Social LCA Researcher School Book

Social evaluation of the life cycle, application to the agriculture and agri-food sectors

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10 The Preston pathway

Wealth and health

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To sum up

In this chapter, we present a pathway linking economic activity and population health state, usable in Social Life Cycle Assessment to assess a social impact. From the general idea, we present the statistic relationship, named the Preston relationship, and the arguments to use it as a pathway to calculate a social impact. We notify how to implement this relation with social LCA perspective. Then we discuss strengths and weaknesses of this pathway.

Outlook

1. General idea
2. Preston relationship
3. From macro (econometrics) to micro (social LCA)
4. The limitations

1. General idea

Changes in health status are very important experiences for people. Even if human health is multifactorial, there are strong empirical and historical evidences suggesting that increased economic activity leads to improvements in the health of population.

Based on the preliminary works of Norris (2006) and Hutchins and Sutherland (2008), the general idea is:

- if there is a **positive effect** of growing economic activity on population health in a given country,
- **if one sector** (gathering farms, workshops or companies) contributes to this growing economic activity,
- then we suggest that the functioning of this sector, generating local added value, could **contribute to health improvement** for population.

Provided that some conditions are fulfilled, it is possible to explain and predict past and future effects on the health of a given population, by studying long-term changes in economic activity of such a sector.

2. The Preston relationship

2.1 The Preston curve and the variables involved

The relationship between health and wealth has been first proposed by Preston in 1975, linking life expectancy at birth (LEX) with real per capita income (GDP) at a given time. He studied this relationship thanks to a cross-section analysis for the first decade of the nineteenth century, the thirties and the sixties.

The proxy for health is Life expectancy at birth (LEX), because it has been demonstrated that there is a strong correlation between LEX and healthy life expectancy meaning the number of years that may be lived in good health, based on data from 192 countries collected in 2002 (Canning, 2010).

Wealth is estimated thanks to the GDP/capita because it is not possible to calculate the overall individual income. GDP is expressed in "Purchasing Power Parity" in order to compare countries.

The basic empirical relationship may be expressed by the following equation:

$$lnLEX_i = \alpha + \beta\, ln\,(GDP\ per\ capita_i) + \varepsilon_i$$

Constant *Coefficient of regression* *Error term*

As illustrated by figure 1, countries with a low GDP/capita have low life expectancy, whereas countries with a high GDP/capita have high life expectancy. Nevertheless many questions are still pending.

2.2 Are the good variables here and is it the right direction?

The effect of income on health is open to question such as "Is income really important to improve health?". It has been demonstrated that variables such as women education, institutional and political systems, clean water and sanitation, or religious background have a role to play in the improvement of health (Filmer and Pritchett, 1999; Pritchett and Viarengo, 2010), but income still remains a major variable. Actually, from a historical perspective, it has been demonstrated that before 1870, LEX was similar among all countries at around 40 years old (Bloom and Canning, 2000). Since

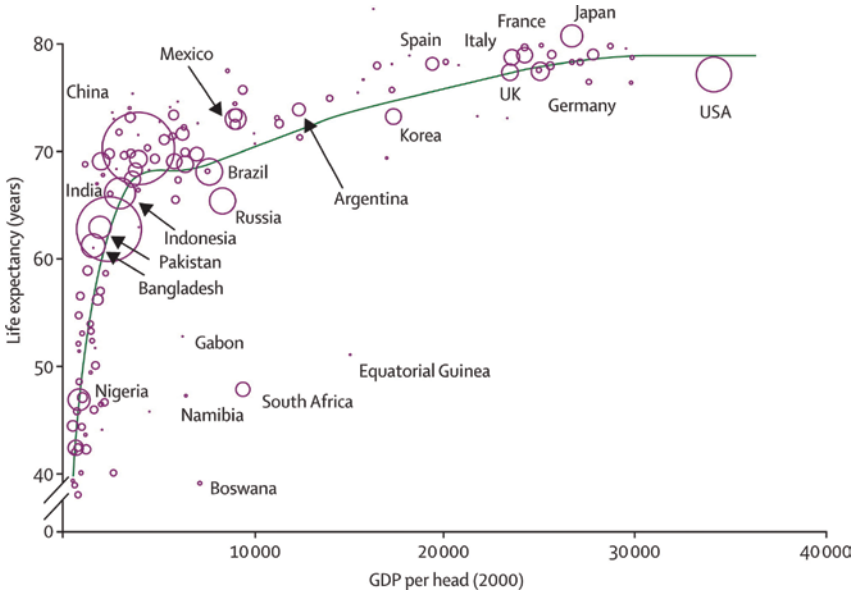

Figure 1: The Preston curve for 2004 (from Deaton, 2004)

then, LEX has increased quickly in rich countries, whereas it has taken more time for poor countries. Significant improvements began after 1930 only.

Regarding the concave aspect of the curve, Deaton (2007) provides a dynamic reading of it: "*On the left of the graph, among the poorest countries, small changes in income are associated with large increases in life expectancy. […] Among the rich countries, on the right of the graph […], increases in income are associated with smaller, but still positive, increases in life expectancy*."

Even if figure 1 might be interpreted as: "there is an impact of income on health", the reverse relationship might be valid too. For example, healthier workers may have a better productivity, or healthier children can attend school and improve their cognitive abilities. This reverse effect exists but it is not so important compared to the other relation from income to health. All the studies which have tried to take into account this reverse effect led to strengthen the Preston relationship!

2.3 Is the relationship valid?

Some authors question the validity of the relationship, because they face some "counter-examples", like Russia, China, side by side with Costa Rica and Tunisia (countries that did not experienced the same economic growth but have similar LEX).

For example, in 1970, a little Tunisian girl had a LEX of 55 years, whereas the Chinese girl's LEX was 63 years. Since then, economic growth in China has been high (about 8% per year) contrary to that of Tunisia (about 3% per year). In 2010 the LEX in Tunisia was 76 years, whereas it was 75 years in China.

These results might be explained by the statistical methods in use (see figure 2), since most of the studies used **cross-section analysis**, focusing on a group of countries at one point in time or different points in time but taken separately. This approach does not provide a dynamic analysis of individual behaviours. It does not give a representation of the trajectory of the country.

We performed our own calculations using a different statistic method with **panel data**, merging **cross-section** and **time series analysis**. We analysed a group of 146 countries during 60 periods, from 1950 to 2009. This method allowed us to consider the trajectory of each country along time and the potential heterogeneity between countries. Thanks to the size of the sample (about 8 760 data), uncertainties were very low.

Considering the first statistic methods (cross section analysis), R^2 was about 0.80, differing slightly depending on the studies. It is very high!

In our case, R^2 is about 0.68. It is still very high, meaning that the relationship is strong for a group of countries and for one country alone over time!

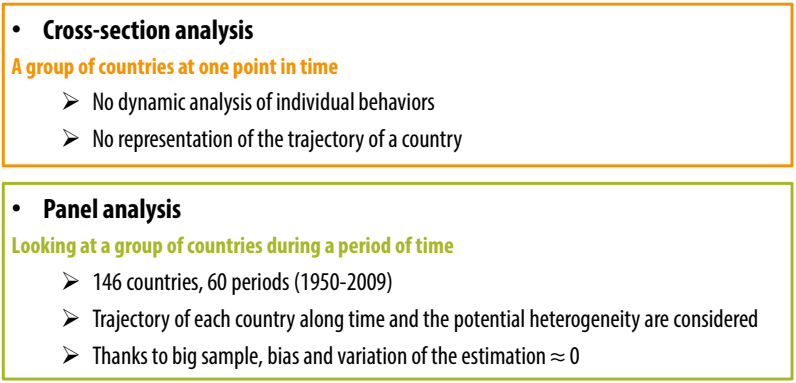

Figure 2: Comparing the analysis methods

2.4 Can we predict an impact?

The idea of social LCA is to predict social impacts due to a change in the system. We wonder if the Preston relationship can be useful to predict an impact, that is to say: if there is a variation of income, is LEX affected?

Some authors answer "no in general" because even if there is a strong correlation between the level of national income and the level of average LEX, there is no correlation between economic growth (variation in national income) and immediate variation in health.

One explanation might be related to the non-linear aspect of the relationship, and to the time lag to observe an effect in the overall population. It is not immediate.

Thanks to a co-integration analysis, we found that there is causality between changes in income and changes in health, but it is very low, due to the time-lag. Thanks to an **impulse response analysis**, we found that this time lag is about four years.

In line with these results, some authors say "yes it is possible to predict an impact on LEX, but only for poor countries and if the economic activity is long enough". As an illustration, Angus Deaton, the Nobel Prize in 2015 for his work related to income poverty and well-being, wrote: "Income poverty and health poverty are positively correlated, and those who suffer from material deprivations are also those who suffer from health deprivations" (Deaton, 2007).

In addition, Easterly (1999), dealing with impacts of economic growth upon quality of life, demonstrated that one of the important parameters to consider, is the duration and the regularity of the growth.

3. *From macro (econometrics) to micro (social LCA): how to use Preston in social LCA?*

Using the Preston pathway in social LCA is tricky, because it implies to downscale the macro-scale relationship (at national level) to the micro-scale (the company level) (see figure 3).

Indeed, the idea is to attribute one part of the variation of LEX to the economic growth of a given sector or company, that is to say to identify the causes of the health effects to the added value generated by a growing sector.

It is a similar approach as the one about "global warming", which is a global effect but related to micro processes.

Of course, the downscaling operation is possible only if some conditions are met.

3.1 The conditions of use

In order to support this downscaling, we suggested that four conditions have to be met before implementing the pathway:

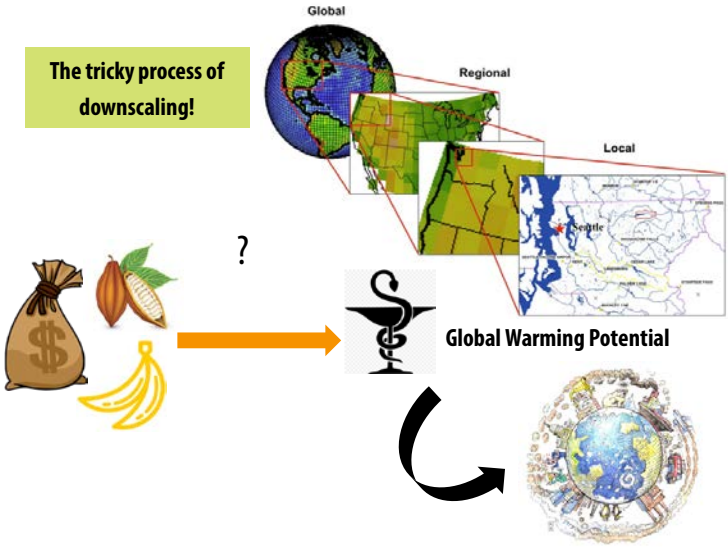

Figure 3: Downscaling process in environmental and social LCA

- the sector under scrutiny (part of the product chain) has to be located into a country where the initial GDP is less than 10 000 $/capita;
- the duration of the activity has to be long enough and regular to observe a significant statistic change. Thanks to an impulse response function we calculated that at minimum four years are necessary to observe an impact of income on LEX;
- the system under scrutiny needs to have a relevant weight into the national economy (more than 1% of the GDP) and/or a strong influence (e.g. lobbying);
- a correlated condition is the distribution among the population to insure that the value added is not captured abroad or by few persons. Wages and local expenditures have to represent more than 60% of the value added created.

As usual, absolute results have no meaning. It is necessary to interpret results in comparison and for the same provided service.

3.2 The steps of the implementation

We make the hypothesis that there is a change in the volume of production in country A during ten years. The different steps of the calculation are gathered in the figure 4.

It will certainly cause a change in the added value generated, whose only a part will stay inside the country, affecting the national GDP through the repartition between

the different sectors of the economy. Thanks to I/O tables and technical coefficients, it is possible to calculate the repartition among economic sectors and the effects on national economy. Gains or losses in life expectancy are calculated applying the Preston relationship in variation.

Hypothesis

Change in the volume of production in country A during 10 years

1. Change in the value added generated
   - **National vs. Abroad value added**
2. Change in national GDP
   - **Repartition between sectors of the economy (I/O tables, technical coefficients)**
3. Change in life expectancy
   - **Implementation of Preston relationship**

Results expressed in days or years won/lost for the national population

Figure 4: The different steps for using the Preston pathway

4. The limitations

As a conclusion, the panel-based relationship may be used under appropriate conditions to explain or to predict the change in potential LEX generated by a change in economic activity. The resulting Preston pathway is an attempt to contribute to a framework for social LCA, consistent with the LCA philosophy developed thus far in environmental sciences. However, some issues deserve to be discussed more deeply, and some others have not yet been addressed.

One source of uncertainty comes from the lack of precision of some data sources of international figures. It would have been preferable to use real income and real health levels (but we do not know them) in order to take into account informal income or unearned income for example, which are very important aspects in developing countries.

Conditions of use are very important and can be improved or adapted according to the context. For example, it is not necessary to calculate precisely the repartition of local added-value through wages if most of the activity is handled by poor smallholders.

Life Cycle Assessment is based on the concept of potential impact, so it is misleading to interpret estimated LEX in itself. It is useful only **in a comparative perspective** between two value chains or two sectors, providing the same service.

Finally, it is absolutely necessary to consider this impact pathway as a **part of a multi criteria framework** including other pathways at the same scale, such as the pathway developed by Bocoum et al. (2015), and including pathways from other scales, in particular to highlight potential impact transfer.

References

Bloom, D.E., and Canning, D. (2000). The Health and Wealth of Nations. Science 287(5456), 1207-1209 10.1126/science.287.5456.1207.

Bocoum, I., Macombe, C., and Revéret, J.-P. (2015). Anticipating impacts on health based on changes in income inequality caused by life cycles. The International Journal of Life Cycle Assessment 20(3), 405-417 10.1007/s11367-014-0835-x.

Canning, D. (2010). Progress in Health around the World (New York (USA): United Nations Development Programme).

Deaton, A. (2007). Global Patterns of Income and Health: Facts, Interpretations, and Policies (Finland: United Nations University-World Institute for Develoment Economics Research).

Easterly, W. (1999). Life During Growth. J Econ Growth 4(3), 239-276 10.1023/a:1009882702130.

Filmer, D., and Pritchett, L. (1999). The impact of public spending on health: does money matter? Soc Sci Med 49(10), 1309-1323 10.1016/s0277-9536(99)00150-1.

Hutchins, M.J., and Sutherland, J.W. (2008). An exploration of measures of social sustainability and their application to supply chain decisions. J Cleaner Prod 16(15), 1688-1698 10.1016/j.jclepro.2008.06.001.

Norris, G. (2006). Social Impacts in Product Life Cycles - Towards Life Cycle Attribute Assessment. Int J Life Cycle Assess 11(0), 97-104 10.1065/lca2006.04.017.

Pritchett, L., and Viarengo, M. (2010). Explaining the cross-national time series variation in life expectancy: income, women's education, shifts and what else? (New York (USA): United Nations Development Programme).