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Equivalent income *versus* equivalent lifetime: does the metric matter?

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Equivalent income *versus* equivalent lifetime: does the metric matter?*

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Abstract

We examine the effects of the postulated metric on the measurement of well-being, by comparing, in the (income, lifetime) space, two indexes: the equivalent income index and the equivalent lifetime index. Those two indexes respect, in some sense, individual preferences, but these rely on two incompatible ethical views on interpersonal comparisons of well-being, which lead to distinct metrics: resourcism and lifetimism. While those incompatibilities arise under distinct indifference maps, we then explore the effects of the metric while relying on a unique indifference map. We illustrate those effects by quantifying, by those two indexes, the (average) well-being loss due to the Syrian War. Assuming resourcism or lifetimism leads, from a quantitative perspective, to different pictures of the deprivation due to the War. This suggests that the metric matters for well-being measurement, even when relying on a unique indifference map.

Keywords: well-being, measurement, equivalent income.

JEL classification codes: I31, J17.

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1 Introduction

Developed in the 1970s by Usher (1973) in the (income, life expectancy) space, the equivalent income is a preferences-based index of well-being, which can potentially include all non-monetary dimensions of standards of living. The equivalent income is defined as the hypothetical income, which, when combined with reference achievements on non-monetary dimensions of well-being, makes an individual indifferent between that hypothetical situation and his current situation. In the recent decades, the equivalent income approach has become increasingly used by economists and economic historians in the measurement of well-being across countries and epochs.[1]

As stated in Fleurbaey (2016), the equivalent income is an inclusive well-being index satisfying two properties. On the one hand, that index respects individual preferences, since it assigns a larger value to a bundle that individuals regard, in the light of their preferences, as better. On the other hand, the equivalent income index satisfies resourcism, a property according to which, when non-monetary dimensions of standards of living take their reference levels, the comparison of the well-being of two distinct individuals (with potentially different preferences) can be carried out merely by comparing their income levels. Resourcism, when combined with the respect of individual preferences, leads to constructing an index of well-being whose metric is money, in line with Pigou's (1920) definition of economic welfare ("the part of welfare that can be brought, directly or indirectly, with the measuring rod of money").

Among those properties, the respect of individual preferences has a strong ethical appeal. When individual preferences are well-defined (and not anti-social), it is hard to see why the measurement of well-being should abstract from how individuals weight the different components of their living conditions.[2]

Resourcism is, from an ethical perspective, more difficult to assess. Using money as a metric for well-being measurement seems at first glance intuitive, since individuals are familiar with that metric. That point was made by Sen (1973) in an early attempt to adjust national income statistics in such a way as to incorporate non-monetary dimensions of standards of living (anterior to Sen's theory of functionings and capabilities). The familiarity with the money metric motivated Sen (1973) to normalize his measure of lifetime income, by dividing it by a reference level of life expectancy, in order to obtain an amount in monetary units, which is of the same order of magnitude as GDP per capita.

However, relying on the money metric can also be questioned. In a recent article, Fleurbaey (2016) questions resourcism, by arguing that a well-being index should ideally rely on a metric that constitutes a fundamental human

[1] See Usher (1980), Williamson (1984), Crafts (1997), Costa and Steckel (1997), Murphy and Topel (2003), Nordhaus (2003), Becker et al (2005), Fleurbaey and Gaulier (2009), Decancq and Schokkaert (2016) and Ponthiere (2016).

[2] There exist, however, some cases where the property of respect of preferences can be questioned. For instance, a child who is unable to read and write may not value schooling a lot, implying that well-being indexes should assign little weight to education. Note, however, that this criticism does not question the property of respecting preferences *per se*, but, rather, the definition of the preferences to be taken into account when measuring well-being.

functioning in Sen's sense, something needed by all individuals to achieve their conception of the good life, whatever their conception of the good life is. Money does not seem to constitute such a fundamental functioning, which tends to question the relevancy of resourcism for the construction of a well-being index.

To what extent does the choice of a particular metric matter for well-being measurement? Does the choice of money as a metric have some impact on well-being comparisons across individuals having different preferences? Alternatively, when considering the measurement of well-being under a unique indifference map, does the reliance on a particular metric matter?

This paper proposes to examine the impact of the postulated metric on the measurement of well-being, by comparing, in the (income, lifetime) space, two well-being indexes: on the one hand, the equivalent income index, and, on the other hand, the equivalent lifetime index.[3] The equivalent lifetime index is defined as the hypothetical lifetime (number of life-years) which, combined with the reference income level, would make the individual indifferent with respect to his current situation. The equivalent lifetime index is built while respecting the same kind of procedure as for the equivalent income index, but differs regarding the metric that is used: life-years instead of money.[4]

In order to examine the impact of the metric on well-being measurement, we develop a simple lifecycle model, where individuals have preference defined in the (income, lifetime) space, and we propose to compare, within that framework, the two equivalent indexes, which differ only regarding the postulated metric. Our comparison proceeds in three stages. First, we study the conditions under which the equivalent income index and the equivalent lifetime index exist. Second, we examine the properties satisfied by those two indexes, while paying a particular attention to interpersonal comparisons of well-being under distinct indifference maps. Third, we examine the extent to which the measurement of well-being is sensitive to the postulated metric, while assuming a unique indifference map (supposed to represent the preferences of a representative agent), as in most applied economic works using the equivalent income approach.[5]

Anticipating our results, we first show that the conditions under which the equivalent lifetime index exists are more restrictive than the ones under which the equivalent income index exists. Actually, the existence of an equivalent lifetime index requires, in addition to the usual conditions on preferences, that the reference income level and the actual income level are both either larger or smaller than the critical income level making life neutral (defined as the income per period making the individual indifferent between, on the one hand, further life with that income, and, on the other hand, death). Regarding the properties satisfied by the two indexes, we show that both indexes respect, in

[3] Our emphasis on 2 dimensions of well-being (instead of n dimensions) is made here for the simplicity of presentation. Introducing $n > 2$ dimensions would add complexity without bringing extra-value for the issue at stake.

[4] The life-year metric is not as widespread as the money metric. One exception is Veenhoven (1996), who developed the happy life expectancy index, which is defined as the product of life expectancy and happy scores normalized on a 0-1 scale. Another exception is the QALY index (see Abellan et al 2016).

[5] One exception is Decancq and Neumann (2016).

some sense, individual preferences, but that these indexes rely on two incompatible ethical views on interpersonal comparisons of well-being: resourcism and lifetimism, which lead to distinct metrics. Finally, concerning the effects of the metric under a unique indifference map, those effects cannot be qualitative (rankings must be preserved under the two indexes, since these are based on the same indifference map), and can thus only be quantitative. To explore those quantitative effects, we use equivalent income and equivalent lifetime indexes to compute the welfare loss due to the Syrian War. Our calculations show that, although these are constructed on the basis of the same indifference map, the two well-being indexes provide, from a quantitative perspective, very different pictures of the deprivation due to the War. This illustrates that the choice of the metric matters for the measurement of well-being not only when individuals have distinct preferences, but also when there is a unique indifference map.

This paper is related to several branches of the literature. First, it is related to the welfare economics literature on the strengths and weaknesses of the equivalent income approach (see Fleurbaey 2011, Fleurbaey and Blanchet 2013, Fleurbaey 2016).[6] This paper complements those works by focusing on the metric of the equivalent income index, and on its impact on well-being measurement. Second, this paper is related to the literature in economics and economic history using the equivalent income approach (see Usher 1980, Williamson 1984, Crafts 1997, Costa and Steckel 1997, Murphy and Topel 2003, Nordhaus 2003, Becker et al 2005, Fleurbaey and Gaulier 2009, Decancq and Schokkaert 2016, Ponthiere 2016). We complement those papers by exploring the effect of the money metric on the measurement of well-being. Our study is also related to the literature on fairness, such as Fleurbaey and Maniquet (2011), since the measurement of well-being, by involving ethical judgements on how to compare the situations of individuals, plays a key role in identifying who is the worst-off, and, hence, who should have priority when considering the allocation of resources. Finally, our study is also related to papers in development economics, such as Ravallion (2012), who showed the sensitivity of standards of living indexes to the postulated functional forms in a multidimensional setting.[7]

The rest of the paper is organized as follows. Section 2 presents our framework. The properties of the equivalent income index are studied in Section 3. Section 4 examines the properties of the equivalent lifetime index, and shows that the two indexes rely on incompatible ethical views on interpersonal comparisons of well-being (under distinct indifference maps): resourcism and lifetimism, which lead to different metrics. Then, to explore the quantitative effects of the

[6] Among the limitations under study, some attention was paid to whether the equivalent income index is too welfarist or not welfarist enough, to the difficult choice of reference levels for all non-monetary dimensions under study, and also to whether that indicator should take into account more subjective aspects of well-being.

[7] Ravallion (2012) shows that, as a consequence of its multiplicative form, the new HDI assigns a lower weight to longevity achievements in poor countries, relatively to rich countries. Like the new HDI, the equivalent income and the equivalent lifetime indexes involve a multiplication of longevity achievements by a transform of income, which explains, in Section 5, the low willingness to pay, in money terms, for coming back to pre-conflict survival conditions, and the high willingness to pay, in life-year terms, for coming back to pre-War income.

metric under a unique indifference map, Section 5 considers the measurement of the (average) welfare loss due to the Syrian War. Section 6 concludes.

2 The framework

Let us first introduce the simple lifecycle model on which our analysis is based. The economy is composed of N individuals, indexed with letters $i, j, ...$ For the sake of the presentation, we consider, throughout this paper, a simple two-dimensional model. In that model, a human life is reduced to two dimensions, which summarize, in a nutshell, the "quality" and the "quantity" of life.[8]

The first dimension is income per period, denoted by $y_i \in \mathbb{R}^+$. Income is here assumed to be constant along the lifecycle. This income per period dimension is a proxy for the "quality" of each period of life.

The second dimension is the length of life $L_i \in \mathbb{R}^+$. This length of life captures the pure "quantity" of life.[9]

It is assumed that individuals have well-defined preferences on the set of all bundles (y_i, L_i). Those preferences are represented by the utility function $U_i(y_i, L_i)$. It is assumed, as usual, that the function $U_i(\cdot)$ is continuous in its two arguments y_i and L_i.

Throughout this paper, we assume that the function $U_i(\cdot)$ is (strictly) increasing in income y_i, that is, that $U_{iy}(y_i, L_i) > 0$. This assumption amounts to state that, whatever the length of life is, it is always strictly welfare-improving to increase the income per period, which is here a proxy for the "quality" of life at a given period. Note that this assumption of strict monotonicity rules out the case of perfect complementarity between income per period and lifetime.

We assume that there exists an individual-specific critical income level $\tilde{y}_i > 0$ that makes individual i indifferent between, on the one hand, further life with that income, and, on the other hand, death.[10] Normalizing the utility of being dead to 0, we have thus $U_i(\tilde{y}_i, L_i) = 0$ for any L_i, as well as $U_i(y_i, L_i) > 0$ when $y_i > \tilde{y}_i$ and $U_i(y_i, L_i) < 0$ when $y_i < \tilde{y}_i$. We have also that: $U_{iL}(y_i, L_i) > 0$ when $y_i > \tilde{y}_i$, $U_{iL}(y_i, L_i) = 0$ when $y_i = \tilde{y}_i$ and $U_{iL}(y_i, L_i) < 0$ when $y_i < \tilde{y}_i$.

Figure 1 shows an example of indifference map in the (y_i, L_i) space satisfying our assumptions. Indifference curves are decreasing when $y_i > \tilde{y}_i$, since in that area both income per period and lifetime are desirable goods. When $y_i = \tilde{y}_i$, lifetime is a neutral good, so that the indifference curve is a vertical line at $y_i = \tilde{y}_i$. Finally, when $y_i < \tilde{y}_i$, lifetime is an undesirable good, and indifference curves are increasing in the (y_i, L_i) space. Arrows in Figure 1 show the direction in which well-being increases in the two areas of the indifference map.

[8] One may want to consider a more general, n-dimensional setting. While doing this would bring a substantial value when doing empirical analysis of well-being, we believe that it would not bring much extra-value for the purpose at stake.

[9] Note that we abstract here from individual's interests in joint survival as studied in Ponthiere (2016) using an equivalent consumption approach.

[10] One can regard the critical level of income $\tilde{y}_i$ as the equivalent, in the money metric, of Broome's (2004) concept of utility level neutral for the continuation of existence.

Finally, for the purposes of constructing our well-being indexes - equivalent incomes and equivalent life years - we assume that there exists some reference levels for the two dimensions of standards of living considered. We denote by $\bar{y} > 0$ the reference income per period level, and by $\bar{L} > 0$ the reference level of the length of life. Those two parameters are supposed to be unique (i.e. the same for all individuals), so that $\left(\bar{y}, \bar{L}\right)$ constitutes a reference point for all.[11]

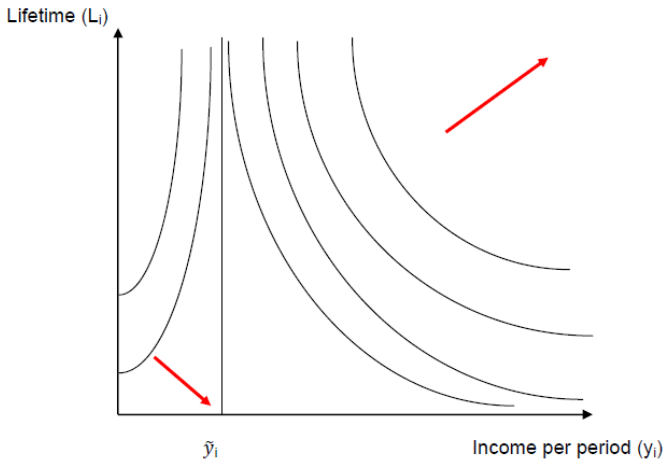

Figure 1. Indifference map in the (income per period, lifetime) space.

3 The equivalent income index

Let us now define the equivalent income index. Consider an individual i with income y_i and lifetime L_i. In the present setting, the equivalent income $\hat{y}_i$ is defined as the hypothetical income level which, combined with the reference level for lifetime $\bar{L}$, would make the individual indifferent with respect to its bundle (y_i, L_i) given his preferences (represented by the function $U_i(\cdot)$).

Definition 1 (equivalent income) *Suppose a reference level for the length of life $\bar{L}$. Suppose that an individual i has preferences represented by the utility function $U_i(y_i, L_i)$. For any bundle (y_i, L_i), the equivalent income index $\hat{y}_i$ is defined implicitly by the following equality:*

$$U_i\left(\hat{y}_i, \bar{L}\right) = U_i(y_i, L_i)$$

[11] Note that one could have, alternatively, defined different reference points for all individuals, but we do not do this here, because it would introduce additional complexity without bringing much extra-value for the issue at stake. Actually, as we discuss below, our main results concerning the comparison of the equivalent income and equivalent lifetime indexes are robust to introducing individual-specific reference levels $\bar{L}_i$ and $\bar{y}_i$.

The equivalent income is an inclusive measure of well-being, since it includes not only the income dimension, but, also, the other dimension of well-being, here the length of life L_i.

It is easy to see, from the definition of the equivalent income index, that it is increasing in income per period y_i. Moreover, as long as $y_i > \tilde{y}_i$, so that $U_{iL}(y_i, L_i) > 0$, the equivalent income is also increasing in L_i.

Regarding the existence of the equivalent income, it is interesting to notice that the existence of that index requires, in the (y_i, L_i) space, that the indifference curve on which a bundle lies must cross, at some point, the horizontal line drawn at $\bar{L}$. This is achieved when the following condition on preferences holds.

Proposition 1 (existence of equivalent income) *Conditionally on a reference level for lifetime $\bar{L} > 0$, the equivalent income index $\hat{y}_i$ exists if and only if, for any individual i, the utility function $U_i(y_i, L_i)$ satisfies the following property: $\forall (y_i, L_i) \in \mathbb{R}^+ \times \mathbb{R}^+, \exists x > 0$ such that: $U_i\left(x, \bar{L}\right) = U_i(y_i, L_i)$.*

Proof. See Figure 2. ■

Note that, in the case of perfect complementarity between income per period and lifetime, the above property is not satisfied, so that the equivalent income does not exist. That case is quite extreme, and is actually ruled out here by the strict monotonicity of preferences in income per period.

Figure 2 shows an example of an indifference map that satisfies the existence property, and which is used for the construction of an equivalent income index under a particular reference level for lifetime $\bar{L}$.

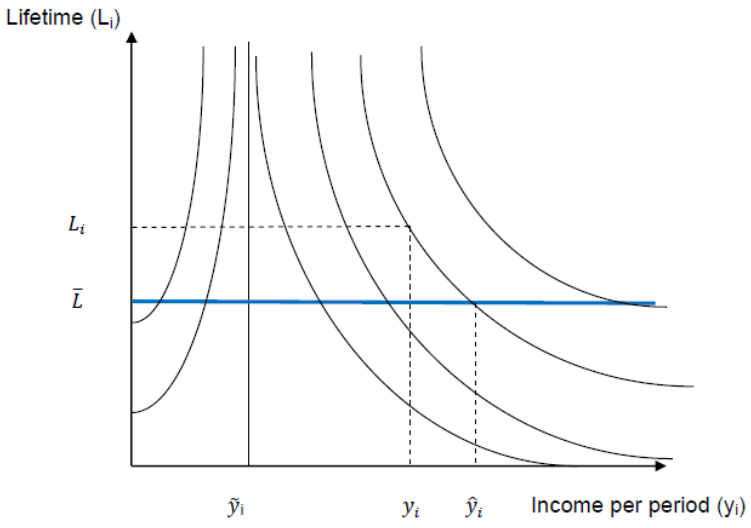

Figure 2. Construction of the equivalent income index.

As stated in Fleurbaey (2016), the equivalent income satisfies two fundamental properties: on the one hand, respect of preferences, and, on the other hand, resourcism. Let us first define those two properties, and discuss their role in the construction of the equivalent income index.

The first property, i.e. respect of preferences, states that, if a variation in y_i or L_i increases (resp. decreases) individual welfare, this will necessarily lead to increase (resp. decrease) the equivalent income $\hat{y}_i$, and that any variation in the equivalent income must necessarily coincide with a variation, in the same direction, of individual welfare.

Definition 2 (respect of preferences) *A well-being index $b_i(y, L)$ respects individual preferences if and only if, for any individual i and any two bundles (y_i, L_i) and (y'_i, L'_i), we have:*

$$b_i(y'_i, L'_i) \gtrless b_i(y_i, L_i) \iff U_i(y'_i, L'_i) \gtrless U_i(y_i, L_i)$$

That ethical property states that moving an individual to a bundle that he considers to be better (resp. worse) must lead to a rise (resp. a fall) of the measured well-being for that person.

Note that this first property has strong implications when considering variations in the bundle where there is some improvement on one dimension, and some worsening on the other dimension. In that case, the respect of preferences property states that whether the well-being index will take a higher or a lower value depends only on how the individual values those changes in the light of his own preferences.

The second property, i.e. resourcism, states that, when comparing the well-being of two individuals, it is sufficient to consider the income level of those individuals when the non-monetary dimension takes its reference level.

Definition 3 (resourcism) *A well-being index $b_i(y, L)$ is resourcist if and only if, when comparing the well-being of two individuals i and j, it is sufficient to consider the income level of those individuals when the non-monetary dimension - here L_i - takes its reference level $\bar{L}$ (for both individuals):*

$$\text{if } L_i = L_j = \bar{L}, \text{ then } b_i(y_i, \bar{L}) \gtrless b_j(y_j, \bar{L}) \iff y_i \gtrless y_j$$

Resourcism is an ethical property, which allows for the interpersonal comparison of well-being. That property amounts to state that, when comparing the situations of two individuals with possibly different preferences and different bundles, it is sufficient to focus only on the income level when the length of life is equal to its reference level for all.

By allowing for the interpersonal comparison of well-being, resourcism is a key ethical property, which is far from neutral for well-being measurement, and has also important consequences when discussing the fair allocation of resources. As stated in Fleurbaey and Maniquet (2011), the theory of well-being measurement is an essential component of a theory of fairness, since the identification of the worst-off is, in several cases, quite sensitive to the adopted approach

for well-being measurement. From that perspective, resourcism consists of one approach - among many others - to compare the situations of individuals.

Note that resourcism is, as an ethical property, more questionable than the property of respect of preferences. A first criticism is that this property requires the definition of a reference level for the non-monetary dimension, here human lifetime. This selection may be, in some contexts, difficult, and this is problematic to the extent that well-being comparisons across individuals may be quite sensitive to the postulated reference level for the non-monetary aspects of life.[12]

But a more fundamental criticism is developed in Fleurbaey (2016). Fleurbaey argues that one may criticize resourcism, on the ground that a well-being index should ideally be defined in terms of a metric that is a fundamental human functioning in Sen's sense, i.e. something that is necessary to realize one's conception of a good life, whatever that conception is. Fleurbaey considers that money is not such a fundamental functioning, so that this resourcist property is questionable. That criticism of resourcism is fundamental, and we will come back on that issue when discussing, in the next section, the equivalent lifetime index, which, as we will show, does not satisfy resourcism.

Our results are summarized in Proposition 1, which states that the equivalent income satisfies respect of preferences and resourcism.

Proposition 2 (properties of equivalent income) *The equivalent income satisfies respect of preferences and resourcism.*

Proof. Consider first the property of respect of preferences. We have, for two bundles (y_i, L_i) and (y'_i, L'_i), equivalent income levels $\hat{y}_i$ and $\hat{y}'_i$ satisfying:

$$\begin{aligned} U_i\left(\hat{y}_i, \bar{L}\right) &= U_i(y_i, L_i) \\ U_i\left(\hat{y}'_i, \bar{L}\right) &= U_i(y'_i, L'_i) \end{aligned}$$

It is easy to see, given the monotonicity of $U_i(\cdot)$ in y_i, that if $U_i(y_i, L_i) > U_i(y'_i, L'_i)$, then it has to be the case that $\hat{y}_i > \hat{y}'_i$. Moreover, if $U_i(y_i, L_i) < U_i(y'_i, L'_i)$, then it has to be the case that $\hat{y}_i < \hat{y}'_i$. Finally, if $U_i(y_i, L_i) = U_i(y'_i, L'_i)$, then it has to be the case that $\hat{y}_i = \hat{y}'_i$. We thus have:

$$\hat{y}'_i \gtrless \hat{y}_i \iff U_i(y'_i, L'_i) \gtrless U_i(y_i, L_i)$$

that is, the respect of preferences condition is satisfied.

Regarding resourcism, it is easy to see that, when $L_i = L_j = \bar{L}$, we have:

$$\begin{aligned} U_i\left(\hat{y}_i, \bar{L}\right) &= U_i(y_i, \bar{L}) \iff \hat{y}_i = y_i \\ U_j\left(\hat{y}_j, \bar{L}\right) &= U_j(y_j, \bar{L}) \iff \hat{y}_j = y_j \end{aligned}$$

Hence it follows that:

$$\hat{y}_i \gtrless \hat{y}_j \iff y_i \gtrless y_j$$

[12] On that criticism, see Fleurbaey (2011).

that is, that the resourcism condition is satisfied. ■

The equivalent income index constitutes a quite intuitive index of well-being, which respects individual preferences over bundles. It should be stressed, however, that this is not the only well-being index that can respect individual preferences. Clearly, there is no obvious reason why one should necessarily adopt resourcism, and the associated money metric, for well-being measurement.

In order to further examine the impact of the metric for well-being measurement, the next section introduces an alternative well-being index, based on a different metric: the equivalent lifetime index.

4 The equivalent lifetime index

Let us now define the equivalent lifetime index. Consider an individual i with income y_i and lifetime L_i. Let us also define a reference level for the income, and denote this by $\bar{y}$. The equivalent lifetime index $\hat{L}_i$ is defined as the hypothetical lifetime level which, combined with the reference level for income per period $\bar{y}$, would make the individual indifferent with respect to its bundle (y_i, L_i) given his preferences represented by the function $U_i(\cdot)$.

Definition 4 (equivalent lifetime) *Suppose a reference level for the income per period $\bar{y} > 0$. Suppose that an individual i has preferences represented by the utility function $U_i(y_i, L_i)$. For any bundle (y_i, L_i), the equivalent lifetime index $\hat{L}_i$ is defined implicitly by the following equality:*

$$U_i\left(\bar{y}, \hat{L}_i\right) = U_i(y_i, L_i)$$

Figure 3 below illustrates the construction of an equivalent lifetime index, using the same example of indifference map as above.

At first glance, the equivalent lifetime index seems to be very similar to the equivalent income index. Actually, both equivalent income and equivalent lifetime indexes are constructed on the basis of indifference maps, and both indexes consist of fixing a reference level for the other dimension, and looking for the hypothetical level of either income or lifetime that makes the individual indifferent with respect to his bundle. Equivalent income indexes and equivalent lifetime indexes thus look like quite similar inclusive measures of well-being, which synthesize standards of living in a single number.

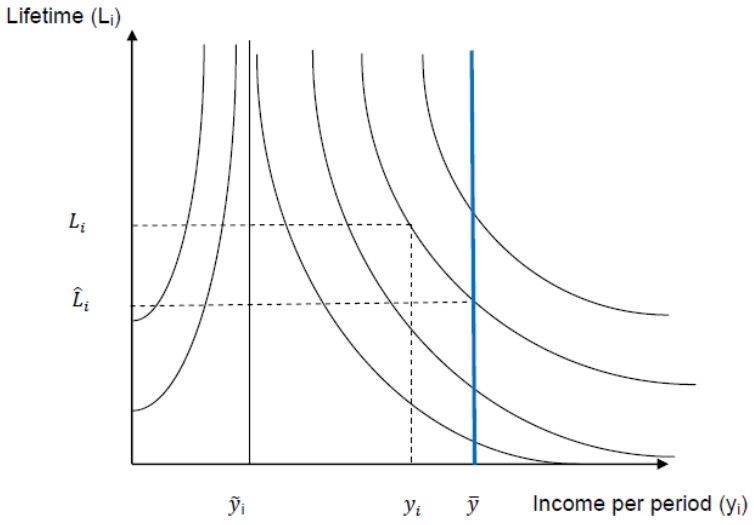

Figure 3. Construction of the equivalent lifetime index.

However, it should be stressed that there are important differences between the equivalent income index and the equivalent lifetime index.

A first, important difference, concerns the conditions under which the equivalent lifetime index exists. As shown below, the existence of the equivalent lifetime index requires more restrictive conditions than the existence of the equivalent income index. Actually, the existence of the equivalent lifetime index requires some restrictions on where the reference income per period must be fixed in comparison to the prevailing income per period.

Proposition 3 (existence of equivalent lifetime) *Assume a reference level for income $\bar{y} > 0$. Then, for any individual i with bundle (y_i, L_i):*

- *If $y_i \leq \tilde{y}_i$ and $\bar{y} > \tilde{y}_i$, or if $y_i = \tilde{y}_i$ and $\bar{y} \neq \tilde{y}_i$, or if $y_i \geq \tilde{y}_i$ and $\bar{y} < \tilde{y}_i$, the equivalent lifetime index does not exist.*

- *If $y_i > \tilde{y}_i$ and $\bar{y} > \tilde{y}_i$, the equivalent lifetime index exists if and only if the utility function $U_i(y_i, L_i)$ satisfies the following property: $\forall (y_i, L_i)$ with $y_i > \tilde{y}_i, \exists x > 0$ such that: $U_i(\bar{y}, x) = U_i(y_i, L_i)$.*

- *If $y_i < \tilde{y}_i$ and $\bar{y} < \tilde{y}_i$, the equivalent lifetime index exists if and only if the utility function $U_i(y_i, L_i)$ satisfies the following property: $\forall (y_i, L_i)$ with $y_i < \tilde{y}_i, \exists x > 0$ such that: $U_i(\bar{y}, x) = U_i(y_i, L_i)$.*

- *If $y_i = \tilde{y}_i$ and $\bar{y} = \tilde{y}_i$, the equivalent lifetime index exists.*

Proof. See Figure 3. ■

The intuition behind that result goes as follows. Remind that the indifference map in the (y_i, L_i) space involves indifference curves that are decreasing when $y_i > \tilde{y}_i$, a vertical line at $y_i = \tilde{y}_i$, and increasing when $y_i < \tilde{y}_i$. As a consequence of that, the existence of an equivalent lifetime level requires that the reference income level $\bar{y}$ lies, with y_i, on the same side of the vertical line drawn at $\tilde{y}_i$. Otherwise, it is not possible, by moving along an indifference curve, to find the hypothetical lifetime level that, combined with the reference income, will make the individual indifferent with respect to his current bundle.

For instance, if the current bundle involves a life not worth being lived, (i.e. $y_i < \tilde{y}_i$), and if $\bar{y} > \tilde{y}_i$, then it is impossible to find a hypothetical lifetime that would, jointly with the reference income level $\bar{y}$, make the individual as worse off as he is under his bundle, since the hypothetical life would, at worst, involve $\hat{L}_i = 0$, which would still be better than the life not worth being lived.

In the light of this, it appears that a first, major difference between the equivalent income index and the equivalent lifetime index is that, whereas the existence of the former holds under general conditions on preferences, this is not necessarily true for the latter, whose existence imposes some additional restrictions. Those additional conditions require that the bundle under study and the reference income level are located on the same side with respect to the vertical line drawn at the income neutral for the continuation of existence $\tilde{y}_i$.

It should be stressed that those additional conditions restrict the possible uses ot the equivalent lifetime index with respect to the use of the equivalent income index. To illustrate this, take the case of a poor individual, whose initial income per period is *above* the neutral level for continuing existence. Then, a natural disaster arises, which reduces his income to a level that lies *below* the neutral level for continuing existence. Given that the initial bundle and the final bundle lie on two distinct sides of the critical income level making life neutral, one cannot, on the basis of a single reference income level, compute the equivalent lifetime index for *both* the pre-disaster and the post-disaster period. On the contrary, it is possible, in that example, to compute the equivalent income index for both periods, since the horizontal line drawn at $\bar{L}$ must necessarily cross the two indifference curves along which the bundles lie.[13]

There exist also other differences between the two indexes. Let us first consider the property of respect of preferences. We know from above that this property is always satisfied by the equivalent income index, since the index takes a higher level when the individual is better off. As shown below, this property is not necessarily satisfied by the equivalent lifetime index when this index exists.

Proposition 4 (equivalent lifetime and respect of preferences)

- *When $y_i > \tilde{y}_i$ and $\bar{y} > \tilde{y}_i$, the equivalent lifetime index satisfies the respect of preferences property.*
- *When $y_i < \tilde{y}_i$ and $\bar{y} < \tilde{y}_i$, the equivalent lifetime index does not satisfy*

[13] Note that this existence problem for the equivalent lifetime index holds whatever the reference income level is uniform (i.e. $\bar{y}$), as in our framework, or individual-specific (i.e. $\bar{y}_i$).

the respect of preferences property, but satisfies instead "reverse respect of preferences" (i.e. it takes a lower value when the bundle is better, and a higher value when the bundle is worse).

Proof. Assume $y_i > \tilde{y}_i$ and $\bar{y} > \tilde{y}_i$. We have, for two bundles (y_i, L_i) and (y'_i, L'_i), equivalent lifetime levels $\hat{L}_i$ and $\hat{L}'_i$ satisfying:

$$\begin{aligned} U_i\left(\bar{y}, \hat{L}_i\right) &= U_i(y_i, L_i) \\ U_i\left(\bar{y}, \hat{L}'_i\right) &= U_i(y'_i, L'_i) \end{aligned}$$

If $\bar{y} > \tilde{y}_i$, it is easy to see that if $U_i(y_i, L_i) > U_i(y'_i, L'_i)$, then it has to be the case, by monotonicity of $U_i(y_i, L_i)$ in L_i, that $\hat{L}_i > \hat{L}'_i$. Moreover, if $U_i(y_i, L_i) < U_i(y'_i, L'_i)$, then it has to be the case that $\hat{L}_i < \hat{L}'_i$. Finally, if $U_i(y_i, L_i) = U_i(y'_i, L'_i)$, then it has to be the case that $\hat{L}_i = \hat{L}'_i$. We thus have:

$$\hat{L}'_i \gtrless \hat{L}_i \iff U_i(y'_i, L'_i) \gtrless U_i(y_i, L_i)$$

so that the respect of preference condition is satisfied.

Assume now $y_i < \tilde{y}_i$ and $\bar{y} < \tilde{y}_i$. We have, for two bundles (y_i, L_i) and (y'_i, L'_i), equivalent lifetime levels $\hat{L}_i$ and $\hat{L}'_i$ satisfying:

$$\begin{aligned} U_i\left(\bar{y}, \hat{L}_i\right) &= U_i(y_i, L_i) \\ U_i\left(\bar{y}, \hat{L}'_i\right) &= U_i(y'_i, L'_i) \end{aligned}$$

If $\bar{y} < \tilde{y}_i$, we have that if $U_i(y_i, L_i) > U_i(y'_i, L'_i)$, then we need $U_i\left(\bar{y}, \hat{L}_i\right) > U_i\left(\bar{y}, \hat{L}'_i\right)$, which implies $\hat{L}_i < \hat{L}'_i$. Thus the respect of preferences property is not satisfied in that case, since a lower value of the index is assigned to a bundle regarded as better. ■

Proposition 4 states that the equivalent lifetime index satisfies the respect of preferences property only if the income level and the reference income level are higher than the critical income level $\tilde{y}_i$. That case is the most general one (i.e. the case of a life worth being lived).

However, one may wonder why the equivalent lifetime index does not respect preferences in the case where a life is not worth being lived (i.e. the case where $y_i < \tilde{y}_i$ and $\bar{y} < \tilde{y}_i$). The intuition behind that violation goes as follows. One expects that the index takes a higher value when the individual is better off. However, in that case, when an individual lies on a lower indifference curve, he is better off. Thus, when moving along indifference curves so as to cross the vertical line at the reference income level, it appears that a bundle involving a higher level of well-being is being assigned a *lower* level of the equivalent lifetime index $\hat{L}_i$.

Note that this violation may be qualified, since, in the area of the space where $y_i < \tilde{y}_i$ (i.e. a life is not worth being lived), a lower lifetime is synonymous of

a higher well-being. Thus assigning a lower value of the index when individuals are better off may not be seen as such an important problem; in some sense, preferences are being respected, in the sense of another definition of "respecting preferences", which would consist of "assigning a higher level of a desirable good" to situations that are regarded as better by the individual. Lifetime being undesirable when $y_i < \tilde{y}_i$, "respecting preferences" can here be interpreted as the requirement of "assigning a lower level of the undesirable good" to situations that are regarded as better by the individual, which is indeed satisfied. One should thus not exaggerate the importance of the violation of (strict) respect of preferences, even though it may be disturbing, when interpreting measurement results, to see larger values of the equivalent lifetime index being assigned to bundles that are actually regarded as worse by individuals.

Having qualified the extent to which the equivalent lifetime index violates the respect of preferences conditions when $y_i < \tilde{y}_i$, we can now discuss the other property that was satisfied by the equivalent income: resourcism. It is easy to show that the equivalent lifetime index does not satisfy resourcism.

Proposition 5 (violation of resourcism) *When it exists, the equivalent lifetime index does not satisfy resourcism.*

Proof. See Figure 4. ■

The violation of resourcism can be easily illustrated by a geometrical example. Suppose that individual a lies at $\left(y_a, \bar{L}\right)$, while individual b lies at $\left(y_b, \bar{L}\right)$. Suppose that $\bar{y} < y_b < y_a$. If the indifference curves of the two individuals cross at an income level larger than $\bar{y}$, we obtain that $\hat{L}_b > \hat{L}_a$, despite $y_b < y_a$.

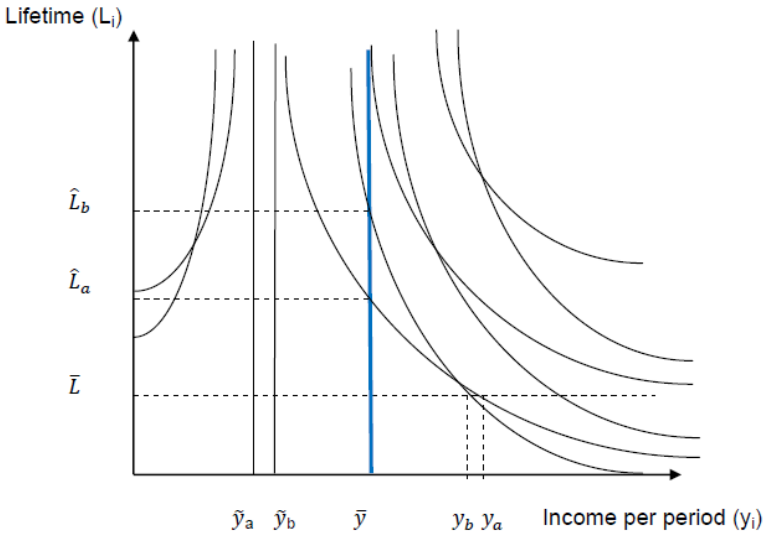

Figure 4. Violation of resourcism by the equivalent lifetime index.

Actually, the equivalent lifetime index satisfies another property, which can be called lifetimism. That property states that, when two individuals enjoy the reference income level $\bar{y}$, it is sufficient, to compare their well-being, to compare their lifetime levels.

Definition 5 (lifetimism) *A well-being index $b_i(y, L)$ is lifetimist if and only if, when comparing the well-being of two individuals i and j, it is sufficient to consider the lifetime level of those individuals when the income takes its reference level $\bar{y}$ (for both individuals):*

$$\text{if } y_i = y_j = \bar{y}, \text{ then } b_i(\bar{y}, L_i) \gtrless b_j(\bar{y}, L_j) \iff L_i \gtrless L_j$$

Lifetimism constitutes an ethical property that allows for the interpersonal comparison of well-being, in a way that differs from the comparisons allowed by resourcism. To better highlight the difference between lifetimism and resourcism, it is sufficient to turn back to the example of Figure 4. When comparing the situations of individuals a and b, resourcism leads to consider that individual a, who has a larger income than individual b, is regarded as better off than individual b. On the contrary, lifetimism leads to the opposite result: individual a is, under lifetimism, regarded as worse off than individual b.

Lifetimism and resourcism are thus two alternative ethical properties, which can lead, in some cases, to contradictions concerning the interpersonal comparison of well-being. Those two properties being incompatible, a choice has to be made between these.

Is lifetimism more ethically attractive than resourcism? That question is complex, but one advantage of lifetimism over resourcism is that it leads to a metric for well-being measurement, i.e. life-years, that has a strong ethical appeal, since lifetime can be regarded as a fundamental human functioning, something that is required to achieve a good life, whatever the conception of the good life is.

That point was emphasized by Sen (1998), who argued that lifetime is a fundamental dimension of standards of living, since lifetime is necessary to achieve one's goals in life, whatever those goals are. "Being alive" is a necessary condition to achieve the goals that one pursues in life. A natural corollary of this is that a premature death constitutes a major form of human deprivation. This motivated Sen (1998) to consider mortality as an indicator of economic success and failure.

Lifetimism relies on the same intuition, and, combined with the previous property of respect of preferences, makes lifetime the metric along which well-being is to be measured. Thus, the fact that lifetimism leads to measuring well-being while using the life-year metric - a fundamental functioning - contributes to make it, to some extent, more appealing than resourcism.

Proposition 6 states that the equivalent lifetime index satisfies lifetimism, whereas the equivalent income index does not.

Proposition 6 (indexes and lifetimism) *The equivalent income does not satisfy lifetimism. The equivalent lifetime satisfies lifetimism.*

Proof. The proof of the first statement follows from the example shown in Figure 4. Regarding the proof of the second statement, we have

$$\begin{aligned} U_i\left(\bar{y}, L_i\right) &= U_i(\bar{y}, \hat{L}_i) \iff \hat{L}_i = L_i \\ U_j(\bar{y}, L_j) &= U_j(\bar{y}, \hat{L}_j) \iff \hat{L}_j = L_j \end{aligned}$$

Hence it follows that: $\hat{L}_i \gtrless \hat{L}_j \iff L_i \gtrless L_j$, i.e., that lifetimism is satisfied. ■

In sum, the equivalent income index and the equivalent lifetime index constitute two alternative well-being indexes, which are both constructed on the basis of indifference maps, and which are both inclusive measures of well-being, aggregating all dimensions into a single number. However, this section emphasized three main differences between those indexes.

First, the conditions under which the equivalent lifetime index exists are more restrictive than the conditions under which the equivalent income index exists. In addition to usual conditions on preferences, the existence of an equivalent lifetime index requires that the bundles under comparison lie together with the reference income level on the same side of the vertical line drawn at the income level neutral for existence. Second, while the equivalent lifetime index satisfies the (strict) property of respect of preferences, this is not necessarily the case with the equivalent lifetime index, which can assign larger numbers to situations that individuals regard as worse, which can raise difficulties in terms of interpretations. Third, whereas the equivalent income satisfies resourcism, the equivalent lifetime violates resourcism, and satisfies lifetimism instead. That difference is the most fundamental one: the equivalent income index and the equivalent lifetime index rely on two distinct ways to compare well-being across individuals, two ways that are, as shown on Figure 4, incompatible.[14]

Those theoretical findings suggest that the choice of a metric for a well-being index matters, since the equivalent income index and the equivalent lifetime index may lead to opposite judgements regarding the comparison of well-being across individuals. Thus a choice is to be made between resourcism and lifetimism, and relying on the former or the latter is a matter of ethical view.

Having stressed those differences, it is not easy to see *a priori* how different are the pictures provided by those two alternative, preferences-based, well-being indexes. Does the reliance on resourcism or lifetimism make a substantial difference when measuring well-being in the real world? Do dissonances between the two indexes arise only when making interpersonal comparisons based on different indifference maps? Or does the metric matter even when one relies on a single indifference map? Those questions are examined in the next section.

[14] Note that those three differences between the equivalent income index and the equivalent lifetime index are robust to introducing individual-specific reference levels for income and lifetime. Existence problems for the equivalent lifetime index would still hold under individual-specific reference levels. Moreover, the violation of respect of preferences by the equivalent lifetime index would also remain, in that alternative setting, when life is not worth being lived. Finally, the dilemma between resourcism and lifetimism would also remain if those properties were defined on the basis of individual-specific reference levels.

5 One indifference map, two well-being indexes: an application to the Syrian War

This section proposes to examine further the role of the metric for well-being measurement, by considering well-being measurement under a *unique* indifference map, which is supposed to capture the preferences of a representative individual. The reason why we would like to explore the sensitivity of well-being measurement to the postulated metric in that simplified context is that most applied studies using equivalent incomes assume, due to the lack of data at the microeconomic level, the existence of a representative agent.[15] Hence it makes sense to explore the extent to which the adopted metric (and, hence, the reliance on resourcism or lifetimism) makes a substantial difference.

From the theory, we know that, under a single indifference map, the equivalent income index and the equivalent lifetime index will always rank two situations in the same way. There cannot be any contradictions in terms of ranking in that case, since both indexes respect preferences, and given the reliance on a unique indifference map, there can be no contradiction in terms of well-being comparison across the two indexes.

One may nonetheless be curious to know to what extent the reliance on a particular metric for well-being measurement is, from a quantitative perspective, benign in the context of a unique indifference map. In order to further examine the sensitivity of well-being indexes to the metric, this section takes the case of the measurement of well-being in the context of the Syrian War. The Syrian War, which started in 2011, is at the origin of thousands of deaths and injured persons, and caused the displacement of thousands of refugees.[16] The War also contributed to a strong contraction of economic activity and to massive destructions (including important cultural sites). As shown in Table 1, a brief look at some basic indicators gives an idea of the magnitude of the consequences of the Syrian War at the economic and demographic levels.

	Before Conflict (2010)	Conflict (2016)
Population (inside Syria)	20.7 million	18.5 million
Per Capita Income (current $)	$2806	$1215
Life expectancy at birth	74.4 years	69.5 years

Table 1: Basic indicators, Syria, 2010 and 2016. Sources: World Bank.

Whereas the War affected numerous dimensions of life, we will, throughout this section, focus only on the two dimensions that were studied in the theoretical part of the paper, i.e. income per period and lifetime. Due to data limitation, we will abstract here from inequality among those two dimensions, and consider

[15] See, for instance, Usher (1980), Williamson (1984), Crafts (1997), Costa and Steckel (1997), Murphy and Topel (2003), Nordhaus (2003), and Becker et al (2005).

[16] On the estimation of the number of deaths and injured persons, see the report of the Syrian Centre for Policy Research (2016). See also the report of the World Bank (2017).

a representative agent framework.[17] In this section, we will measure the first dimension by the income per capita (in current US$), denoted by y, and measure the second dimension by life expectancy at birth, denoted by L.[18]

The computation of equivalent income and equivalent lifetime indexes requires to impose some functional form for the utility $U_i(y, L)$. For that purpose, we rely on the standard functional forms in the literature (see Becker et al 2005). We assume that preferences on lotteries of life satisfy the expected utility hypothesis (i.e. preferences on lotteries can be represented by a weighted sum of utilities associated to the different possible durations of life, with weights representing the probabilities of occurrence of those different durations).[19] Assuming that the utility of a scenario of life is additive in temporal utilities, and that temporal utility depends only on his income, and takes a standard constant-elasticity form, his preferences can be represented as follows:[20]

$$U_i(y, L) = L\left[\frac{(y)^{1-\sigma_i}}{1-\sigma_i} - \alpha_i\right] \tag{1}$$

where L is the life expectancy, while $\sigma_i > 0$ and $\alpha_i \lesseqgtr 0$ are two preference parameters.

Given the absence of microdata on preference heterogeneity, we will, throughout this section, focus on a representative agent, and assume that those two preference parameters take unique values: $\sigma_i = \sigma$ and $\alpha_i = \alpha$.

Based on that functional form, the equivalent income index, derived from $U_i\left(\hat{y}, \bar{L}\right) = U_i(y, L)$, is equal to:

$$\hat{y} = \left[(1-\sigma)\left[\left(\frac{(y)^{1-\sigma}}{1-\sigma} - \alpha\right)\frac{L}{\bar{L}} + \alpha\right]\right]^{\frac{1}{1-\sigma}} \tag{2}$$

where $\bar{L}$ is the reference lifetime.

Moreover, the equivalent lifetime index, derived from $U_i\left(\bar{y}, \hat{L}\right) = U_i(y, L)$, is here equal to:

$$\hat{L} = L\frac{\left[\frac{(y)^{1-\sigma}}{1-\sigma} - \alpha\right]}{\left[\frac{(\bar{y})^{1-\sigma}}{1-\sigma} - \alpha\right]} \tag{3}$$

where $\bar{y}$ is the reference income per period.

Regarding the calibration of preference parameters α and σ, we follow the common practices in the literature. As far as the calibration of σ is concerned,

[17] Obviously, abstracting from inequalities is a strong simplification, since the War affected the population in an asymmetric manner, depending, among other things, on the geographical location. However, our goal being methodological, this simplification is not problematic.

[18] Throughout this section, we thus take life expectancy as an indicator of the average lifetime in the population, i.e. the lifetime of the representative individual.

[19] We abstract here from pure time preferences. Survival probabilities play here the role of biological discount factors.

[20] As above, the utility of being dead is normalized to 0.

we follow Blundell et al (1994) and take $\sigma = 0.83$. Concerning α, this can be calibrated using studies on the value of a statistical life (VSL), defined as the marginal rate of substitution between income and mortality risk:

$$VSL = -\frac{\frac{\partial U}{\partial d_0}}{\frac{\partial U}{\partial y_0}} = \frac{\frac{L}{s_0}\left[\frac{y_0^{1-\sigma}}{1-\sigma} - \alpha\right]}{s_0 \left(y_0\right)^{-\sigma}} \tag{4}$$

where d_j is the probability of death at age j while $s_i = \prod_{j=0}^{i}(1 - d_j)$ is the probability of survival to age i.

In order to calibrate α on the basis of VSL estimates, we rely here on the meta-analysis of VSL studies carried out by Miller (2000). Miller collected 68 studies estimating VSL across 13 countries, while using various methodologies (wage-risk studies, contingent valuation methods, behavioral studies), in order to estimate rules of thumb, which relate the VSL to the level of GDP per capita. The interest of those rules of thumb is the following. Most VSL studies have focused exclusively on rich countries, whereas for most countries there exists no direct VSL estimate. Hence, the rules of thumb estimated by Miller allow us to extrapolate VSL estimates for any country, by merely knowing the GDP per capita of that country. This is the case for Syria, for which there exists no direct VSL estimate. Thus Miller's rules of thumb allow us to have an indirect estimate of the VSL for Syria, and to use it for our calibration.[21]

Following Miller's (2000) rules of thumb, the VSL amounts to between 120 and 180 times GDP per capita. Hence, on the basis of the pre-conflict income per head ($2806), we obtain two values for α: α equal either to 16.46 (lower bound of VSL) or to 13.35 (upper bound of VSL).[22]

In order to compare equivalent income with equivalent lifetime indexes, this section will take, as reference levels for income per period and lifetime, the pre-War levels of y and L, which leads to $\bar{y} = 2806$ and $\bar{L} = 74.4$. Then, we compute the two well-being indexes for 2010 (pre-War) and 2016 (War), to see how those two indexes measure the well-being loss due to the War.

Figure 5 compares incomes and equivalent incomes (under low and high VSL). The equivalent income for 2016 is computed as the hypothetical income which, combined with the survival conditions of 2010, would make the representative agent indifferent with respect to the 2016 situation (with 2016 income and survival conditions).

[21] Note that relying on rules of thumb constitutes an approximation. One limitation of using rules of thumb is that this assumes some form of stability of preferences concerning income-risk trade-offs across countries and time periods. Back to the case of Syria, if the War modified preferences in a particular way, this will not be captured by our calibrations based on Miller's rules of thumb.

[22] We take here, as a proxy, $s_0 \approx 1$.

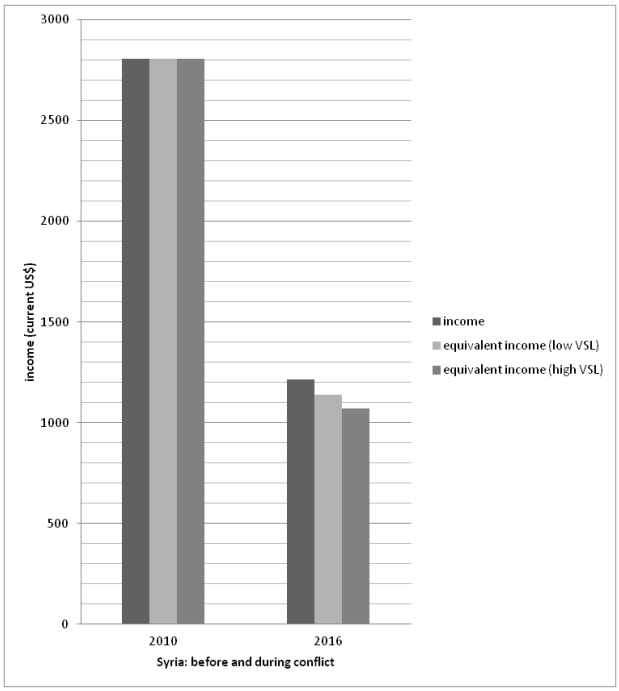

Figure 5: Income and equivalent income in Syria, 2010 and 2016.

When looking at Figure 5, one can see immediately, by comparing years 2010 and 2016, the strong deterioration in standards of living due to the War. Whatever the income index on which one relies, it appears clearly that it takes a much larger value before the War (in 2010) than during the War (in 2016). The decline represents about 60 % of the pre-conflict income level.

Concerning the quantification of the welfare loss due to the War, one may expect that equivalent incomes, which incorporate the variation in survival conditions, should show a much stronger decline of standards of living in comparison to the standard income, which does not incorporate variations in survival conditions. However, contrary to what one may expect, the size of the differential between the standard income and the equivalent income is quite small. The gap, for 2016, equals only $\$1215 - \$1140 = \$75$ under the lower bound of the VSL, and $\$1215 - \$1071 = \$144$ under the higher bound of the VSL. Note that measuring the differential between the equivalent and the standard income in *relative* terms rather than in absolute terms can make the gap seem less small. In relative terms, the gap lies between $\frac{\$1215-\$1140}{\$1215} = 6$ % (under low VSL) and $\frac{\$1215-\$1071}{\$1215} = 12$ % (under high VSL) of the standard income in 2016.

Let us now compare those figures with the picture provided by the equivalent lifetime index. For that purpose, Figure 6 compares lifetime with equivalent lifetime, computed while taking the pre-War income level as a reference.

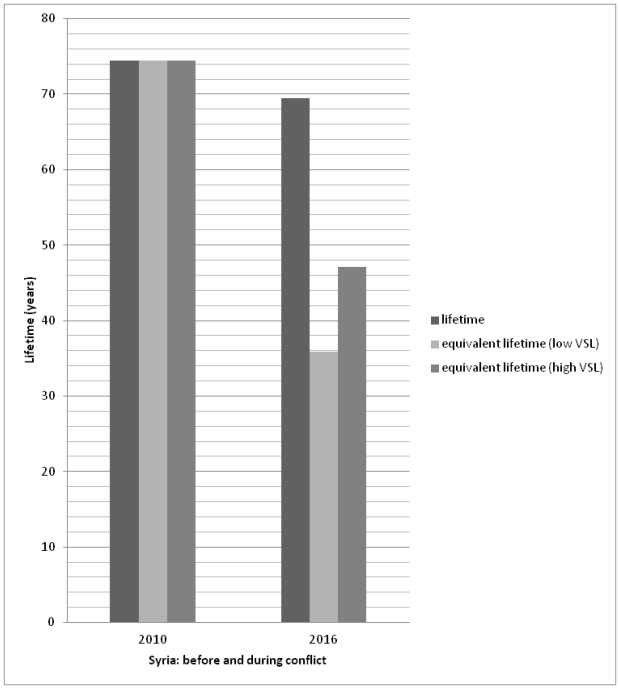

Figure 6. Lifetime and equivalent lifetime in Syria, 2010 and 2016.

Not surprisingly, the ranking (pre-War *versus* War situations) is, under the equivalent lifetime index, the same as under the equivalent income index. This similarity of ranking arises because the two well-being indexes are here constructed on the basis of the same, unique indifference map, representing the preferences of a representative agent.

However, although the two indexes agree qualitatively, in the sense that these provide the same rankings, these lead to quite different pictures from a quantitative perspective. Two important differences should be highlighted.

First, whereas the equivalent income indexes during the War are close to the standard income, this is not the case when considering equivalent lifetime indexes, which exhibit much lower levels than the (unadjusted) lifetime. Figure 6 shows that the hypothetical lifetime that would, combined with the pre-War income, make the representative individual indifferent with respect to the War situation is as low as 36 years (under the low VSL) and 47 years (under the high VSL). Thus, based on our calculations, the deprivation due to a lower income has been so strong that a representative individual would be willing to give up between 22.5 years (i.e. $69.5 - 47$) and 33.5 years (i.e. $69.5 - 36$) of life to go back to the pre-War income. In relative terms, the differential between the equivalent lifetime and the standard lifetime (between 32% and 48%) is much larger than the differential between the equivalent income and the standard

income (between 6% and 12%).

Another, second important difference concerns the comparison of well-being indexes under the high and the low VSL estimates. Whereas the equivalent income takes lower levels when the high VSL estimate is adopted, it is the opposite for the equivalent lifetime index, which takes higher levels when the high VSL estimate is assumed. The intuition goes as follows. When a higher value is assigned to life in comparison to income, this means that the willingness to pay (WTP), in income terms, to come back to pre-conflict survival conditions goes up, leading to a lower equivalent income index. On the contrary, when a higher value is assigned to life in comparison to income, this tends to reduce the WTP, in life-year terms, to come back to pre-conflict income conditions, which leads to a higher equivalent lifetime index.

In the light of Figures 5 and 6, it appears that relying on the equivalent income index or the equivalent lifetime index provides, from a quantitative perspective, very different pictures of the (average) well-being loss due to the War. Equivalent income indexes are close to the standard income in the War time, and exhibit little sensitivity to the postulated VSL estimate. On the contrary, equivalent lifetime indexes are much lower than the standard lifetime measure in the War time, and are strongly sensitive to the postulated VSL estimate.

Those observations are quite surprising: adopting resourcism (for the equivalent income index) or lifetimism (for the equivalent lifetime index) should be neutral in our example, since we rely here on a *unique* indifference map. Why is it the case that adopting resourcism or lifetimism makes such a difference here?

The answer to that question is provided by Figure 7, which shows the indifference map under the low VSL estimate, the equivalent income index appearing on the horizontal axis, whereas the equivalent lifetime index appears on the vertical axis. A key observation to be made is that the point (1215, 69.5) in the (income, lifetime) space is located in an area of the indifference map where the slope of indifference curves is high, coinciding with a low value of a statistical life. This particular location explains why relying on either the equivalent income index or on the equivalent lifetime index makes such a big difference.

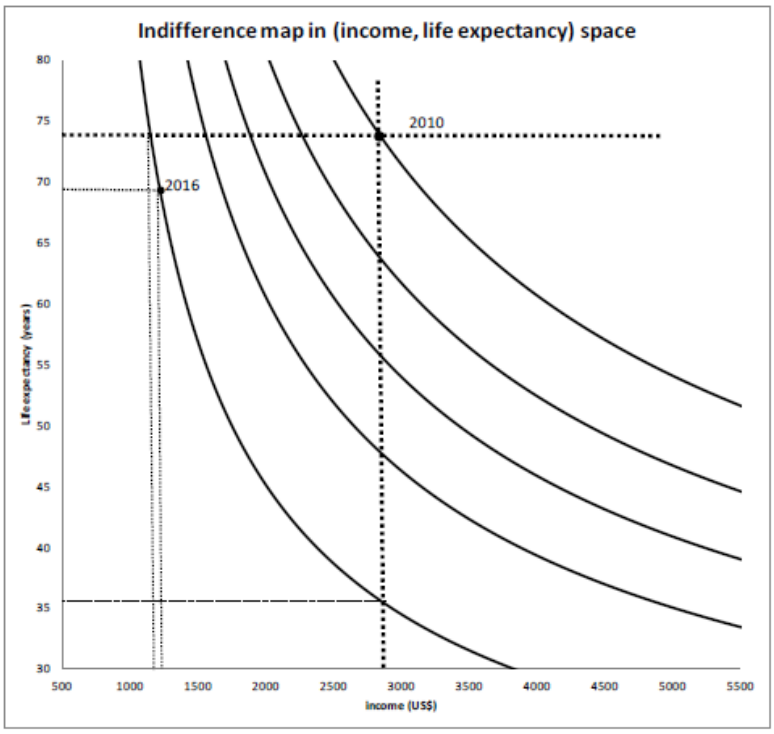

Figure 7. Construction of equivalent income index and equivalent lifetime index for 2016.

Consider first the equivalent income index. The high slope of indifference curve at the War point explains why a small movement along the indifference curve - and thus a small income reduction - suffices to compensate for the 5-year improvement in life expectancy when the reference (pre-conflict) survival conditions are imposed. This low WTP for coming back to pre-conflict survival conditions can be explained by the extreme poverty due to the War. This low WTP, in income terms, for an increase in lifetime, explains why the equivalent income is very close to the standard income in 2016.

Consider now the equivalent lifetime index. The high slope of the indifference curve at the War point explains that a large lifetime reduction is needed to compensate the substantial loss in income (from \$2805 to \$1215). Thus the high WTP, in life-year terms, for an increase in income explains why the equivalent lifetime index is much lower than (unadjusted) lifetime in 2016. Note that this high WTP (in life-year terms) for coming back to the pre-War income is also explained by the extreme poverty due to the War. Extreme poverty explains

why, although individuals would be willing to give up little income to turn back to pre-conflict survival conditions, they would be willing to give up a large number of life-years to turn back to pre-War material standards of living.

All in all, the measurement of the well-being loss due to the War illustrates that relying on resourcism or on lifetimism leads to very different pictures of the deprivation caused by the War. That result may seem somewhat surprising, since our example is based on a *unique* indifference map, unlike in the previous section, where we showed the incompatibility of resourcism and lifetimism when individuals have different preferences.

But our example shows that, even if we adopt a unique indifference map, the choice of the metric matters for well-being measurement. The reason why the pictures provided by the two indexes are so different lies in the fact that the War bundle lies in an area of the indifference map where life-years have a low value with respect to income (or, alternatively, income has a high value with respect to life-years). As a consequence of this, relying on the income metrics or on the lifetime metrics makes a substantial difference when describing the overall deprivation due to the War.

6 Conclusions

In the recent decades, the equivalent income index has become a major tool for well-being measurement, allowing for numerous applications in welfare economics, development economics and economic history. While the respect of individual preferences is regarded as a major strength of the equivalent income method - in comparison to arbitrary ways to aggregate different dimensions of life -, its reliance on money as a metric is more open to questions and criticisms.

In that paper, we proposed to examine the role of the metric in the measurement of well-being by means of equivalent indexes, by comparing, in the (income, lifetime) space, the equivalent income index with the equivalent lifetime index. The latter index is, like the equivalent income index, constructed on the basis of an indifference map, and relies, like the equivalent income index, on the selection of some reference levels for other dimensions of living standards.

At first glance, one may believe that relying on the money metric or on the life-year metric does not make a difference for well-being measurement. However, our analysis revealed several important differences between those indexes.

At the theoretical level, we first showed that the mere existence of those well-being indexes does not require the same conditions. The equivalent income exists under general conditions on preferences, whereas this is not the case for the equivalent lifetime index, which requires, in addition to those conditions, that the actual income and the reference income are both either higher or lower than the critical level of income making life continuation neutral.

More fundamentally, our analysis showed that the equivalent income index and the equivalent lifetime index rely on two incompatible ethical views for the interpersonal comparison of well-being: resourcism and lifetimism. Resourcism and lifetimism are two incompatible ethical properties, which imply distinct

metrics for the measurement of well-being. In the light of the contradictions between those two views, it appears that the choice of a metric definitely matter for the measurement of well-being.

In the last part of the paper, we proposed to explore further the impact of relying on a particular metric, by comparing the equivalent income index and the equivalent lifetime index while assuming a unique indifference map, supposed to represent the preferences of a representative agent, as this is assumed in most applied works using the equivalent income method. For that purpose, we developed the particular example of the measurement of the (average) well-being loss due to the Syrian War, and we showed that, even if one relies on a unique indifference map, the choice of the metric definitely matters. Whereas the equivalent income index is, in War times, very close to the standard income, and almost insensitive to the postulated VSL, this is not the case for the equivalent lifetime index, which is, in War times, much lower than the standard lifetime, and largely sensitive to the postulated VSL. Therefore, although the two well-being indexes rely on exactly the same indifference map, these provide quite different pictures of the well-being loss due to the War. Those differences are due to the fact that the chosen metric imposes movements along the indifference curve in two opposite directions, which makes a big difference when one dimension of standards of living is much more valued than the other, as it is the case in Syria, where the extreme poverty leads to a low WTP, in money terms, for going back to pre-conflict survival conditions, and, necessarily, to a high WTP, in life-year terms, for going back to pre-conflict income standards.

In sum, our comparison of the equivalent income index and the equivalent lifetime index shows that the choice of the metric matters for well-being measurement. This is true when considering the comparison of well-being across individuals having distinct indifference maps, since resourcism and lifetimism are incompatible ways to carry out interpersonal comparisons, which can lead to opposite ranking across individuals. But even if one assumes a unique indifference map, the chosen metric still matters, not from a qualitative perspective (since rankings are here preserved), but from a quantitative perspective.

7 Bibliography

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