individual well-being at times when aggregate unemployment is lower. Explain why this result is apparently counter-intuitive and give an explanatory hypothesis.

**Solution** This result is counter-intuitive since in an economy with high aggregate unemployment, the chance of the individual obtaining a job is even smaller. A possible explanation for the described fact may be related to the relative evaluation of the situation. That is, in assessing his well-being, the individual compares himself with those around him and analyzes how he is relative to them. Therefore, being unemployed when everyone is employed may seem worse than being unemployed when everyone is in the same situation.

- \*\*\* ii)** Empirical studies based on subjective questions suggest that, in some societies, for example most Latin American societies, inequality is seen as negative, while in others, such as the United States, inequality is seen as something virtuous to some degree. Give a possible explanation for this result.

**Solution** Inequality in Latin America is due in large part to inequality of opportunities, that is, due to circumstances that are beyond the control of individuals such as race, parenting, parental occupation, among others. There is a consensus in the literature that this type of inequality is not only detrimental to the efficiency of the economy, but also unfair. In the United States, however, the share of total inequality attributed to inequality of opportunities is substantially lower, indicating that it is primarily the consequence of individual choices and efforts.

## Exercise III

**Comment, agreeing total, partially or not. If is the case, justify in three or four lines the following propositions (if possible, present a formula or graphic in capsular form to illustrate your answer):**

- i)** “One of the possible explanations for the Easterlin Paradox is that people’s aspirations rose proportionately to income and as a consequence happiness didn’t rise over time, besides the big economic growth experience.”

**Solution** The proposition is true. By experiencing higher levels of income and consumption, people redefine their levels of aspirations, so that the new consumption, higher, could provide the same level of utility obtained initially.

ii) “The subjectivist approach for welfare is based on the theoretical framework of choice theory and revealed preference, thereby seeking to make inferences about welfare based exclusively on people’s behaviour.”

**Solution** The proposition is false. The subjectivist approach recognizes that observed behavior is an incomplete indicator of individual well-being and therefore admits the possibility of capturing individuals’ satisfaction through questions asked directly to them.

iii) “One of the main ideas behind the Economics of Happiness is that well-being can be captured by asking people directly about their life satisfaction.”

**Solution** The proposition is true, once it is assumed that people are the best judges on their quality of life and that no strategy can be more natural and precise than asking them about their well-being.

iv) “The Economics of Happiness approach, or the Subjective Well-Being approach, allow a cardinal analysis of utility, thereby going beyond the objectivist approach.”

**Solution**

v) “By asking in a given moment of time present and prospective individuals’ satisfaction, it is possible to filter the effect of the variation in aspirations, once it is constant in the temporal comparison realized in a given moment.”

**Solution** The sentence is true. By answering questions about his present and future satisfaction, the individual does it so with a single level of aspirations. Only later will his level of aspirations be readjusted given a change in income and/or consumption. Therefore, it is possible to filter the effect of the variation in his aspirations.

vi) The empirical evidence shows that unemployment decreases happiness even when income is constant, which is consistent with the theory of choice between work and leisure.



**Solution** According to the standard theory of choice between work and leisure, people should be happier if they keep the same income and have more leisure. Therefore, we would expect that if people work less but keep the same income, they should be happier. However, this is in contradiction with the empirical evidence, which shows that unemployment actually decreases happiness even when income is constant.

- \*\* vii)** The empirical evidence from the Gallup World Poll data for 2006 shows that:
- a. The individual present and future life satisfaction show that Brazilians are optimistic about the future and that Brazil strictly follows the international norm that “money brings happiness”.
  - b. Individual and collective (with the country as a whole) present satisfaction show that Brazilians are more positive with their own lives than with the country in the present.
  - c. Present happiness tends to fall with age.

**Solution**

**a.** The first part of the sentence is true while the last part is false. It is true that Brazilians are optimistic about the future, as the country is in the top of the ranking of future individual life satisfaction. However, the norm that "money brings hapiness" does not apply to Brazil as well as to other Latin American contries since, despite being a middle income country, Brazil presents high levels of present happiness, higher than many developed countries. The relationship is positive in Brazil but somewhat not greater than in any other country included in the Gallup World Poll.

**b.** The sentence is true. While individual levels of present life satisfaction are high in Brazil, when the question is about the country as a whole, the levels are much lower.

**c.** The sentence is false. Actually, present happiness is almost constant during the life cycle. Future happiness, however, presents a descending trajectory. Young people tend to expect levels of future happiness much higher than the ones they experience in the present. This difference tends to get smaller along the life cycle and at some point it turns to be negative, that is, people project smaller levels of happiness in the future than in the present.

**viii)** From the equation below, evaluate the propositions

$$W = u(x^*) = \int_0^\infty u(x)w(x)f(x)dx$$

- a. The literature of subjective hapiness seeks to study directly the utility function c from the answers given by the people about their own lives.
- b. Traditional literature on welfare studies strictly through the function  $w(x)$  how to aggregate people’s well-being in a single number.

- c. The multidimensional welfare literature basically transform the vector  $x$  in a matrix.
- d. The literature of temporal choice can be represented exactly by the equation above.

**Solution**

- a. The sentence is partially true. The functional form of the utility function doesn't represent a direct concern to the literature of subjective happiness. The aim of this literature is actually to identify what are the determinants of happiness. However, one could represent the subjective preferences as the utility function and derive implications for the Social Welfare of a given society.
- b. The sentence is false. Traditional literature on welfare also considers the utility function  $u(x)$ , which is fundamental. For example, the social welfare function associated with the Gini index assumes  $u(x) = x$ , while the one associated with the Theil uses  $u(x) = \ln(x)$ .
- c. The sentence is true. This matrix is constituted by several columns in addition to  $x$  (which traditionally represents income), each one being a vector representing a dimension of interest like education, longevity, working conditions, etc.
- d. The sentence is false, since the equation above only considers the income distribution in a given moment of time.

**Exercise IV** - Imagine a set of four countries to be compared. In Table I, you will see some of their respective social indicators, for each there is a minimum and maximum values to be considered for calculating the Human Development Index. In Table II, you will see their loss due to inequality.

Indicator	Minimum	Maximum	Country's arithmetic mean
Life expectancy (years)	20	85	Brazil: 75.7
			Cuba: 79.9
			USA: 79.5
			China: 76.4
Expected years of schooling (years)	0	18	Brazil: 15.4
			Cuba: 14.0
			USA: 16.5
			China: 13.8
Mean years of schooling (years)	0	15	Brazil: 7.8
			Cuba: 11.8
			USA: 13.4
			China: 7.8
Gross national income per capita (2011 PPP \$)	100	75000	Brazil: 13,755
			Cuba: 7,524
			USA: 54,941
			China: 15,270

Loss of HDI due to inequality

Brazil	23.9
China	14.5
Cuba	0
United States	13.8

- i. Calculate the HDI for each country and rank them.
- ii. Calculate the Inequality Adjusted HDI for each country. Was there a re-ranking? Summarize your findings.

	HDI	Rank	InAdj HDI	Rank
Brazil	0.751924	3	0.572214	4
Cuba	0.777754	2	0.777754	2
USA	0.924204	1	0.796664	1
China	0.746589	4	0.638333	3

Brazil went from third to fourth place, outpaced by China, which has less loss due to inequality.

**Exercise V** - Below there is a fictitious city, with 5,700 households. They were separated in 4 groups, by their similar characteristics for the multidimensional poverty index.

		Number of Households				
		Weights	500	3000	800	1400
<b>Average Individuals by Household</b>			3	2	4	1
<b>Education</b>						
1	No one has completed 6 years of schooling	16.67%	0	0	1	0
2	At least one school-age child is not enrolled in school	16.67%	1	0	1	1
<b>Health</b>						
1	At least one member is malnourished	16.67%	0	0	1	0
2	One or more children have died	16.67%	1	0	0	0
<b>Living Conditions</b>						
1	No electricity	5.56%	1	0	0	0
2	No access to clean drinking water	5.56%	1	1	1	0
3	No access to adequate sanitation	5.56%	1	0	0	0
4	House has dirt floor	5.56%	0	0	0	0
5	Household uses "dirty" cooking fuel	5.56%	0	1	1	1
6	Household has no access to information, mobility of livelihood	5.56%	0	1	1	0
HH deprivation score			0.5	0.167	0.67	0.22
Multidimensional poor?			Yes	No	Yes	No

Knowing that each group of indicators (Education, Health and Living Conditions) have 1/3 weight and every indicator has the same weight within group, calculate the multidimensional poverty index in this city.

Headcount ratio (H):  $(500 \cdot 3 + 800 \cdot 4) / (500 \cdot 3 + 800 \cdot 4 + 3000 \cdot 2 + 1400 \cdot 1) = 0.388 = 38.8\%$

Intensity of poverty (A):  $(500 \cdot 3 \cdot 0.5 + 800 \cdot 4 \cdot 0.67) / (500 \cdot 3 + 800 \cdot 4) = 0.6157 = 61.57\%$

Multidimensional Poverty Index (MPI):  $H \cdot A = 0.2389 = 23.89\%$

Extra) Is the MPI well suited as a social target linked to resources transfers? If any what type of adaptation would be required? **Solution:** Conceptually the same critic that applies to income-based headcount ( $P^0$ ) as a social target is also valid here. The easiest way to fulfill the target is to address the least poor of the poor first to make them just cross the poverty criteria. One should use a cardinal measure of assets possession and calculate a Squared Poverty Gap ( $P^2$ ), in this way the inequality among the poor is also addressed and the priority becomes the poorest of the poor. This structural approach creates exit doors to poverty.