Beyond GDP: Is There Progress in the Measurement of Individual Well-Being and Social Welfare?*

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Abstract

This paper critically examines the various approaches to the measurement of individual well-being and social welfare that have been considered for the construction of alternatives to GDP, and scrutinizes the connections of these approaches with economic theory and with philosophical principles. Special attention is devoted to recent developments in the analysis of sustainability, in the study of happiness, in the theory of social choice and fair allocation and in the capability approach, as well as to the link between recent ideas and less recent parts of welfare economics, in particular the classical arguments behind real national income and the Bergson-Samuelson approach. It is suggested in the conclusion that not one but three broad (families of) alternatives to GDP are worth exploring.

1 Introduction

The purpose of this paper is to examine the main approaches to the measurement of social welfare that one encounters in the literature on alternative indicators to GDP and to propose some reflections on their foundations in economic theory and, secondarily, their connection with philosophical approaches. This paper focuses on theory and, with a few exceptions, does not scrutinize the frequent gap between foundations and applied measures, between concepts and statistics.

The construction of better indicators of social welfare is not only interesting for economic theorists, it is also, recurrently, a hot issue in public debate and a concern for politicians and governments. The last two decades have witnessed an explosion in the number of alternative indicators and a surge of initiatives from important institutions such as the OECD, the UNDP, the European Union — more recently the newly elected French President has appointed a committee, chaired by Joseph Stiglitz and including three other Nobel Prize winners, to propose new indicators of "economic performance and social progress". In the meantime, welfare economics has burgeoned in various directions, involving the theory of social choice, the theory of fair allocation, the capability approach, the study of happiness and its determinants, in

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conjunction with new developments in the philosophy of social justice and the psychology of well-being. These conceptual developments provide new analytical tools that may ultimately be useful for concrete measurements. About a decade ago, Slesnick made the following observation: "While centrally important to many problems of economic analysis, confusion persists concerning the relationship between commonly used welfare indicators and well-established theoretical formulations" (1998, p. 2108). It is probably safe to say that pretty much the same now holds about the relationship between concrete measures of welfare — old, new, and potential — and up-to-date theories.

These parallel developments in concrete initiatives and in the field of theory are related to a recurrent debate about the role of economic theory in the construction of indicators and about the articulation of expertise with participatory processes. Two extremes should presumably be avoided. One is the idea that there is one and only one good theory and that we should seek to find it and implement it through indicators directly inspired by it. This position is untenable in view of the current diversity of approaches, and in practice it is likely to produce some kind of technocratic imposition of values under the guise of expertise. The other extreme is to consider that the construction of indicators should be done by grassroot movements and general debates, avoiding all expertise that requires a technical knowledge inaccessible to the multitude. Such anti-intellectual stance is of course equally unacceptable. A middle-ground approach must be found, probably, in which basic values are made transparent to all while expertise is called upon to transform general principles into precise indicators. This paper does not seek to settle this issue but unashamedly ventures into theoretical terrain.

The various approaches examined in this paper are the following. Sections 2–4 deal with monetary measures. Section 2 re-examines classical results involving the value of total consumption and usually invoked in justification of GDP-like measures. Section 3 is devoted to the intertemporal extension of this approach, as featured in the Net National Product (NNP) and "green" accounting. Section 4 focuses on measures based on willingness-to-pay and money-metric utilities, and analyzes their relationship with social choice theory and fair allocation theory. Sections 5–7 explore non-monetary approaches. Section 5 is about social indicators such as the Human Development Index. Section 6 examines happiness studies in the light of the classical debate about welfarism. Section 7 deals with the capability approach. Section 8 makes concluding remarks about the relative strengths and weaknesses of the various approaches analyzed in the paper.

2 Total consumption

There is a long tradition of economic theory that seeks to relate social welfare to the value of total income or total consumption.[1] As we will see, however, most of the theory deals with the limited issue of determining the sign of welfare change rather than its magnitude, not to mention the level of welfare

[1] It is surveyed in Sen (1979) and Slesnick (1998). It has inspired important applications, most famously Nordhaus and Tobin (1972), who compute "a comprehensive measure of the annual real consumption of households. Consumption is intended to include all goods and services, marketed or not, valued at market prices or at their equivalent in opportunity costs to consumers." (p. 24)

itself.

2.1 A revealed preference argument

Start from the revealed preference argument that, assuming local non-satiation, if a consumer chooses a ℓ-commodity bundle x in a budget set defined by the ℓ-price vector p, then x is revealed preferred to all bundles y such that $py < px$. If x is interior and assuming differentiability, for an infinitesimal change dx, $x + dx$ is strictly preferred to x by the consumer if and only if $pdx > 0$. Note the importance of the interiority assumption here. If the consumer does not consume some of the goods, $pdx > 0$ is compatible with a decrease in satisfaction. To simplify matters, we suppose in this section that commodity bundles lie in the non-negative orthant $\mathbb{R}^{\ell}_{+}$.

This argument can be extended to social welfare $W(u_1(x_1), ..., u_n(x_n))$ and total consumption $X = x_1 + ... + x_n$ under various sets of assumptions. One approach consists in considering a representative agent who consumes X and whose utility $U(X)$ is identified to social welfare. This approach is quite discredited. Even when the aggregate demand is consistent with the behavior of a representative agent, there is little reason to identify the representative agent's revealed preferences with social welfare. Kirman (1992) has famously shown that the representative agent can appear to be better off even when all individual members of the population are actually made worse off. It must be noted, however, that the representative agent still survives — and is actually assumed to have infinite lifetime — in the literature on green accounting examined in the next section.

Another approach, due to Samuelson (1956), consists in assuming that X is optimally distributed, in the sense that $(x_1, ..., x_n)$ maximizes $W(u_1(x_1), ..., u_n(x_n))$ subject to the constraint $x_1 + ... + x_n = X$. Under this assumption there is a welfare function that depends on total consumption:

$$W^*(X) = \max W(u_1(x_1), ..., u_n(x_n)) \quad \text{s.c. } x_1 + ... + x_n = X. \tag{1}$$

It is much like a utility function and can serve to apply the revealed preference argument to total consumption for the evaluation of market allocations. The limitation of this approach is that it is not realistic to assume that consumption or wealth can be redistributed at will by lump-sum transfers (as is implicit in positing that the only constraint is $x_1 + ... + x_n = X$), and that the status quo is socially optimal. Dropping any of these two assumptions invalidates the approach. When the status quo is not optimal, an improvement in social welfare is even compatible, obviously, with a decrease in total consumption, not just a decrease in the value of total consumption. When redistribution is made by distortionary taxes, at a second-best optimum the social marginal value of income for different individuals typically remains unequal, so that a change of allocation that favors individuals with greater social marginal value may improve social welfare even if the market value of total consumption is reduced.

2.2 Decomposing welfare

A third approach consists in decomposing social welfare into a sum and a distributive component. Focusing on the sum can then be justified as legitimate under the explicit proviso that one ignores the

distributional aspect of social welfare. Consider a simple social welfare function defined directly on expenditures or incomes, $W(m_1, \ldots, m_n)$, and assumed to be increasing in each argument. Following Kolm (1969) and Atkinson (1970), one may compute the equally-distributed equivalent $e(m_1, \ldots, m_n)$, defined as the solution to

$$W(m_1, \ldots, m_n) = W(e(m_1, \ldots, m_n), \ldots, e(m_1, \ldots, m_n)).$$

For inequality averse social preferences, $e(m_1, \ldots, m_n)$ is less than the average $\mu(m_1, \ldots, m_n) = \frac{1}{n}\sum_i m_i$. The function $e(m_1, \ldots, m_n)$ is ordinally equivalent to $W(m_1, \ldots, m_n)$. This makes it possible to write the decomposition

$$e(m_1, \ldots, m_n) = \mu(m_1, \ldots, m_n) \times \frac{e(m_1, \ldots, m_n)}{\mu(m_1, \ldots, m_n)}, \tag{2}$$

in which the second term captures distributional preferences and the first term is average income. This kind of decomposition can be generalized but if one wants to have a term representing total or average income or expenditure, the argument of the function W must be the vector of incomes or expenditures, which is rather restrictive.[2]

There are other ways to make total expenditure appear in a decomposition. Slesnick (1998) proposes an additive decomposition of social welfare as measured by Pollak's (1981) social expenditure function, which is defined as follows, with a reference price vector p^* :

$$V(x_1, ..., x_n) = \min p^* (y_1 + ... + y_n) \quad \text{s.c. } W(u_1(y_1), ..., u_n(y_n)) \geq W(u_1(x_1), ..., u_n(x_n)). \tag{3}$$

Under mild regularity conditions, this function is well defined and is ordinally equivalent to $W(u_1(x_1), ..., u_n(x_n))$. The first term in Slesnick's decomposition is the value of Pollak's social expenditure function at p^* for the maximum level of social welfare that could be obtained by redistributing the total income at $(x_1, ..., x_n)$ at current prices. If $(x_1, ..., x_n)$ is a market allocation with current prices p^*, this equals p^*X. The second term is the difference between $V(x_1, ..., x_n)$ and the first term. Jorgenson (1990) makes a similar decomposition in a multiplicative fashion — the first term is total expenditure and the second term is the ratio of Pollak's social expenditure function to total expenditure:

$$V(x_1, ..., x_n) = p^*X \times \frac{V(x_1, ..., x_n)}{p^*X}. \tag{4}$$

A related kind of decomposition has been proposed earlier by Graaff (1977). He computes an efficiency index as the smallest fraction of any producible bundle which maintains everyone at current satisfaction,[3] normalizes social welfare as the smallest fraction of any producible bundle which maintains social welfare at its current level, and measures an equity index as the ratio of normalized social welfare over efficiency. Then normalized social welfare is the product of the efficiency and equity indexes. Graaff's

[2] This respects individual preferences only if prices are fixed (or at least relative prices, if income is deflated), and aversion to income inequality is defensible only if individuals have identical needs.

[3] This bears some similarity with Debreu's (1951) coefficient of resource utilization (which is the smallest fraction of the resources available before production that would have made it possible, given the technology and the preferences, to maintain everyone at current satisfaction — unlike Graaf's measure, this coefficient depends on the role of commodities as net inputs or net outputs in production).

efficiency term is based on the Scitovsky frontier and one may regret that a similar measure of the efficiency of the current allocation is absent from the decompositions proposed by Slesnick and Jorgenson — in effect, they restrict attention to efficient allocations. On the other hand, Graaff's decomposition does not feature total expenditure and his measure of normalized social welfare is not invariant to changes in production possibilities, unlike Pollak's social expenditure function. In the Appendix it is shown how one can try to combine the advantages of these two kinds of decomposition and derive a decomposition involving total expenditure, efficiency, and equity.

For small variations, assuming differentiability an altogether different (and simpler) decomposition of social welfare is

$$dW(u_1(x_1),...,u_n(x_n)) = \beta\ pdX + \sum_{i=1}^{n} (\beta_i - \beta)\,(pdx_i - pdX/n)\,, \tag{5}$$

where

$$\begin{aligned} \beta_i &= \frac{\frac{\partial W}{\partial u_i} du_i}{pdx_i} = \frac{\sum_{k=1}^{\ell} \left(\frac{\frac{\partial W}{\partial u_i}\frac{\partial u_i}{\partial x_{ik}}}{p_k} \right) p_k dx_{ik}}{pdx_i}, \\ \beta &= \frac{1}{n}\sum_{i=1}^{n} \beta_i. \end{aligned}$$

It is most intuitive to read this formula while thinking of an initial market allocation with price vector p, although the formula is of a purely accounting sort — it involves no behavioral assumption — and holds for any arbitrary price vector. For an interior market allocation, the ratio $\frac{\partial W}{\partial u_i}\frac{\partial u_i}{\partial x_{ik}} \Big/ p_k$ does not depend on k (β_i then coincides with it) and equals the social marginal value of money for i, i.e., the maximum increase in W that can be obtained by spending an additional dollar on i. In general, β_i is simply the actual marginal social return on the incremental money spent on i (it can even be negative if $du_i < 0$ while $pdx_i > 0$, as can happen in a non-interior allocation). The second term in the decomposition depends on the correlation between the social priority of individuals and their consumption variation and is quite intuitive for a distributional term.[4]

Do formulae like (4) and (5) make it legitimate to focus on the evolution of total expenditure provided it is explicitly stated that distributive issues are ignored? The fact that both formulae can be computed equally well for arbitrary price vectors suggests that one should not make too much of such decompositions. A catastrophe can often be described as the combination of an even greater catastrophe with some good event — it seldom gives a serious reason to rejoice. On the other hand, an analysis of the evolution of social welfare based on such decompositions should obviously appear as useful information if all the terms of the decomposition are computed and displayed. In this light, standard aggregate income or expenditure figures are (no more, but no less than) a relevant part of the full picture.

[4] It is reminiscent of the "distributional characteristic" (Feldstein 1972a,b, Atkinson and Stiglitz 1980) that plays an important role in the analysis of optimal indirect tax or public pricing. However, the distributional characteristic depends on the correlation between β_i and the *level* rather than the *variation* of consumption of a commodity.

2.3 A variant of the revealed preference argument

Sen (1976) considers a variant of the revealed preference argument. If consumer preferences are convex, at any bundle x there is a price vector p such that for all bundles y, $py < px$ implies that x is preferred to y. This argument does not assume that x maximizes utility in the budget set, which means that the vector p need not coincide with market prices. In fact some components of x may not even be marketed.

As explained by Sen, this argument can be immediately extended to social welfare if social welfare is measured by a Bergson-Samuelson function $\overline{W}(x_1, ..., x_n)$ — defined directly on quantities — that is quasi-concave. But the corresponding price vector $\bar{p}$ must then have $n\ell$ components. If $(x_1, ..., x_n)$ is a market allocation in which all individuals face the same ℓ-price vector p, then the $n\ell$-vector $\bar{p}$ can be chosen such that the ratios $\bar{p}_{ik}/\bar{p}_{il}$ (individual i, commodities k and l) are the same for all i. The computation of the inner product $\bar{p} \cdot (x_1, ..., x_n)$ then simply boils down to $\alpha_1 px_1 + \cdots + \alpha_n px_n$, for a vector of weights $(\alpha_1, \ldots, \alpha_n)$ which embodies distributional preferences. If these weights are scaled so that $\alpha_1 + \cdots + \alpha_n = n$, the sum can be decomposed into two terms:

$$pX \times \frac{\alpha_1 px_1 + \cdots + \alpha_n px_n}{pX}, \tag{6}$$

the second of which is less than unity if $(\alpha_1, \ldots, \alpha_n)$ and $(px_1, ..., px_n)$ are inversely ranked, i.e., in case of inequality aversion over expenditures. For instance, if the weights are simply proportional to the ranks (by decreasing order) of the individuals in $(px_1, ..., px_n)$, one computes

$$\frac{\alpha_1 px_1 + \cdots + \alpha_n px_n}{pX} = 1 - G(px_1, ..., px_n), \tag{7}$$

where $G(px_1, ..., px_n)$ is the Gini coefficient.[5]

2.4 Limitations of the approach

A noteworthy feature of the approaches described in this section is their silence about how to make interpersonal comparisons — with two exceptions: the income approach in (2) and the rank-order weighting based on the value of consumption in (7). The various approaches assuming that the distribution is optimal, or that it is described in a separate term as in decompositions (4)-(6), make it possible to focus on total consumption without even specifying further the distributive judgments. The function $\overline{W}(x_1, \ldots, x_n)$ or $W(u_1(x_1), \ldots, u_n(x_n))$ that is referred to in these constructions could be based on many different sorts of evaluation of individual well-being. That can be viewed as an advantage because it makes a focus on total expenditure compatible with many different distributive principles. But as soon as one wants to also evaluate the distribution, it creates a danger. Indeed, formulae such as (5) and (6) naturally suggest to take the monetary value of individual consumption as the measure of individual well-being, and this is indeed done explicitly in (7). It is, however, important to be aware that the theory itself does not give any reason to adopt this measure of individual well-being. Independent arguments

[5] Such rank-order weights are, however, very special and cannot be used in general. Indeed, Hammond (1978) shows that the partial ordering of allocations generated by this approach is compatible with a Paretian social welfare function $\overline{W}(x_1, ..., x_n) = W(u_1(x_1), ..., u_n(x_n))$ only if all individual Engel curves are linear and identical.

are needed. Here is an example of such an argument. In the theories of justice proposed by Rawls (1971) or Dworkin (2000), social justice consists in allocating resources in a fair way, letting individuals make use of the resources at their disposal according to their own conception of the good life. If one ignores differences in internal resources (talent, disabilities), the fair distribution is that which maximizes the smallest share of resources — the market valuation appearing the most convenient for the comparison of resource shares.[6] In sum, individual wealth is then a suitable measure for interpersonal comparisons. The market value of individual consumption can then be defended as a reasonable proxy for comparisons of wealth.

If internal resources are unequal, this line of argument no longer supports the market value of consumption as a proper metric. A very important example concerns the valuation of leisure time, which is part of consumption broadly construed. The two variants of the revealed preference argument that have been invoked in this section both advocate using individuals' net wage rate as the proper valuation of leisure time. There is nothing objectionable in this practice if one refrains from making interpersonal comparisons. Extrapolating this approach to interpersonal comparisons would mean comparing full incomes across individuals, considering that those with a greater full income are better off and that it would be nice to reduce inequalities in full incomes. This is, however, a case in which the extrapolation from total valuation to interpersonal comparisons is highly questionable. Equalizing full incomes across individuals would imply that those with greater productivity would have strictly smaller budget sets than those with lower productivity, in a strange reversal from the laisser-faire situation. Moreover, they would be forced to work to pay their taxes, implying what Dworkin (2000) called a "slavery of the talented". The literature on fairness has proposed various reasonable ways of comparing the resource shares of individuals with unequal productivity.[7] From the perspective of fairness theory, full income is an extreme, quite unreasonable, metric for interpersonal comparisons.

Other limitations of the theory described in this section are linked to the fact that, at the exception of the decompositions (2)–(5), the purpose is only to justify the claim that if, for the prices p prevailing at X, one has $pX > pY$, then X is better than Y in some relevant sense. Beyond the obvious fact that this yields a very partial criterion, two specific issues are worth stressing.

One important shortcoming — which also plagues the decompositions (4)–(5) — is that this approach cannot be used to compare the situations of two *different* populations, as in international comparisons, or intertemporal comparisons over substantial time spans. It can only serve to examine a change of consumption for a given population with given preferences. Sen (1976) examines this problem and shows that, under the mild additional principle that only the statistical distribution of individual situations matters, not the size of the population, the approach can be extended to comparisons between populations in a limited way: specifically, one can then check if the population in one country is better off than if it were served the distribution of consumption of another country. Concretely this is done by checking if

[6] Rawls' list of primary goods includes non-marketed items such as basic freedoms, the powers and prerogatives of positions of responsibility, and the social bases of self-respect. Wealth is only one item.

[7] They are connected to the money-metric approach that is discussed in Section 4. For a survey that also includes the issue of unequal consumption needs, see Fleurbaey (2008).

$\alpha_1 px_1 + \cdots + \alpha_n px_n > \alpha_1 py_1 + \cdots + \alpha_n py_n$, where $i = 1, \ldots, n$ refer to n-quantiles instead of concrete individuals. But this sort of comparison is still very partial — it is for instance possible to find in some cases that country A is better off (in its eyes) than country B and that country B is also better off (in its eyes) than country A.

Another limitation is that, not only is the criterion silent in some comparisons, but when it is conclusive, one does not get a *quantitative* evaluation of welfare change, as would be obtained with an index number such as GDP in volume. It is only in the decompositions (4)–(5) that one can give a quantitative meaning to the evolution of total consumption at certain well-defined prices. More direct attempts to obtain numerical estimates can be found in the theory of index numbers.

2.5 Toward an index

Initiated by Fisher (1922), the theory of index numbers has burgeoned in three directions. One consists in defining desirable properties for the price and quantity indexes. Here are three examples of such properties. The first says that the product of the price index and the quantity index must equal the value index. The second says that when the price vector is unchanged, the quantity index must equal the value index. The third says that reversing time should yield inverse values of indexes.

$$P(p^1, p^0, x^1, x^0)\; Q(p^1, p^0, x^1, x^0) = \frac{p^1 x^1}{p^0 x^0}; \tag{8}$$

$$Q(p, p, x^1, x^0) = \frac{p x^1}{p x^0}; \tag{9}$$

$$P(p^1, p^0, x^1, x^0)\; P(p^0, p^1, x^0, x^1) = 1. \tag{10}$$

Diewert (1992b) provides a list of 21 axioms of this sort, and shows that the pair of Fisher indexes

$$P^F(p^1, p^0, x^1, x^0) = \left(\frac{p^1 x^0}{p^0 x^0}\frac{p^1 x^1}{p^0 x^1}\right)^{1/2},$$

$$Q^F(p^1, p^0, x^1, x^0) = \left(\frac{p^0 x^1}{p^0 x^0}\frac{p^1 x^1}{p^1 x^0}\right)^{1/2},$$

satisfies all of them and is the only one to do so (the characterization, however, involves quite controversial axioms).[8] Observe for instance that the Laspeyres and Paasche indexes do not satisfy (10). The axioms in this first branch of the theory are not, however, directly connected with welfare considerations and that is a serious shortcoming.

The second branch of the theory of index numbers seeks indexes which depend only on price and quantity data but are good approximations of measures of welfare change such as equivalent variations.

[8] In addition to (8) and (10) and the requirement that the indexes be positive, the characterization relies on the following properties, which impose symmetry among the weights of periods 0 and 1:

$$P(p^1, p^0, x^1, x^0) = P(p^1, p^0, x^0, x^1),$$
$$Q(p^1, p^0, x^1, x^0) = Q(p^0, p^1, x^1, x^0).$$

Diewert (1992a) notes that various formulae proposed in the literature have proved unsatisfactory because they involved dubious approximations or assumptions. He suggests an approach that consists in seeking functional forms for the expenditure functions which are (*i*) flexible enough so that they provide good approximations to the second order of any twice differentiable expenditure function, and (*ii*) simple enough so that the corresponding equivalent variation depends only on price and quantity data. The obtained measure of equivalent variation is called "superlative" by Diewert, who provides several examples, among which one involves the geometric mean of the Laspeyres and Paasche indexes (i.e., the Fisher index) and another involves the arithmetic mean:[9]

$$p^0x^0\left[\left(\frac{p^0x^1}{p^0x^0}\frac{p^1x^1}{p^1x^0}\right)^{1/2}-1\right]; \tag{11}$$

$$p^0x^0\left[\frac{1}{2}\frac{p^0x^1}{p^0x^0}+\frac{1}{2}\frac{p^1x^1}{p^1x^0}-1\right]. \tag{12}$$

A limitation of this approach is that it is strictly local and cannot be used for the study of large welfare changes. Even for local applications, it is puzzling that different expressions, which equally pretend to be good approximations of the equivalent variation, may have different signs in certain cases.[10] No approximation result can circumvent the hard fact that price and quantity data cannot completely determine the sign of welfare changes, even locally.

The third branch, initiated by Samuelson and Swamy (1974), seeks indexes which, contrary to those examined in the previous paragraphs, may depend on individual preferences and not just on prices and quantities, while retaining typical features of index numbers. A particularly interesting proposal is the money-metric utility function $e(p^*, u(x))$, which computes the minimal expenditure required to obtain the same satisfaction as with x at reference prices p^*, and which is therefore measured in monetary units. Another famous proposal is the ray utility function defined by the property $u(x) = u(u(x)x^*)$, for a reference bundle x^*. This utility is unitless but corresponds to fractions of a bundle and can therefore be also treated like a quantity index.[11] This approach is more demanding because it requires data on preferences, not just on prices and quantities. The counterpart is that, contrary to the previous

[9] The second formula was proposed in Weitzman (1988).

[10] Even when the Laspeyres and Paasche indexes are arbitrarily close to unity, their geometric mean can be lower than unity while their arithmetic mean is greater. The explanation of this apparent contradiction in the results is that each formula for the equivalent variation is correct only when the true expenditure function is exactly equal to a particular flexible function (one for each formula) over a range spanning the initial utility u^0 and the final utility u^1. Otherwise there is an error term, which converges to zero when u^1 tends to u^0 but may remain larger than the welfare change throughout. Diewert (1992a) provides results to the effect that the different formulae approximate each other to the second order, but only for the case when p^1 and x^1 are proportional to p^0 and x^0, respectively — observe that x^1 being proportional to x^0 is enough for the two expressions (11) and (12) of the equivalent variation to be equal.

[11] This function, discussed, among others, in Malmquist (1953), Samuelson (1977), Pazner (1979), is also linked to the "distance function" studied in Deaton (1979), which can be defined by the formula

$$d(v,q)=\frac{1}{u(x)},$$

where u is the ray utility function with reference q and v is the utility level (for any given utility function) of the individual at x.

approaches, these indexes do always reflect preferences. Another interesting feature is that they that can serve for comparisons between different individuals with different preferences, if an ethical justification can be provided for such comparisons. Money-metric utilities (also named "equivalent incomes" by King 1983) have been popular in the 1970s and early 1980s,[12] but various objections have been raised against using such utility functions in the context of social welfare evaluation. These objections will be examined in Section 4.

On the basis of Pollak's (1981) social expenditure function, it has been proposed to apply the money-metric utility function at the social level directly. The function $V(x_1, ..., x_n)$ defined in (3) is indeed a social money-metric utility function, with reference prices p^*. Being expressed in monetary units, its evolution in time can be compared to that of GDP, no matter what social welfare function $W(u_1(x_1), ..., u_n(x_n))$ is adopted. Along this vein, Jorgenson (1990, 1997) and Slesnick (2001), for instance, boldly adopt a particular specification for the indirect utility function of households, estimate it on demand data (making restrictions in order to be able to perform the estimation on aggregate demand), define a social welfare function that incorporates some degree of inequality aversion, and compute an index of social welfare with $V(x_1, ..., x_n)$. The specific calibration of utility functions chosen by Jorgenson and Slesnick is not provided much justification, apart from the æsthetic feature that these functions essentially correspond to the logarithm of expenditure. The main limitation of the Pollak approach, obviously, is that it needs a well-defined social welfare function as an input and does not help at all in its construction. This approach is useful only in the translation of a social welfare function into a monetary index. Moreover, it cannot in general be extended to comparisons of situations across populations with different preferences. Such an extension would require that for all profiles of utility functions $(u_1, \ldots, u_n)$, $(u'_1, \ldots, u'_n)$, with associated social welfare functions W, W', the corresponding V, V' functions should be such that

$$V(x_1, ..., x_n) = V'(x'_1, ..., x'_n) \text{ if and only if } W(u_1(x_1), ..., u_n(x_n)) = W'(u'_1(x_1), ..., u'_n(x_n)). \tag{13}$$

This is a very demanding property. It can be satisfied when the original social ordering is based on money-metric utilities at the individual level (for the same reference price p^* as that used for V, V'), but it is hard to see how its scope of validity could be broader.[13] Therefore, this approach does not make much progress compared to the application of money-metric utilities at the individual level.

[12] See in particular Deaton and Muellbauer (1980).

[13] Consider a social welfare function $W(u_1(x_1), ..., u_n(x_n))$. It can be rewritten as a function of individual money-metric utilities:

$$W(u_1(x_1), ..., u_n(x_n)) = \hat{W}(e(p^*, u_1(x_1)), ..., e(p^*, u_n(x_n))).$$

The function $V(x_1, ..., x_n)$ is simply the value of the expenditure function of $\hat{W}$ at price $(1, \ldots, 1)$:

$$V(x_1, ..., x_n) = \min e_1 + ... + e_n \quad \text{s.c. } \hat{W}(e_1, ..., e_n) \geq W(u_1(x_1), ..., u_n(x_n)).$$

Therefore, (13) means that the corresponding $\hat{W}$ and $\hat{W}'$ have the same expenditure function at price $(1, \ldots, 1)$. This, in itself, does not put any logical constraint on the ordinal properties of $\hat{W}$ and $\hat{W}'$. But the identity of expenditure functions at a particular price seems an unlikely coincidence. Now, if $\hat{W}$ and $\hat{W}'$ have the same expenditure function at *all* prices, they are identical, which implies that the social ordering is always defined as the same social welfare function $\hat{W}$ on individual money-metric utilities.

In conclusion, although the market value of total consumption at initial or final prices can be given some justification as a partial indicator (partial in at least one of two ways: an incomplete ordering; ignoring distribution) of welfare variation, it is of little use for comprehensive and quantitative assessments. Particularly limiting is the restriction in most approaches described here to the comparison of bundles or budget sets for *given* preferences, rather than across different situations involving *different* preferences.[14] Money-metric utilities at the individual level appear more promising in this respect and are the topic of Section 4.

3 NNP and green accounting

Total consumption should ideally be computed over a lifetime, or at least over some reasonable life horizon. Statistics like national income or GDP add up consumption and savings (or investment). One can of course take savings as an argument of individual utility and proceed as in the previous section, but that is much less satisfactory than a rigorous treatment deriving the utility of savings from the prospect of future consumption (or bequest). Similarly, the depletion of natural resources should not just be counted as immediate consumption if it reduces the prospects for future consumption.

3.1 Wealth and social income

The motivation for computing NNP has originally come from the idea of measuring the wealth of a nation and the corresponding sustainable level of consumption.[15] NNP is equal to the amount of consumption that is compatible with keeping the stock of capital constant. Population growth and exogenous technical progress complicate the matter a little. One may then compute the total amount of consumption compatible with keeping per capita consumption constant in the future (implying a reduction in capital per capita compensated by technical progress).[16] The problem with a measure of wealth (or sustainable consumption) is that it tells little about the real prospects for future generations. Depending on how the present generation manages its stock of wealth, the future may look very different. NNP-like statistics, apparently, neglect this issue entirely because they simply ignore whether the present generation consumes more or less than the sustainable level they measure. In a nutshell, this kind of measure may appear myopic.

[14] The following view, quoted from Weitzman (2001, p.8) justifying an assumption of identical preferences over two countries, is probably shared by many authors: "Unless preferences are postulated to be comparable in some way across any two situations, it is impossible to make rigorous general welfare comparisons." It will argued in Section 4 that this is unduly pessimistic.

[15] See Samuelson (1961), Nordhaus and Tobin (1972).

[16] Alternatively, one may compute the amount of consumption compatible with keeping a growth rate of per capita consumption equal to the rate of technical progress. Nordhaus and Tobin (1972, p. 34) favor this approach with the following argument: "Our proposed measure ... is more austere and, we believe, more consonant with revealed social preference. We do not observe current generations consuming capital on the grounds that successors will reap the benefits of technological progress." Taking account of natural capital, one might object that the frivolous approach, or even worse, has actually prevailed.

3.2 Constant-equivalent consumption

An interesting approach, initiated by Weitzman (1976), consists in computing the constant equivalent consumption to the planned consumption path. Much of the literature on green accounting[17] focuses on optimal growth paths, which is of little practical interest. Following Dasgupta and Mäler (2000) and Asheim (2007a), one can however develop a reasoning for any arbitrary path.

Suppose the consumption C_t (a real number) over the time interval $[0, +\infty)$ is limited by the evolution of a real vector of stocks denoted S_t, which includes produced capital, natural resources, technological knowledge, and any other kind of social and human capital that influences consumption possibilities. The variation of these stocks over time is governed by a system of equations

$$\frac{dS_t}{dt} = F(S_t, C_t, R_t).$$

In these equations, R_t is a vector of instruments such as investment in research or replenishment and F is a vector of functions. There is no exogenous technical progress, which is partly justified by the fact that S_t can be as comprehensive as one wishes.[18] The population is assumed to remain constant.[19]

Consider an arbitrary program[20] that defines the evolution path of all the variables C, S, R over any subinterval $[t, +\infty)$ as a function of the stock S_t available in t. We assume throughout this section that this program is independent of t and time-consistent. This program makes it possible to define a function computing the present value of the future consumption path

$$Z(S_t) = \int_t^{+\infty} e^{-\delta(\tau - t)} C_\tau(S_t) d\tau. \tag{14}$$

The corresponding constant equivalent consumption equals $Z(S_t) \Big/ \int_t^{+\infty} e^{-\delta(\tau-t)} d\tau = \delta Z(S_t)$.

Recall that this program need not be optimal or efficient. One can nonetheless compute the corresponding "accounting prices" $p_t = \nabla Z(S_t)$. By the assumption that the program is independent of t and time-consistent, the evolution of $Z(S_t)$ over time equals

$$\frac{d}{dt} Z(S_t) = p_t \frac{dS_t}{dt}.$$

From (14) one also directly computes

$$\frac{d}{dt} Z(S_t) = \delta Z(S_t) - C_t(S_t) + \int_t^{+\infty} e^{-\delta(\tau-t)} \nabla C_\tau(S_t) \frac{dS_t}{dt} d\tau,$$

in which the last term is null because time consistency requires $C_\tau(S_t) = C_\tau(S_{t+dt})$ along the path.[21]

[17] Syntheses of the theory are provided by Asheim (2000) and Heal and Kilström (2005).

[18] Climate change and variations in terms of trade, however, should require making the technology time dependent.

[19] On the variable population case, see Arrow et al. (2003b).

[20] This is called a "resource allocation mechanism" in the literature. In Dasgupta and Mäler (2000), a "program" is a particular path of all variables over the future.

[21] Rigorously, one should write functions in which the value of initial stocks is distinguished from its time: $C_\tau(S;t), S_\tau(S;t), R_\tau(S;t)$. Time consistency requires: $C_\tau(S;t) = C_\tau(S_{t'}(S;t);t')$ for all $\tau \geq t' \geq t$. Time invariance requires: $C_{t+\tau}(S;t) = C_{t'+\tau}(S;t')$ for all $\tau \geq 0$ and all t, t'.

Combining these two equalities, one obtains

$$\delta Z(S_t) = C_t(S_t) + p_t \frac{dS_t}{dt}. \tag{15}$$

On the left-hand side, one has the constant equivalent consumption. On the right-hand side, the expression looks very much like NNP.[22] What is remarkable about this formula is that, while $Z(S_t)$ depends on the whole future of the economy, the expression on the right-hand side depends only on current variables of flows and prices. It therefore seems to invalidate Samuelson's conclusion that in a dynamic setting welfare cannot be measured in terms of income but only in terms of wealth, with serious difficulties because "there is so much "futurity" in any welfare evaluation of any dynamic situation as to make it exceedingly difficult for the statistician to approximate to the proper wealth comparisons" (1961, p. 53).

3.3 Is that NNP?

Before one can deduce from this reasoning that NNP is a good measure of social welfare, many obstacles have to be taken into consideration. They fall under two headings. First, (15) is not the usual notion of NNP from national accounts. Second, (15) need not be a good measure of social welfare, even assuming a representative agent, as is typically done in this literature.

The formula in (15) does not correspond to standard NNP, and is hard to estimate in practice, because the stock S_t encompasses much more than physical capital, and because accounting prices are not market prices unless, as assumed in Weitzman's results, there is a complete set of markets and the path is a market equilibrium in which an infinitely-lived representative agent maximizes a utility function that is ordinally equivalent to the discounted sum defining $Z(S_t)$. When this is not the case, in particular when the market equilibrium is not efficient, because for instance the depletion of natural resources involves a tragedy of the commons between different agents, or because the environment involves external effects, the market prices are not reliable indicators for the estimation of accounting prices.[23] Valuing natural resources may be rather difficult, and valuing other stock variables such as technological knowledge or social capital may be even harder. It already appears very demanding that S_t should not only incorporate natural resources but also any other stock variable which influences future consumption prospects. But measuring quantities is the easiest part of the exercise. It is the evaluation of accounting prices p_t which bears the whole load of "futurity" that Samuelson found daunting and that has not

[22] One also recognizes in the right-hand side a form of the Hamiltonian at $\tau = t$. More precisely, one has

$$H_\tau = e^{-\delta(\tau - t)} C_\tau + \lambda_\tau F(K_\tau, L_\tau, C_\tau, R_\tau),$$

with a vector of costate variables λ. If one chooses $\lambda_t = p_t$, (which must be true at a path satisfying the equations of the maximum principle — recall that the path under consideration here need not be optimal, but when the maximum principle equations are not required any choice of costate variables is permissible), one has

$$H_t = C_t + p_t \frac{dS_t}{dt}.$$

[23] See, e.g., Dasgupta and Heal (1979). More recent syntheses include Freeman (1992), Arrow et al. (2003a), Heal and Kriström (2005).

magically disappeared, unfortunately, in the derivation of (15).

3.4 Is that social welfare?

The second set of issues has to do with the point that the connection between (15) and social welfare is problematic. Many authors have criticized Weitzman (1976, 1998) for assuming that social welfare is the discounted sum of consumption, which implies in particular the absence of inequality aversion across generations. Moreover, when consumption is multidimensional the level of NNP cannot be so easily interpreted and a variant of Weitzman's holds only for infinitesimal variations of NNP through the proportionality between marginal utility and market prices for commodities. We examine these issues by modifying the framework slightly.

Assume now that C_t is a vector (including also labor, in particular) and that social welfare is computed as a discounted sum of utility

$$Z^*(S_t) = \int_t^{+\infty} e^{-\delta(\tau - t)} U(C_\tau(S_t)) d\tau,$$

which takes account of inequality aversion via decreasing marginal utility. From similar computations as in the previous subsection, the constant-equivalent flow of utility equals:

$$\delta Z^*(S_t) = U(C_t(S_t)) + p_t \frac{dS_t}{dt}, \tag{16}$$

where the accounting prices are computed anew with respect to $Z^*(\cdot)$. We also have

$$\frac{d}{dt} Z^*(S_t) = p_t \frac{dS_t}{dt}.$$

Moreover, differentiating (16) and letting $q_\tau = \nabla U(C_\tau(S_t))$, one computes:

$$\delta \frac{d}{dt} Z^*(S_t) = q_t \frac{d}{dt} C_t(S_t) + p_t \frac{d^2 S_t}{dt^2} + \frac{dp_t}{dt} \frac{dS_t}{dt}.$$

Suppose that NNP_t is computed with prices $(\hat{q}_t, \hat{p}_t)$ proportional to (q_t, p_t) and is therefore equal to $\alpha_t \left(q_t C_t + p_t \left(dS_t/dt\right)\right)$ for some $\alpha_t > 0$. Its variation at fixed prices is then proportional to

$$q_t \frac{dC_t}{dt} + p_t \frac{d^2 S_t}{dt^2}$$

and is therefore *not* proportional to the variation in constant-equivalent utility, for lack of a term involving the change in accounting prices of S_t. Another option, proposed by Asheim and Weitzman (2001), is to deflate $(\hat{q}_t, \hat{p}_t)$ by a *consumer* (not an NNP) price index π_t satisfying the Divisia property

$$\frac{1}{\pi_t} \frac{d\pi_t}{dt} = \frac{\frac{d\hat{q}_t}{dt} C_t}{\hat{q}_t C_t}. \tag{17}$$

One then obtains

$$\frac{d}{dt}\left(\frac{\mathrm{NNP}_t}{\pi_t}\right) = \frac{\hat{q}_t}{\pi_t} \frac{dC_t}{dt} + \frac{d\left(\hat{q}_t/\pi_t\right)}{dt} C_t + \frac{\hat{p}_t}{\pi_t} \frac{d^2 S_t}{dt^2} + \frac{d\left(\hat{p}_t/\pi_t\right)}{dt} \frac{dS_t}{dt},$$

where the second term vanishes by (17). This can be rewritten

$$\begin{aligned}\frac{d}{dt}\left(\frac{\text{NNP}_t}{\pi_t}\right) &= \frac{1}{\pi_t}\left(\hat{q}_t\frac{dC_t}{dt}+\hat{p}_t\frac{d^2S_t}{dt^2}+\alpha_t\frac{dp_t}{dt}\frac{dS_t}{dt}\right)+\frac{1}{\pi_t}\frac{d\alpha_t}{dt}p_t\frac{dS_t}{dt}-\frac{1}{\pi_t^2}\frac{d\pi_t}{dt}\hat{p}_t\frac{dS_t}{dt}\\ &= \frac{\alpha_t}{\pi_t}\left(\delta-\frac{1}{\pi_t}\frac{d\pi_t}{dt}+\frac{1}{\alpha_t}\frac{d\alpha_t}{dt}\right)\frac{d}{dt}Z^*(S_t),\end{aligned}$$

which shows that with this price index, the variation of real NNP_t is proportional to the variation of $Z^*(S_t)$ provided the "real interest rate"[24] $\delta-\frac{1}{\pi_t}\frac{d\pi_t}{dt}+\frac{1}{\alpha_t}\frac{d\alpha_t}{dt}$ is positive.[25]

Building on Samuelson (1961), Heal and Kilström (2005, 2008) propose to seek a more direct adaptation to the dynamic context of the local version of the revealed preference argument of the previous section. Consider the value of consumption at supporting prices $q_\tau=\nabla U(C_\tau(S_t))$:

$$\overline{Z}^*(S_t)=\int_t^{+\infty}e^{-\delta(\tau-t)}q_\tau C_\tau(S_t)d\tau.$$

One computes, for any particular kth component of S_t :

$$\begin{aligned}\frac{\partial}{\partial S_{tk}}\overline{Z}^*(S_t) &= \int_t^{+\infty}e^{-\delta(\tau-t)}\nabla U(C_\tau(S_t))\frac{\partial}{\partial S_{tk}}C_\tau(S_t)d\tau\\ &= \frac{\partial}{\partial S_{tk}}Z^*(S_t).\end{aligned}$$

As a consequence,

$$\frac{d}{dt}\overline{Z}^*(S_t)=\frac{d}{dt}Z^*(S_t)=p_t\frac{dS_t}{dt}.$$

The evolution of welfare can therefore also be interpreted in terms of a notion of intertemporal income, computed over the whole consumption path at supporting future prices, and measurable by the evolution of stocks at current accounting prices. As before, one can also directly compute

$$\frac{d}{dt}\overline{Z}^*(S_t)=\delta\overline{Z}^*(S_t)-q_tC_t(S_t),$$

implying that

$$\delta\overline{Z}^*(S_t)=q_tC_t(S_t)+p_t\frac{dS_t}{dt}.$$

If the proportionality coefficient α_t that relates $\hat{q}_t$ to q_t is constant over time, one then obtains an interpretation of NNP in terms of intertemporal income evaluated at prices $\hat{q}_\tau$, as a direct extension of (15):

$$\text{NNP}_t=\alpha_t\left(q_tC_t(S_t)+p_t\frac{dS_t}{dt}\right)=\delta\int_t^{+\infty}e^{-\delta(\tau-t)}\hat{q}_\tau C_\tau(S_t)d\tau.$$

These results show that one cannot connect NNP or intertemporal income to a meaningful level of welfare, but only to evolutions of welfare over time or in response to policy changes. The limitations of the revealed preference approach listed in the previous section apply equally well to these developments for the

[24] Note that

$$\frac{1}{\pi_t}\frac{d\pi_t}{dt}-\frac{1}{\alpha_t}\frac{d\alpha_t}{dt}=\frac{\frac{dq_t}{dt}C_t}{q_tC_t}.$$

[25] See Asheim (2007a) for an extension of this result to a more general objective than discounted utilitarianism.

dynamic context, with the additional twist that the prices p_t are even harder to estimate. Comparisons across countries are still problematic, not only when the populations have different preferences but also when the countries follow different programs because their respective accounting prices are then different. In conclusion, not much progress is achieved with respect to the static context and, as could only be expected, more complications arise.

3.5 To discount or not to discount?

Another critical issue is whether social welfare, in the intergenerational context, should be defined as a discounted sum of utility. Discounting appears to violate the most minimal requirement of impartiality between individuals living at different times and many authors, after Sidgwick (1907) and Ramsey (1928), have rejected it vehemently. In absence of discounting, however, a social welfare function with finite aversion to inequality faces a problem of infinite sum. A vast literature has addressed this issue, with many recent developments.[26] A striking result, due to Zame (2007),[27] is that a social ordering over infinite utility streams satisfying Weak Pareto (i.e., if utility at each period is increased, this is a strict improvement) and finite anonymity (i.e., permuting the utility of two periods gives an equivalent stream) cannot be constructible. In order to get a sense of the problem, consider two slightly stronger requirements, Strong Pareto (i.e., if utility is increased at one period and decreased at none, this is a strict improvement) and adjacent anonymity (i.e., permuting the utilities of adjacent periods gives an equivalent stream, even when infinitely many pairs are permuted).[28] The latter requirement means in particular that $(0, 1, 0, 1, \ldots)$ is equivalent to $(1, 0, 1, 0, \ldots)$, and that, starting the transpositions from the second period, $(1, 0, 1, 0, 1, \ldots)$ is equivalent to $(1, 1, 0, 1, 0, \ldots)$. By transitivity, one concludes that $(0, 1, 0, 1, \ldots)$ is equivalent to $(1, 1, 0, 1, 0, \ldots)$, a clear violation of Strong Pareto.[29] It is clear that such difficulties, in this particular field, come from the infinite horizon. These problems are intellectually fascinating and challenging, but for practical purposes, one may be worried about making concrete decision criteria depend in a deep fashion on the non-finiteness of the horizon.

A more promising — and realistic — approach might be to work with a finite but uncertain horizon. Interestingly, this approach may not bring back a standard discounted sum of utilities with a discount factor equal to the survival probability. The literature addressing the problem in this way is sparse[30] and this is probably a promising field of research, albeit full of difficulties because it combines the theory

[26] A sample of such developments, with ample reference to the recent and less recent literature, can be found in Roemer and Suzumura (2007).

[27] See also Lauwers (2006) for a very similar result.

[28] Restricting adjacent anonymity to a finite number of permutations gives a condition that is equivalent to finite anonymity. To see the difference between finite anonymity and adjacent anonymity, observe for instance that the overtaking criterion (which weakly prefers a utility stream if and only if the sum of utilities is at least as great for all dates except a finite number) violates adjacent anonymity but satisfies finite anonymity.

[29] Discounted utilitarianism is transitive, complete and constructible, it satisfies Strong Pareto but violates adjacent (and finite) anonymity. The $\liminf$ criterion satisfies adjacent anonymity and is transitive, complete and constructible, but it violates Strong (and Weak) Pareto.

[30] Dasgupta and Heal (1979) is a classical reference. A recent paper addressing this problem, and showing that the discount factor need not correspond to the probability of survival, is Bommier and Zuber (2008).

of social choice under uncertainty with the study of population ethics.[31] Indeed, in order to assess a prospect with uncertain horizon, one needs a well defined measure of intertemporal social welfare for any finite population size. For instance, take Ng's (1986) number-dependent utilitarian criterion

$$W(u_1, \ldots, u_n) = \frac{f(n)}{n} \sum_{i=1}^{n} u_i,$$

where f is a non-decreasing function such that $1 \leq f(n) \leq n$ for all n. This criterion corresponds to classical utilitarianism — generally considered to be excessively populationist — for $f(n) = n$ and to average utilitarianism — considered Malthusian — for $f(n) = 1$. The situation that is the most favorable to obtaining a form of discounting is when there is a fixed infinite sequence of utilities $(u_1, u_2, \ldots)$ and the risky scenario says that this sequence may stop at any time, the conditional probability of surviving one more period given that one has reached period t being equal to a constant $\pi < 1$. The probability of the world ending just after period t is $\pi^t(1-\pi)$. To simplify, we suppose that there is only one individual per generation.

It is reasonable to compute social welfare for a risky scenario as the expected value of social welfare over each possible state of the world. The expected social value of the whole scenario is then

$$\sum_{t=1}^{\infty} \pi^t (1-\pi) \frac{f(t)}{t} \sum_{i=1}^{t} u_i.$$

The weight of u_T in this expression is proportional to

$$\sum_{t \geq T}^{\infty} \pi^t \frac{f(t)}{t}.$$

This yields the awaited discount factor π if $f(t) = t$ (classical utilitarianism), but this series decreases at a greater pace, implying a greater preference for the present, if $f(t)/t$ is decreasing. Intuitively, if large populations do not bring much social value by their size, it becomes relatively more important to enhance the well-being of earlier generations which are more likely to exist.[32]

A much more modest option consists in abandoning the project of a global criterion, and in focusing on two simpler issues.[33] One issue is the measurement of social welfare for certain generations or cohorts. The other issue is forecasting the evolution of social welfare for the future generations, and a comparaison between current consumption and sustainable consumption may be helpful for this purpose. More precisely, one can rewrite (16) as:

$$\delta Z^*(S_t) - U(C_t) = p_t \frac{dS_t}{dt},$$

and interpret this expression as a measure of "genuine savings" which is informative about the future evolution of instantaneous welfare $U(C_t)$. Indeed, along the program under consideration, utility has

[31] For a synthesis on population ethics, see Blackorby et al. (2005). They do not, however, specifically study the link between uncertainty and discounting.

[32] Bommier and Zuber (2008) show that introducing inequality aversion in the criterion may affect the discount rate in the opposite direction.

[33] It is defended, e.g., by Neumayer (2004), who points out that it is illusory to seek to assess social welfare and sustainability in a single measure.

to be lower than $U(C_t)$ at some future time if $\delta Z^*(S_t) - U(C_t) < 0$. Sustainability understood as a non-decreasing utility path therefore requires non-negative genuine savings, i.e., $p_t dS_t/dt \geq 0$.[34] Importantly, this reasoning does not require endorsing the discounted sum $Z^*(S_t)$ as a criterion of social welfare. Moreover, it is valid for any arbitrary value of the discount rate δ, and therefore the requirement $p_t dS_t/dt \geq 0$ must be satisfied for the prices p_t corresponding to all possible values of δ. For a high value of δ, p_t depends mostly on the influence of S_t on $U(C_\tau)$ for τ close to t. For δ close to zero, p_t depends mostly on the influence of S_t on the utility of distant generations. The weakness of this formula, however, is that p_t, being the gradient of $Z^*(S_t)$, is based on the definition of a "program", i.e., a function that defines the impact on the future growth path of all possible counterfactual changes in the current stock S_t. It is unlikely that such a program exists or can be elaborated in practice, even for small changes in S_t. Market prices can provide the needed parameters only if the equilibrium maximizes $Z^*(S_t)$, which is quite unlikely as already explained. Therefore, even though this approach has inspired ample applications, it is not clear how much practical help it provides in forecasting the evolution of welfare and checking sustainability.

4 Money-metric utility and equivalence

The theory underlying measures of total consumption or the social expenditure function involves social welfare functions $\overline{W}(x_1, \ldots, x_n)$ or $W(u_1(x_1), \ldots, u_n(x_n))$ and is somewhat embarrassed about defining a precise metric for interpersonal comparisons and for the calibration of inequality aversion. Such embarrassment has been compounded by the development of social choice theory under the shadow of Arrow's impossibility theorem. "This starkly negative finding became a major stumbling block to the empirical implementation of an explicit social welfare function." (Slesnick 1998, p. 2139). However, various branches of welfare economics have developed constructive proposals around the money-metric utility and similar notions.

4.1 Arrow's theorem

It is worth briefly recalling the main axioms of Arrow's impossibility because they provide a nice way to classify the various approaches that constitute welfare economics. The axioms listed below are not Arrow's original axioms but a convenient reconstruction that has become popular after Sen's (1970) seminal analysis. Consider the problem of ranking alternatives from a set A on the basis of the profile of individual utility functions $(u_1, \ldots, u_n)$ in the population. The arguments of individual utility functions are the alternatives from A. The social ordering that ranks the alternatives is a complete and transitive binary relation R. One such ordering must be defined for every possible profile of utility functions in a suitable domain D, and the problem is therefore to find a "social ordering functional" f defining a

[34] This is called Hartwick's rule after Hartwick (1977). See Asheim et al. (2003). The expression "genuine savings" is due to Hamilton and Clemens (1999). For syntheses on sustainability, see, e.g., Aronsson et al. (1997), Asheim (2007b).

particular social ordering $R = f(u_1, \ldots, u_n)$ for each profile in the domain. The axioms of interest for our purposes are the following:

Ordinalism: Only the ordinal preferences of the individuals should be taken into account, i.e., for all $(u_1, \ldots, u_n)$, $(u'_1, \ldots, u'_n) \in D$, if they are ordinally equivalent then $f(u_1, \ldots, u_n) = f(u'_1, \ldots, u'_n)$.

Independence: The ranking of two alternatives depends only on the vector of individual utility levels at each of these alternatives, i.e., for all $a, a' \in A$, all $(u_1, \ldots, u_n)$, $(u'_1, \ldots, u'_n) \in D$, if

$$(u_1(a), \ldots, u_n(a)) = (u'_1(a), \ldots, u'_n(a)) \text{ and } (u_1(a'), \ldots, u_n(a')) = (u'_1(a'), \ldots, u'_n(a'))$$

then

$$aRa' \Leftrightarrow aR'a',$$

where $R = f(u_1, \ldots, u_n)$, $R' = f(u'_1, \ldots, u'_n)$.

Weak Pareto: At any given profile, if an alternative gives a greater utility to each individual than another, it is ranked higher by the social ordering, i.e., for all $a, a' \in A$, all $(u_1, \ldots, u_n) \in D$, if for all i, $u_i(a) > u_i(a')$, then aPa', where P is the asymmetric part of $R = f(u_1, \ldots, u_n)$.

Arrow's theorem says that if the domain of profiles of utility functions is rich enough, and if there are more than two alternatives, these axioms imply that the social ordering must follow the strict preferences of a fixed individual ("dictator"). This is correctly interpreted as an impossibility because this kind of "dictatorship" is unpalatable. But the strength of an impossibility theorem depends on how compelling its axioms are. In the case of Arrow's theorem, the Ordinalism and Independence axioms have been found questionable by various approaches.

4.2 Escapes

Later developments of social choice theory have rejected Ordinalism, observing that when information about utility numbers can be used, the impossibility disappears.[35] Social welfare functions $W(u_1(x_1), \ldots, u_n(x_n))$, where W is an increasing function that remains the same for all profiles of utility functions, yield social ordering functionals that satisfy Independence and Weak Pareto. The motivation for dropping Ordinalism, as it is often presented in the literature, is that it should be possible to compare individuals, distinguishing the better off from the worse off. Rigorously speaking, however, Ordinalism does not exclude interpersonal comparisons because it is perfectly compatible with comparing individuals in terms of wealth, for instance. It only excludes interpersonal comparisons *of utility*. One must drop Ordinalism if one considers that individual ordinal non-comparable preferences do not constitute a sufficient informational basis for interpersonal comparisons. In particular, a welfarist approach must definitely reject this axiom. But non-welfarist approaches may also want to reject it, for instance if, in the framework at hand, the utility functions contain relevant information about the unequal talents and needs of the individuals.

[35] For a synthesis on this approach, see Sen (1999).

For applications, it remains to determine how to measure utility. Many different approaches can — although not all of them need to — be described as differing on the measurement of utility while being similar in the fact that they apply a certain social welfare function W to the vectors of utility levels. A welfarist theory will measure utility in terms of subjective happiness or satisfaction. Non-welfarist theories can be described as measuring utility in terms of resources, opportunities, capabilities, and so on.[36]

Other branches of welfare economics have instead avoided an impossibility by rejecting or ignoring Independence while retaining Ordinalism. A first branch was developed by Bergson (1938, 1966) and Samuelson (1947, 1977), who have argued that the social welfare function $\overline{W}(x_1, \ldots, x_n)$ must work with individual indifference sets. Samuelson (1977) takes the example of the ray utility function as a possible calibration of indifference curves permitting interpersonal comparisons based solely on ordinal non-comparable preferences. A controversy has opposed Samuelson to social choice theorists over the possibility of a Bergson-Samuelson social welfare function without interpersonal comparisons of utility.[37] While one may consider that, in some trivial sense, the ray utility function, for instance, is a utility function, it is clear that Bergson and Samuelson were right that their construction relies only on ordinal non-comparable preferences. In their approach, the expression $W(u_1(x_1), \ldots, u_n(x_n))$ is just a representation in which $u_1, \ldots, u_n$ can be replaced by any other representations of the same ordinal preferences, if W is correspondingly adjusted so as to keep the social ordering of allocations unchanged. What Bergson and Samuelson can be criticized for is never to have proposed a method, similar to the axiomatics of social choice, making it possible to think rigorously about the particulars of their social welfare function — how to compare indifference sets, how much priority for the worse off. In the absence of precise examples backed up with solid ethical arguments, it has been all too easy for the profession to ignore the potential of their approach.

A second branch of welfare economics in which Independence has never been considered is cost-benefit analysis. In order to apply the Kaldor-Hicks compensation tests to two alternatives a, a', one must be able to determine a third alternative a'' that is obtained from, say, a by transfers between individuals, and is then compared to a' by the Pareto principle. This characteristically violates Independence because it requires an estimate of individual preferences over a'' in order to rank a and a'. Similarly, computations of equivalent variations or compensating variations require evaluating the minimal expenditure needed to obtain the same satisfaction as in, say, a at the prices prevailing in a'. Cost-benefit analysis based on compensation tests and on equivalent or compensating variations has been under the fire of severe criticism for being potentially inconsistent (generating cycles) and generally unethical (forcibly transferring desirable objects from the poor to the rich is always good for such criteria when the latter's willingness to pay exceeds the former's). More acceptable versions of cost-benefit analysis rely on Bergson-Samuelson social welfare functions,[38] implying that the computation of the sum of individual willingnesses to pay must incorporate ethical weights representing the social marginal value of money for each individual —

[36] Recall that Jorgenson and Slesnick develop their measure of social welfare simply by picking a particular utility function.
[37] A review of the controversy is made by Fleurbaey and Mongin (2005).
[38] As advocated by Drèze and Stern (1987).

this is developed in the next subsection. Some embarrassment about the weights often confronts practitioners, due to the silence of the Bergson-Samuelson approach about the shape of the social welfare function.

A third branch in which Independence has been ignored is the theory of fair allocation which is known in particular for the concepts of no-envy and egalitarian-equivalence.[39] The former concept requires checking that no individual would rather consume another's bundle. The latter relies on the ray utility function in the simple model of distribution of unproduced divisible commodities: an allocation is egalitarian-equivalent if it is efficient and if every individual is indifferent between his bundle at this allocation and a fraction of the reference bundle, this fraction being the same for all individuals. It has often been argued that the theory of fair allocation avoids the negative consequences of Arrow's theorem because it only seeks to select a subset of efficient allocations instead of ranking all allocations. In fact the selection of a subset does define an ordering, albeit a coarse one. The true reason for the positive results obtained in the theory of fair allocation is that it is not loaded with Independence. Recent developments in the theory of fair allocation have produced fine-grained rankings based on axiomatic characterizations that mimic Arrow's list of axioms except that Independence is dropped or weakened and that additional fairness axioms help define how to compare individual situations — an example is provided in the next subsection.[40] One can consider that this branch of the theory of fair allocation gives flesh to the concept of Bergson-Samuelson social welfare function, by determining precisely how to compare individual indifference sets and how much priority to give the worse off.

4.3 Equivalent sets, equivalent incomes

One feature of the theory of fair allocation is that, like all branches of economic theory, it works with precise economic models describing specific distributive contexts. This is helpful and even necessary in order to grasp the specific issues of each allocation problem. The downside is that the theory offers many special solutions for particular contexts but is, for the time being, unable to give precise recommendations concerning the problem of devising a reasonable social criterion for a "real-life" context involving divisible and indivisible commodities, private and public goods, marketed and non-marketed goods and activities, production with unequal talents, multiple generations, and so on.

In the meantime, one can observe that many interesting solutions in the existing set of results are of the egalitarian-equivalent family. Such solutions apply the maximin criterion or the leximin criterion to specific numerical indexes of individual indifference sets. Individual indifference sets are indexed with the help of a collection of nested sets $(B_\lambda)_{\lambda\in\mathbb{R}_+}$ such that $\lambda \leq \lambda'$ if and only if $B_\lambda \subseteq B_{\lambda'}$. An individual's situation in a given allocation is evaluated by computing the "equivalent set" in the collection, i.e., the set B_λ that would give him the same satisfaction (if he could freely choose from B_λ) as the current allocation. Individual situations are then compared in terms of equivalent sets, which can be done unambiguously

[39] For a survey, see Moulin and Thomson (1997).

[40] For a survey, see, e.g., Maniquet (2007) or Fleurbaey and Maniquet (forth.).

because these sets are nested: the larger, the better.[41] The money-metric utility and the ray utility are two examples illustrating this approach (for the money-metric utility, consider the collection of sets B_λ defined by the condition $p^*x \leq \lambda$, where x denotes an individual bundle belonging to B_λ and p^* is the reference price vector; for the ray utility, consider the collection of sets B_λ defined by the condition $x \leq \lambda x^*$, where x^* is the reference bundle). Because such interpersonal comparisons can be made across individuals with different preferences, there is no serious obstacle to extending such social criteria to comparisons of social situations across different populations.

In order to illustrate how a particular criterion of the egalitarian-equivalent sort can be justified following the Arrovian approach, consider the social ordering proposed by Fleurbaey (2005) for a model with two goods, health H and income I (a composite commodity). Health is assumed to lie between zero and one. Individual utilities are assumed to be self-centered, i.e., each individual's utility depends only on his own health and income. The social ordering applies the maximin criterion to vectors of individual "healthy-equivalent incomes". For any individual i, his healthy equivalent income is the level of income I^* which would make him indifferent between his current situation and a situation of perfect health with income I^* (for monotonic preferences this can also be described in terms of equivalent sets containing the bundles (H, I) satisfying the constraint $I \leq I^*$ and $0 \leq H \leq 1$). One can relate the axiomatics justifying this criterion to the Arrow axioms listed above in the following way: (1) Ordinalism is retained; (2) Independence is weakened, stipulating that the ranking of two allocations is unchanged when the utility levels and, in addition, the indifference sets at the two allocations remain the same with the new profile of utility functions; (3) Weak Pareto is retained; (4) A fairness axiom is introduced, stipulating that a Pigou-Dalton transfer reducing income inequality between two individuals having the same health yields an at least as good allocation, provided these two individuals have the same utility function overall, or have perfect health and the same utility function over perfect-health bundles.[42]

A similar idea underlies the computation of equivalent income growth made in Becker et al. (2005). They consider a representative agent per country and compute equivalent income growth of a country as the growth of income that would have provided the same gain in satisfaction if health (life expectancy, in their work) had remained constant. This amounts to taking initial health, instead of perfect health, as the reference for computing the equivalent income. This is a quite natural and intuitive measure, which can be viewed as a generalization of the idea of equivalent variation.[43] The standard notion of equivalent variation takes initial prices as the reference for the computation of equivalent income change. The price vector is just one among many variables, such as personal health or features of the environment, which influence indirect utility. It makes sense to compute the income variation that would have generated the same variation in satisfaction if all variables other than income had been kept constant. It is not easy, however, to incorporate equivalent variations into a consistent social criterion, especially if one

[41] We assume the absence of satiation in order to simplify the presentation.

[42] The restriction to individuals with same utility function makes the axiom weaker and is motivated by the fact that an individual with a greater income at the same health level than another is not necessarily better off if he has different preferences (e.g., he may suffer more from this health condition).

[43] This kind of generalization was studied in particular by Hammond (1994).

wants to avoid the representative agent approach. In particular, equivalent variations are not convenient for interpersonal comparisons as they focus on changes rather than levels. One cannot, for instance, compare the final equivalent incomes, computed with the Becker et al. approach, for two individuals having different initial health. Another problem with a variable reference is that the chained index may have little meaning: the addition of equivalent income gains with moving references is not equal to the augmented income gain with respect to a fixed reference. In spite of these difficulties, one may consider that a systematic computation of such equivalent income growth (if possible, by adding up individual equivalent variations rather than assuming a representative agent) would provide valuable information in complement to ordinary income growth. Comparing the two curves of growth rates would be informative about the evolution of the dimensions of quality of life incorporated into the computation. This can be justified by a variant of the decomposition formula (5). Consider a social welfare function $W(u_1(m_1, z_1), \ldots, u_n(m_n, z_n))$, where m_i denotes income and z_i the other dimensions. Let $\nabla_z u_i$ denote the gradient of u_i with respect to z_i and let willingness-to-pay (equivalent variation) be defined as:

$$WTP_i = dm_i + \frac{1}{\frac{\partial u_i}{\partial m_i}} \nabla_z u_i dz_i.$$

One can then write the decomposition

$$dW = \sum_i \beta_i WTP_i = \beta \sum_i WTP_i + \sum_i (\beta_i - \beta) \left(WTP_i - \frac{1}{n} \sum_j WTP_j \right),$$

where $\beta_i = \frac{\partial W}{\partial u_i} \frac{\partial u_i}{\partial m_i}$, $\beta = \frac{1}{n} \sum_{i=1}^{n} \beta_i$.

Like equivalent variations, the notion of equivalent income can be applied to any number of dimensions of quality of life. One simply has to fix a reference vector for these dimensions, and compute the equivalent income as the income that would yield the same satisfaction if quality of life were at the reference level. Equivalent income equals ordinary income minus the willingness to pay to have quality of life at the reference level. Considering market prices as an element of quality of life, one obtains the money-metric utility and a rigorous way to perform PPP corrections of income. Considering household size as an element of quality of life for individuals, one can compute the equivalent income that would give the member of a household the same individual satisfaction if he belonged to a reference type of household (e.g., if he were single). This method, proposed for instance in Browning et al. (2006), appears superior to standard household equivalence scales which are not identifiable from market demand in absence of heroic assumptions.[44] Considering the risk of unemployment, it is natural to compute the certainty equivalent income by deducting a risk premium from ordinary income. Considering leisure, there are several reasonable possibilities highlighted in the theory of fair allocation, not all of which

[44] For a synthesis on household equivalence scales, see Lewbel (1997). Equivalence scales based on individual equivalent income may ultimately provide familiar formulae. It is shown in Fleurbaey and Gaulier (2007) that if one assumes that households spend half of their budget on local public goods and the rest on private goods, and that individuals are identical within households, equivalence scales based on individual equivalent income coincide with the OECD household equivalence scales relying on the square root of household size.

consist in computing an equivalent income. A simple option is to take a reference quantity of labor.[45] In order to compare the standard of living across OECD countries, Fleurbaey and Gaulier (2007) have used the equivalent income approach for the corrections concerning leisure, health, the risk of unemployment, and household size.

The equivalent income approach involves a special kind of the collections of nested equivalent sets that are used in the egalitarian-equivalent approach. Other options exist and appear no less reasonable. Instead of fixing the non-income variables at a reference level, one could make them vary from one set B_λ to the other along a progression path in which quality of life and income would grow simultaneously.

4.4 Criticisms

Money-metric utilities, as mentioned in Subsection 2.5, have triggered criticism, which also can be directed at the egalitarian-equivalent approach in general and at the equivalent income approach in particular.

The first criticism points to the neglect of welfare aspects, in particular those having to do with special needs. As stressed in Sen (1985), resourcist approaches may seem fetishistic about external resources, neglecting the fact that different individuals have unequal abilities to transform resources into flourishing. Needs are, however, easily incorporated into the equivalent income approach if they are explicitly taken into account among the dimensions of quality of life. Therefore, properly handling needs in interpersonal comparisons does not require abandoning Ordinalism, but merely broadening the object of ordinal preferences in order to encompass certain personal parameters. This procedure supposes that individuals have well-defined preferences over various possible levels of needs and over various combinations of needs and income. Although this assumption may appear demanding, it seems hard to avoid relying on this sort of preferences if one seeks to determine how to compensate specific needs with transfers of external resources. It should also be emphasized that the egalitarian-equivalent approach is not really tied to a narrowly materialistic notion of resources, as it can be applied to any broader class of objects of preferences, such as, for instance, functionings or capabilities. What characterizes the approach is its method of comparing indifference sets, not the space in which the indifference sets are defined.

Beyond the incorporation of "internal" resources or broader notions of functionings into the objects of preferences, is there a need for taking account of more subjective dimensions of well-being, such as happiness or levels of satisfaction? This is obviously a controversial issue. It is worth noting that respectable philosophies of justice, due to Rawls and Dworkin, argue against compensating individuals for pure deficits in satisfaction and in favor of a purely ordinal reading of individual preferences. Their view is that individuals, as morally autonomous agents, should assume responsibility for their ends and for the ensuing level of satisfaction, once society has provided them with fair shares of resources. Another part

[45] In the egalitarian-equivalent family, there are three other salient options, corresponding to different ethical principles. One option consists in computing a tax-free equivalent budget (i.e., the hypothetical wage rate which would maintain satisfaction in absence of transfers). Another option consists in computing an equivalent budget at the market wage rate for unskilled work. A third option consists in computing an equivalent budget corresponding to a zero net wage rate (with monotonic preferences, this boils down to computing a leisurely equivalent income). See, e.g., Fleurbaey (2008).

of Rawls' (1982) argument, in particular, is worth considering. He notes that directly comparing the satisfactions of individuals with different conceptions of the good life would use a questionable metric, a sort of super ordering that would make satisfaction the supreme goal in life, independently of the conception of life that relates satisfaction to objective achievements. If we consider that the only judgments about the dimensions of life that are available are those formed by individuals, it seems indeed advisable to treat those judgments as ordinal non comparable preferences. Consider two individuals who have the same preferences over the various possible lives and who both deem the life of one of them to be better than the other's. It may, however, happen that their satisfactions are ranked in the opposite order because of different aspiration levels. Comparing their situations in terms of satisfaction would fail to respect their own comparison of their lives. Paraphrasing J.S. Mill, it is better to be a rich dissatisfied than a poor satisfied, *if the rich and the poor both prefer the former's life*. These issues will be taken up again in Sections 6 and 7.

The second criticism is that a social welfare function W whose arguments are individual money-metric utilities may fail to be quasi-concave in resources (Blackorby and Donaldson, 1988). This observation can in fact be substantially generalized on the basis of results from the theory of fair allocation (e.g., Maniquet and Sprumont, 2004): Any approach which obeys the Pareto principle and which evaluates individual situations by the indifference sets at the contemplated allocation (i.e., not just money-metric utilities) will fail to be quasi-concave unless it gives absolute priority to the worse off. The literature on fair allocation deduces from this observation that the maximin and leximin criteria are the only acceptable aggregators. This may sound an ominous result because these criteria are considered extreme on the spectrum of inequality aversion, but the theory is flexible about how to evaluate individual situations. For instance, it can justify the laisser-faire policy if individual endowments are considered fair and are suitably incorporated into the comparisons of individual indifference sets.[46]

An alternative reading of this result is that if one does not want to adopt the maximin or leximin criterion, one has to accept certain apparent violations of inequality aversion. Consider the healthy-equivalent income, and imagine two individuals with health equal to 0.5 (recall that the range for health is $[0, 1]$). Suppose that their ordinary incomes in allocation x are $(100, 200)$ and their equivalent incomes $(80, 150)$. Imagine that a regressive transfer between them would produce a new situation with ordinary incomes $(90, 210)$ and equivalent incomes $(75, 190)$. If one considers that, for two healthy individuals, the distribution $(75, 190)$ is better than $(80, 150)$, it is only logical, by Pareto-indifference, that for the half-healthy individuals under consideration, the regressive transfer yields an improvement. This is intuitively defensible if one observes that the regressive transfer triggers a reduction in both individuals' willingness to pay for a good health, especially for the beneficiary of the transfer. This example may also suggest that, in practice, such violations of the Pigou-Dalton principle are unlikely to occur in dramatic proportions if the aggregator has substantial inequality aversion.

A third criticism has been raised against money-metric utility functions. Developed by Slesnick (1991) and inspired from Roberts (1980), the point is that money-metric utility functions depend on a

[46] See Fleurbaey and Maniquet (forth.).

reference price p^*, and that if one wants the social welfare function to be independent of these reference parameters severe restrictions are required (e.g., homothetic preferences). Similarly, the computation of equivalent incomes is sensitive to the choice of the reference. It is not clear, however, why one should worry about such dependence, or impose independence from the reference, because the choice of a reference need not be arbitrary. The example of the healthy-equivalent income, for instance, suggests that the reference in this case is natural. With the healthy-equivalent income, one can compare individual situations in perfect health solely in terms of income, without inquiring about individual preferences about health (because equivalent income is then equal to ordinary income), whereas situations with less than perfect health require taking account of individual preferences about health and income. This seems the proper methodology, and taking a low level of health as the reference would have counterintuitive implications, with the sick being compared without consulting their preferences while the healthy could not be simply compared in terms of income. Similarly, as mentioned above the literature on fairness suggests specific references for the case of leisure. The literature on equivalence scales has generally taken singles as the reference type of household, and again this seems rather natural, although perhaps debatable. Even in the case of reference prices for PPP computations, it would be exaggerate to claim that all price vectors are equally acceptable candidates for the reference. In sum, even if the theory of references is still in its infancy, the idea that the choice of the reference is arbitrary is simply unwarranted.

In conclusion, money-metric utilities and equivalent incomes, linked to the egalitarian-equivalent approach from the theory of fairness and to social choice theory, might deserve more interest than they have received so far. This approach takes an interesting middle-ground position in the debate on welfarism. It is distinctively non welfarist because it compares individual situations in terms of "resources" broadly construed — more precisely in terms of equivalent sets B_λ — instead of subjective utility, but it retains a key element of welfarism by respecting the Pareto principle. The main limitation of the approach is that it has so far been applied to special economic models dealing with particular allocation problems. A rigorous analysis of the definition of the sets B_λ in a richer context remains to be done, but intuitive applications in terms of equivalent income are quite easy to conceive.

5 Social Indicators

We now turn to non-monetary approaches. There is now a wealth of summary indicators that combine various domain indicators of economic, social and environmental performance.[47] Prominent indicators include the Human Development Index (HDI) and the indicators computed by Osberg and Sharpe (2002) and Miringoff and Miringoff (1999).

Discussing the theory underlying such indicators can be done shortly because there is little theory. The weights of the various domain indicators in the general index are conventional and the proponents of such indicators rarely formulate a framework for a rational discussion about what these weights should

[47] For a survey, see Gadrey and Jany-Catrice (2006).

be.[48] One can of course invoke the ethical preferences of the observer and ask her, for instance, how she trades the suicide rate off against the literacy rate, but there is little philosophical or economic theory that gives us clues about how to form such preferences.

A problematic feature of these indicators is that they are not individualistic. That is, they do not form an aggregate of individual indexes, but instead add up social indicators for various domains of individual well-being. Consider for instance health and income. Adding up a social index of health (e.g., average life expectancy at birth) with a social index of income (e.g., GDP), as is done in the HDI, gives the same result for societies having the same value for both indexes, independently of the correlation between health and income at the individual level. If one thinks that such a correlation is important, because a society with no correlation is better than a society in which being richer implies being healthier, one cannot rely on these summary indicators.[49] Assuming that information about this correlation is available, one can of course use it as an additional component of the summary indicator, but it appears a much more satisfactory procedure to evaluate situations at the individual level before going up to social summaries.

Dowrick et al. (2003), however, do propose an economic theory for the use of such indicators, based on a revealed preference argument. Their approach supposes a representative agent (which of course puts aside the correlation issue) facing a technology for the production of performance in the various domains, together with a budget constraint. They propose to say that country A is better off than country B if, given its technological and budgetary constraints, country A could obtain a vector of performances dominating the vector of B. This approach enables them to make binary comparisons. It is in principle possible to find that A is better off than B and B is better off than A, simultaneously (as occurs in their data for Finland and Austria). They also discuss the possibility of computing numerical indexes by assuming homothetic preferences over commodities for the representative agent, with identical preferences across countries. While this approach may yield interesting insights about comparisons of multidimensional feasible sets in the space of domain indicators, it appears difficult to connect it to a standard notion of social welfare. The difficulties in estimating the technology of production of social performance in various dimensions (Dowrick and coauthors only look at income and health) may also render the approach hardly applicable on a large scale.

6 Happiness

The literature on happiness has surged in the last decade. The findings are well summarized in many surveys.[50] The question that has to be examined here is how this approach can inform the evaluation of social welfare. No author argues that happiness studies are of no value at all, but there is wide variety of positions, from those who propose to measure and maximize national happiness (Diener 2000, Kahneman et al. 2004, Layard 2005) to those who firmly oppose this idea on various grounds (Burchardt 2006, Frey

[48] This point is made, e.g., by Ravallion (1997) commenting on the HDI.

[49] See Dutta et al. (2003).

[50] See in particular Diener (1994, 2000), Diener et al. (1999), Frey and Stutzer (2002), Kahneman and Krueger (2006), Layard (2005), Oswald (1997).

and Stutzer 2007, Nussbaum 2007). There seems to be a consensus on the idea that happiness studies suggest a welcome shift of focus, in social evaluation, from purely materialistic performances to a broader set of values. For instance, the importance of social relations is highlighted by this literature while the role of consumption is downplayed.

6.1 Subjective well-being is measurable

Above all, one can consider that the traditional suspicion among economists about the possibility to measure subjective well-being should be assuaged by the recent progress. Combining questionnaire surveys ("Taking all things together, how satisfied are you with your life as a whole these days? Are you very satisfied, satisfied, not very satisfied, not at all satisfied?"), the methods of experience sampling (mood declaration at random moments of the day) and day reconstruction (short recall mood declaration), physiological measures (hormone concentration, skin conductivity...), neurological measures (brain activity), as well as behavioral observations (smiling...), it now seems more possible than ever to obtain a rather consistent estimate of subjective well-being. Doubts remain about whether the results coming from verbal statements and scaling questions can really be compared across individuals (especially across cultures),[51] but it would be exaggerate to give no significance to interpersonal patterns in the data. On the whole, one can be optimistic about the increasing reliability of data on subjective well-being in the near future.

One important notion that psychological studies reveal, and which is sometimes downplayed in the economic part of the literature, is the multidimensionality of subjective well-being. A key divide opposes cognitive components (what people think of their life) to affective components (how they feel in their life). The affects themselves come in many shapes and colors, with a surprising independence between the positive and the negative affects which seem to be connected to different mechanisms in the brain. In this light, Bentham's and Edgeworth's "utility" is an artificial concept that ignores the complexity of human psyche. Even instantaneous mood is the result of sensations combined with judgmental evaluation, while questions about satisfaction with life "as a whole" are disturbingly influenced by the mood of the day, the current weather, or anecdotal events such as finding a dime a few minutes before the questionnaire. One shortcoming of the available set of findings is the relative lack of separation between affects and judgments in most studies. Recent "ladder-of-life" questionnaires asking respondents to rank their life on a scale between 0 (worst possible life) and 10 (best possible life) may come closer to identifying the cognitive part of people's satisfaction.[52]

Much of the literature in happiness studies seeks to understand the determinants of happiness, with

[51] For instance, Krueger et al. (2008) find out that American and French women seem to have different attitudes about presenting themselves as "very happy" or "happy". Doubts about comparability motivate the difference between the indicator proposed in Kahneman and Krueger (2006), which is a measure of average time spent in predominantly negative affects, and the index proposed in Kahneman et al. (2004), which is a time-weighted mean of the average happiness obtained by the population in various activities. The latter requires a cardinal scale of affect whereas the former only needs to identify moments where negative affects dominate.

[52] See Deaton (2008).

many fascinating findings about the relative importance of income, health, social status and unemployment, marital status and family life, religions, rights and political freedom, and about the complexity of dynamic effects and comparisons to peer groups.[53] A particular difficulty that pervades many studies is that cross-section analysis tracks correlates of happiness but the direction of causation is not always clear. For instance, a strong correlation between unemployment and unhappiness may reflect the effect of unemployment on happiness but also the underlying combined influence of a third factor such as personality on job stability and happiness or even a direct influence of mood on the willingness to quit one's job.[54]

6.2 Treadmills

The fact that subjective well-being *can* be measured does not imply that it *ought* to be taken as the metric of social evaluation. It is rather surprising that the literature on happiness refers very little to the lively philosophical debates of the previous decades about welfarism, and in particular the criticisms raised by Rawls (1982) and Sen (1985) against utilitarianism.[55] Nonetheless, one of the key elements of that earlier debate, namely, the fact that subjective adaptation is likely to hide objective inequalities, does happen to come up as a puzzle challenging happiness specialists.[56] Subjective well-being seems relatively immune in the long run to many aspects of objective circumstances, individuals displaying a remarkable ability to adapt. After most important life events, satisfaction returns to its usual level and the various affects return to their usual frequency.[57] A key determinant of usual mood and satisfaction is the individual's personality (extroversion versus neuroticism). If subjective well-being is not so sensitive to objective circumstances, should we stop caring about inequalities, safety, and productivity?

Kahneman (1999) wonders whether this phenomenon should be attributed to a hedonic treadmill reflecting a progressive desensitization of subjects to repeated stimuli, or to an aspiration treadmill due to the fact that the subjects evaluate their hedonic situation according to adaptive aspiration levels. This is important for normative conclusions. Suppose, following the early utilitarian tradition, that the normatively relevant metric for social evaluation is experiential hedonic utility (a mostly affective part of satisfaction, although it is pervaded by judgments). If it turned out that adaptation affects aspirations more than individuals' hedonic experience, then one could safely seek to measure a hedonic index of "national happiness", because such an index would actually be sensitive to objective circumstances. Simply, such an index could not be simply computed by summarizing declarations of satisfaction and

[53] See the quoted surveys for a detailed presentation of the results.

[54] Many authors, such as Frey and Stutzer (2002) or Ferrer-i-Carbonell and Frijters (2004), recommend using panel data so as to eliminate individual fixed effects. Clark et al. (2008) discuss the limits of panel data.

[55] Two exceptions are Burchardt (2006) and Schokkaert (2007a). Layard (2005) also mentions and quickly rebuts some of the arguments against welfarism.

[56] The first influential study on adaptation (Brickman and Campbell 1971) even predates Sen's example of the tamed housewife who accepts her impoverished condition and is happy about it.

[57] An individual's aspirations do not only depend on past experience, but also on the achievements of his group of reference (see, e.g., Clark and Oswald 2002, Clark et al. 2008, Van Praag and Ferrer-i-Carbonell 2007, Frederick and Loewenstein 1999).

other methods of data collection would then have to be used. Another obstacle to the measure of hedonic experience that is described by Kahneman et al. (1997) is that people's memory keeps track of experienced affects in a distorted way, giving excessive attention to peaks and last moments of a given episode. One then has to find ways (such as the experience sampling and the day reconstruction methods) to retrieve individuals' true hedonic experience.

Kahneman and Krueger (2006), however, write that preliminary evidence actually points to the predominance of the hedonic treadmill over the aspiration treadmill, because data on satisfaction show a greater correlation with life events than records on affects. This undermines the idea of measuring national happiness in terms of hedonic utility, at least if one would like such a measure to display a certain sensitiveness to material life conditions — the alternative is to declare material conditions to be of little importance. Although it may be less overwhelming, the aspiration treadmill also questions using reported satisfaction as a measure of well-being. In a recent study of ladder-of-life surveys over the world, Deaton (2008) observes that globalized information about living conditions makes it unsurprising that respondents rank their life in accordance with common rankings of living standards, and argues that such surveys cannot be trusted over time because of shifting references. Moreover, he concludes that "neither life satisfaction nor health satisfaction can be taken as reliable indicators of population well-being, if only because neither adequately reflects objective conditions of health" (p. 70).[58]

6.3 Two conceptions of satisfaction

The early debate on liberalism versus welfarism and the recent literature on happiness suggest that two normative conceptions of how to make use of subjective data compete.

The welfarist conception, inspired by Bentham and Edgeworth, predominates in the happiness literature, even when it is not explicitly or fully endorsed. In its hedonic version, it views utility primarily as an affect characterized by two quantities, duration and level, the latter being measured on a numerical scale with negative values for unpleasant affects and positive values for pleasant ones. As positive and negative affects can coexist during the same short episode, the instantaneous utility level is conceived as a net balance sheet. Assuming separability over time, total utility can be computed as the integral of instantaneous utility over time. As already mentioned, individuals do not recall this integral efficiently and moreover they are often mistaken about what generates positive and negative affects, so that their preferences and decisions fail to maximize their "true" utility. For instance, they think that a new car will make them happy but after a couple of weeks their utility increment dwindles. They think that working extra hours and earning extra money will make them happy, but their impoverished family relationships turn out to have a much more lasting effect on their utility. If one wants to maximize national happiness, one will then have to conceive policies which will possibly curb the satisfaction of people's preferences in order to promote their true happiness. Hedonic adaptation, however, suggests that psychological in-

[58] A puzzling finding in Deaton (2008) is indeed that life satisfaction correlates well with (the logarithm of) income in cross section, but not with the level of health, not even HIV prevalence. "It seems astonishing that reported life satisfaction should be unaffected by a plague whose severity is unparalleled in modern times" (p. 63).

terventions may be more efficient than most changes in objective life conditions. In this perspective, research in a happiness drug without negative side effects might even be a more urgent priority than anything else.[59]

A variant of this conception puts more stress on the cognitive part of happiness, namely, satisfaction, even though most of the available data tend the blur the difference between affects and satisfaction judgments. Satisfaction may be argued to matter more than hedonic utility because affects are just one domain of life, and most people are willing to trade hedonic affects for objective achievements.[60] People also differ in the kind of affects they want to cultivate. In particular, the hedonic model of utility level on a linear scale does not square well with the observation that many people prefer quiet contentment to intense joy.[61] This variant seeks to find a measure of satisfaction that can be used as a measure of utility and be compared and aggregated across individuals. It is also interested in finding the determinants of satisfaction and to fight people's misconceptions of what really gives them a greater satisfaction in the long run.

An alternative to welfarism, in its hedonic and satisfaction versions, can be imagined on the basis of the approach of liberal philosophers such as Rawls, Dworkin and Sen. Like satisfaction welfarism, it recommends paying attention to individuals' cognitive evaluation of their life and would for instance seek to promote affects only in proportion to their importance in individuals' view of a good life. Moreover, this approach would consider ordinary satisfaction questionnaires as imperfect because they are unlikely to reflect people's most rational and informed evaluation, their "true" preferences. It therefore accepts the idea that people sometimes make bad choices and does not systematically condone individual choices. But the issue, from this perspective, is not mainly that people fail to accurately predict experienced affects.[62] Rather, mistakes reflect the discrepancy between immediate preferences and deeper preferences, due to a lack of information and deliberation in daily circumstances. For this reason the liberal model is actually compatible with a kind of soft paternalism in which some correction to individual preferences is permitted in the computation of social welfare provided one is confident that it produces a better picture of people's deep preferences. But more importantly, and radically unlike satisfaction welfarism, this approach rejects the idea that one should compare satisfaction across individuals and seek to maximize some aggregate of individual satisfaction levels. Some of the underlying arguments have been introduced in Subsection 4.4. The key objection from the liberal approach against satisfaction welfarism, perhaps, is that satisfaction

[59] This position is endorsed by Layard (2005), who defends it by arguing that if such a drug existed, most people would take it. But observe that for deciding to take the pill (assuming taking the pill does not hinder other activities), people only have to give *some* value to their own happiness, not to give it *exclusive* value.

[60] The popular say, often attributed to Aristotle, that happiness is the only ultimate, non-instrumental goal of human beings is either tautological (when happiness is identified to the satisfaction of goals) or empirically incorrect (when happiness is an affect). On the views of Aristotle, Mill and Bentham on this issue, see Nussbaum (2007).

[61] On this point, see Diener (2000, p. 36), who also insists in this paper on the multidimensionality of subjective well-being (SWB) and proposes an ecumenical set of indicators: "Ideally, the national SWB indicators would include various components of SWB, such as pleasant affect, unpleasant affect, life satisfaction, fulfillment, and more specific states such as stress, affection, trust, and joy." (p. 40)

[62] In fact, if people have systematically distorted memories and predictions of hedonic utility, one could argue that it undermines the value of promoting hedonic utility (Hausman 2007).

welfarism fails to distinguish "obtaining what one wants" from "being satisfied", and mistakenly focuses on the latter instead of the former. There are three ways to be satisfied, and obtaining what one wants is only one of them. One can also become satisfied by adapting one's aspiration level or by adapting one's preferences.[63] If we could move to a situation in which people would have less of what they want but would reduce their aspiration levels and end up being more satisfied, the welfarist approach would approve this change and the liberal approach would oppose it.[64]

A good illustration of this point and of the different implications of the two conceptions is provided by how they interpret the "Easterlin paradox".[65] For the welfarist approach, the paradox reflects the fact that individual decisions are misguided. People strive for material achievements which have little impact on their subjective well-being, whether it is measured in terms of hedonic utility or in terms of satisfaction. For the liberal approach, there is no paradox at all: people may rationally want to improve their material conditions of life, even if, in the long run, it does not increase their hedonic experiences (because of the hedonic treadmill) and does not much improve their evaluation of life success (via the aspiration treadmill). Both ex ante and ex post they do strongly prefer the higher living standard and would not want to stay at or go back to the lower level. They may perhaps overestimate the subjective benefits of material growth, but this is unlikely to affect their decisions so much that they would not seek material improvements otherwise. Assuming that they do value material achievements such as the ability to travel and communicate or a better control of health, they would still strongly prefer the higher standard of living even if they perfectly predicted the stability of their affects and of their satisfaction. This is Frederick and Loewenstein's (1999, p. 320) conclusion of a long study of adaptation: "Assuming that future research provides a deeper understanding of hedonic adaptation, is it likely that such information would cause people to conduct their lives differently? Would they stop wearing seatbelts with the assurance that they would get used to being paralyzed? Would they exploit an embezzlement opportunity knowing that prison wouldn't be all that bad in the long run? We suspect not. However, perhaps a few would be saved from the misery of renting a noisy[66] apartment they would never have gotten used to."

The two conceptions also diverge a little on the analysis of the inefficiency of growth in connection with peer comparison and positional goods. For the welfarist approach, it is clearly inefficient to want to earn more if this triggers a rat race that ultimately decreases utility. For the liberal approach, one must distinguish two phenomena. If individual preferences are concerned with positional goods, society will indeed be trapped in a prisoner's dilemma in absence of coordination. People will sacrifice their personal

[63] Barry (2007) compares an individual who would seek to be satisfied per se — instead of getting what he wants — to a football fan who would support whatever team is most likely to win. What kind of football fan would that be?

[64] The debate can be pursued further. The welfarist can bite the bullet and argue that adapting to one's current condition is an honorable way to become satisfied, which should be encouraged. The liberal would perhaps retort that there is a difference between elevating one's goals beyond basic materialism and adopting bland ambitions.

[65] This paradox, suggested first by Easterlin (1974, 1995), is that in developed countries, average happiness has been stable over decades while income was multiplied by two to five. Recent discussions of this paradox can be found in Clark et al. (2008), Deaton (2008) and Leigh and Wolfers (2008).

[66] Noise is a stimulus that has been shown to be sensitizing rather than desensitizing. People do not adapt to it.

comfort in order to improve their relative position, and this is collectively wasteful.[67] No additional inefficiency, however, is entailed in this approach by the fact that aspiration levels are influenced by the others' achievements. Because efficiency must be assessed with respect to the individual ordinal preferences, not with respect to satisfaction levels which fluctuate with aspirations.

6.4 A revolution in utility theory?

The developments in happiness studies may sound as if the standard model of well-being based on a well-defined utility function (or preference ordering) bearing on personal consumption, which inspires in particular the monetary measures reviewed in Sections 2–4, has to be radically revised. The multi-dimensionality of subjective well-being, the hedonic and satisfaction treadmills and the importance of social comparisons appear to require a much more complex picture. Paradoxically, this questioning is not prominent in happiness studies, where many authors seem to keep searching for the "utility" Graal and to believe that the recent developments bring them closer to it.

As a matter of fact, the required changes to the standard model may be less dramatic than it appears. Suppose one reads the classical model of consumer preference as describing what the individual wants for his life, and let us take the object of preference to be a comprehensive vector of "functionings" or "capabilities" (see Section 7) rather than a narrow vector of consumption. Such preferences correspond presumably more to the cognitive part of subjective well-being than to the affective part. Hedonic utility, in this model, is just one component of the object of preference, and the hedonic treadmill means that this component is relatively stable and immune to changes in the other components of the life vector. It does not imply any problematic instability in the preference ordering, even if it may sometimes produce apparent changes in preferences. For instance, if one initially dislikes baby-sitting because of its unpleasantness and finally finds great fun in it, one may come to like it because it has a different impact on hedonic utility. This is compatible with a stable underlying ordering over hedonic utility and other dimensions.

Whether the same can be said about the satisfaction treadmill is more ambiguous. An adaptation of the aspiration level and of the references for comparisons is compatible with a stability of the preference ordering. It is possible to become, say, more difficult about comfort and safety because one gets used to affluence, without changing one's ranking of the various possible life vectors. But the satisfaction treadmill may also partly include an adjustment in the orientation of ordinal preferences. Someone who initially prefers the countryside may come to like urban life after several years in a town. Most of such changes in preferences can be interpreted in terms of learning rather than a deep alteration of the direction of tastes. But even real changes in preferences are not seriously challenging for the classical model of preferences, because it would be exaggerate to interpret this model as requiring perfect stability of the ordering. Recall that there are measures of well-being, such as money-metric utilities, which permit comparisons across different preferences.

[67] The disincentive effects of income taxation, for instance, can be viewed favorably as a brake on wasteful competition for positional goods (Layard 2005).

Perhaps the most challenging part of happiness studies, for the classical model, is the revealed importance of social comparisons.[68] Much of traditional welfare economics is built on the assumption that what matters is what individuals want for themselves. What they want for their neighbors has been the subject of some perplexity. Many models in welfare economics have simply assumed that individuals are selfish (i.e., only have self-centered preferences), which eliminates the issue in a way that now appears very unrealistic. Another possibility, which may have implicitly underlied the theory of fair allocation, is to declare that the non self-centered part of individual preferences is irrelevant and should be disregarded. This makes a lot of sense because it nicely separates the question of personal interests, for which individual preferences are the best guide according to consumer sovereignty, from the question of social conflict, for which some different kind of ethical preference has be constructed on a more solid basis than the contingent benevolent and malevolent feelings of the population. One problem with this strategy of separation is that the self-centered part of individual preferences may not be well-defined in isolation and may substantially depend on the others' consumption. Whether such social influences make the self-centered preferences too unreliable for classical welfare economics may be considered an open issue, although no author seems to be taking that line. After all, it is still possible to take self-centered preferences as the measure of individual well-being even if they strongly depend on the whole allocation. But this, once again, requires a measure of individual well-being that cuts across different preferences. Otherwise it becomes problematic to say whether an individual is better off in an allocation than in another, because his self-centered preferences are different in the two allocations. Even more challenging is the fact that delineating the self-centered part of preferences may itself be difficult. Preferences over positional goods and over one's relative position seem to irreducibly combine a self-centered part and a social part.

In conclusion, recent developments in happiness studies do not seem to require an overhaul in the classical utility model of welfare economics, but call for a more serious apprehension of the influence of social comparisons on, and their place in, individual self-centered preferences.

6.5 Interpersonal comparisons and inequalities

The authors who propose to maximize average happiness seem unconcerned with inequalities between individuals. But it is conceptually easy to introduce inequality aversion in the definition of national happiness by putting a greater weight on the less happy and the more miserable individuals, as suggested by Layard (2005).

It is interesting to contrast the two approaches distinguished in Subsection 6.3 about how to perform interpersonal comparisons for the purpose of social evaluation. The welfarist approach advocates comparing people either in terms of experiential utility (hedonic welfarism) or in terms of satisfaction level. The hedonic and aspiration treadmills make inequalities in utility rather shallow and quite different from material inequalities. The most miserable are those who suffer from psychological problems, from great

[68] The importance of social comparisons has also been the hallmark of a large recent literature in experimental behavioral economics.

physical pain, or from unadjusted aspiration levels, not necessarily the materially poor and the socially oppressed.

The liberal model would presumably advocate comparing people in some metric that would take account of their own judgments over the dimensions of life. For instance, Rawls suggests to rely on the preferences of a representative individual from the worst off group in order to weight the various primary goods. However, Rawls does affirm that society should focus on resources and opportunities, in the assessment of the distribution, rather than on whatever people care about in their lives. One can imagine an even more liberal approach that considers that, when individuals have been able to form consistent views of the good life, these views should provide the metric of evaluation. Such a super-liberal approach could entail quite different consequences depending on the values of the population. If the only dimension of life that people value were some kind of hedonic utility, then this approach would advocate comparing individuals in terms of hedonic utility. The super-liberal approach could then coincide with hedonic welfarism. If the only dimension of life valued by the population were wealth, then equalizing wealth would be the way to equalizing the value of life across individuals. If, as it more likely to be the case, people had different values and therefore different ordinal rankings of lives, one would have to find a way to reconcile their divergent evaluations. This is the indexing problem, which is examined in the next section.

In conclusion, the idea that GDP should be replaced by a single index of national utility is far from consensual, even among happiness specialists. This does not make happiness studies useless and a panel of subjective indicators would provide valuable information in complement to more objective indicators of living conditions. A better connection between the recent happiness literature and earlier philosophical debates about liberalism and utilitarianism would be welcome, because the happiness literature is replete with normative conclusions that do not seem sufficiently founded. Interestingly, the happiness studies can also prove useful for the liberal conception. Indeed, in spite of the aspiration treadmill, a clever use of satisfaction data, or the use of new questionnaires which would enable the respondents to express their ordinal preferences more directly than through the prism of a satisfaction level, may provide valuable information about people's deep preferences over the various dimensions of life (Clark and Oswald 2002, Schokkaert 2007a).

7 Capabilities

The capability approach, developed in Sen (1985, 1992),[69] is often presented as intermediate between resourcist and welfarist approaches, but it is perhaps accurate to present it as more general. A "functioning" is any doing or being in the life of an individual. A "capability set" is the set of functioning vectors that an individual has access to. Sen proposed capabilities as the metric of advantage for the definition of a liberal egalitarian theory of justice. This proposal has attracted a lot of interest in particular because

[69] Recent surveys on this approach and its applications can be found in Basu and Lopez-Calva (forth.), Kuklys (2005), Robeyns (2006), Robeyns and Van der Veen (2007), Schokkaert (2007b).

it makes it possible to take into account all the relevant dimensions of life, in contrast with the resourcist and hedonic approaches which can be criticized as too narrow.

7.1 Toward applications

Being so general, the approach needs to be specified in order to inspire original applications. The body of empirical literature that takes inspiration from the capability approach is now numerically impressive. As noted in Robeyns (2006) and Schokkaert (2007b), in many cases the empirical studies are essentially similar, but for terminology, to the sociological studies of living conditions. But there are more original applications, e.g., when an evaluation of development programs that takes account of capabilities is contrasted with cost-benefit analysis (Alkire 2002), when a poverty rate is corrected in order to take account of the extra expenses borne by disabled persons (Kuklys 2005), or when a list of basic capabilities is enshrined in a theory of what a just society should provide to all citizens (Nussbaum 2000). More generally, all studies which seek to incorporate multiple dimensions of quality of life into the evaluation of individual and social situations can be considered, broadly speaking, as pertaining to this approach.

Two central questions pervade the empirical applications. The first concerns the distinction between capabilities and functionings. The latter are easier to observe because individual achievements are more accessible to the statistician than pure potentialities. There is also the normative issue of whether the evaluation of individual situations should be based on capabilities only, viewed as opportunity sets, or should take account of achieved functionings as well. The second central question is the index problem, which has also been raised about Rawls' theory of primary goods. There are many dimensions of functionings and capabilities and not all of them are equally valuable. The definition of a proper system of weights has appeared problematic in connection to the difficulties of social choice theory.

7.2 The index problem

The two questions are related. The indexing problem is often presented as a dilemma. If a single index is defined in order to weight the various dimensions of life for all individuals, uniformly, there is no chance that the weights will respect the individuals' own values about life and the procedure will appear paternalistic or perfectionist. If, on the contrary, one seeks to respect each and every individual's views about the relative importance of the various dimensions of life, one is taking the welfarist route, it is said, and ends up dealing with utility functions. In this light, turning attention to capability sets, as opposed to functionings, is often viewed as a solution. Even if the index of capabilities is the same objective index for all individuals, capabilities are just opportunity sets and individuals are free to choose from these sets, so that a society seeking to equalize capability indexes across individuals can still be considered a liberal society.

An additional possibility, also suggested by Sen, consists in abandoning the project of a precise numerical index and in devising a partial ordering of individual situations based on the intersection of individual orderings. Assuming that individuals have well-defined preference orderings over capability sets

or functionings, one can consider that individual i is better off than individual j, in terms of capabilities or functionings, if this judgment is shared by all the preferences of the population (or all the preferences in a suitable domain). Rawls also invoked the possibility of this kind of unanimous judgment in order to identify the worst off group in terms of primary goods.

This "intersection" approach, however, has paradoxical consequences.[70] Suppose that individual situations are represented by vectors in some space of capabilities or functionings, and that all reasonable preferences are monotonic. In this context, the intersection approach can motivate a dominance principle stipulating that an individual having more in all dimensions is better off. All monotonic individual preferences do indeed agree with this principle. But another natural way to respect individual preferences, especially if one wants to avoid paternalism, is to say that two situations that are deemed equivalent by an individual should be considered equivalent when they are given to this individual. Formally, consider a transitive but not necessarily complete ranking $\succeq$ of situations (individual vectors) $x \in X$, the expression $(x,i) \succeq (y,j)$ meaning that i in situation x is at least as well off as j in situation y, and the expression xR_iy meaning that x is at least as good as y for i's preferences (with xI_iy denoting indifference). The *dominance principle* means that for all i,j, all $x,y \in X$, if $x \gg y$ then $(x,i) \succ (y,j)$. The *non-paternalism requirement* means that for all i, all $x,y \in X$, if xI_iy then $(x,i) \sim (y,i)$. Now, these two requirements are incompatible whenever there are individuals with different preferences (under mild assumptions). Because one can then find $x,y,z,w \in X$ and i,j such that $x \gg y$, $z \gg w$, xI_iw and yI_jz (see Figure 1). By the dominance principle, $(x,i) \succ (y,j)$ and $(z,j) \succ (w,i)$, but by non-paternalism, $(x,i) \sim (w,i)$ and $(y,j) \sim (z,j)$, which violates transitivity.

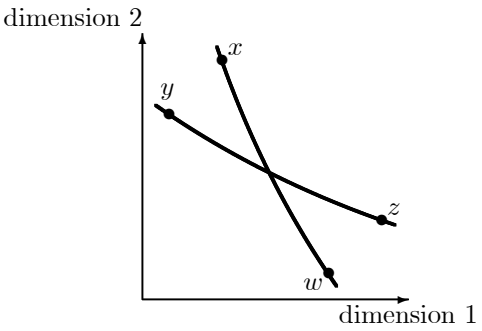

Figure 1

This fact implies that one must accept to relax one of the two requirements. If one gives priority to non-paternalism, one can nonetheless seek to preserve as much of the dominance principle as is compatible with non-paternalism. A restricted dominance principle, for instance, stipulates that for some subset $A \subseteq X$, it holds that for all i,j, all $x,y \in A$, $x \gg y$ implies $(x,i) \succ (y,j)$. Under mild regularity conditions, the combination of this restricted dominance principle with non-paternalism implies that the ranking $\succeq$ must be of the egalitarian-equivalent sort.[71] In particular, the subset A over which dominance

[70] See, e.g., Brun and Tungodden (2004).

[71] See Fleurbaey (2007).

applies has to be a monotone path (an increasing curve in X) and interpersonal comparisons are performed as follows: $(x,i) \succeq (y,j)$ if and only if $a \geq b$, where $a, b \in A$ are defined by xI_ia and yI_jb. The equivalent-income approach is an example of such a ranking, with a path defined by all levels of income associated with the reference values for the non-income dimensions. This example shows that the indexing problem does not imply the alleged dilemma. It is possible to avoid welfarism while respecting preferences at the individual level.

If one gives priority to the dominance principle but seeks to avoid paternalism as much as possible, a natural solution is to take a reference preference ordering over X that is somehow a summary of the population preferences.[72]

7.3 Capabilities or functionings?

The other question that pervades the literature is whether one should focus on functionings or on capabilities. The empirical literature almost exclusively with functionings because they are observable. However, many functionings, such as income and health, also directly determine capabilities (to consume, to move around...). In addition, some recent work has explored the possibility to inquire directly by questionnaires whether individuals feel able to do certain things.[73]

Independently of observability, there is the normative issue of whether the appropriate metric for interpersonal comparisons corresponds to achievements or to opportunities. Several justifications for an opportunity metric have been provided. One has already been mentioned, namely, the need to respect individual preferences without falling back into welfarism. But we have seen that the egalitarian-equivalent approach makes it possible, if one wishes, to focus on achievements while respecting individual preferences.

The main justification in Sen's work for a focus on capabilities is the importance of freedom. Classical welfare economics can indeed be criticized for being tied to the measurement of achievements (income, consumption, utility) and for being impervious to the importance of the freedom to choose. Several philosophers, however, have noted that the importance of freedom justifies taking account of capabilities, but not necessarily an exclusive focus on capabilities.[74] One can imagine a broader framework in which both capabilities and achieved functionings serve to describe individual situations, and are weighted according to individuals' valuations of the relative importance of opportunity and achievement. This would come close to a variant actually proposed by Sen (1992), which considers "refined functionings", i.e., the achieved functioning vectors combined with information about the capability sets from which they are obtained.

Another possible justification for an exclusive focus on opportunities comes from theories of justice based on personal responsibility. According to such theories, success or failure should be up to individuals provided they have been given suitable opportunities.[75] Several authors have criticized this approach for

[72] Chakraborty (1996) proposes to compute an "average" preference ordering for this purpose. Sprumont (2007) has also explored this kind of solution and given it an axiomatic foundation based on the dominance principle.

[73] See, e.g., Anand et al.(2005).

[74] See, e.g., Arneson (1998).

[75] See in particular Arneson (1989), Cohen (1989).

being potentially harsh with the losers, and for embroiling distributive justice in the metaphysics of free will.[76] It has also been noted that opportunities are not always well defined in a social context, because what is accessible to an individual may depend on what the others achieve. For instance, consumers are often momentarily rationed when others have bought all the local stock of a particular commodity. The possibility to have a successful career may be apparently open to two parents but in fact at least one of them must take care of the children.[77]

In conclusion, the capability approach has the merit of providing a lot of flexibility about the evaluation of individual situations, especially if one considers legitimate to take account of functionings as well. This flexibility comes at a cost, which is the difficulty for many authors to specify a precise measurement method. One can however consider that making progress on the indexing problem should help substantially in applications.

8 Concluding remarks

Is there progress in the measurement of individual well-being and social welfare? While the classical results on the total value of consumption seem to be definitively limited, the developments described in this paper suggest a possible integration of such disparate approaches as Bergson-Samuelson welfare economics, social choice theory, fair allocation theory, and the capability approach. Within the space delineated by such integration, definite possibilities appear for the construction of reasonable indexes of individual well-being which can be incorporated into classical-looking social welfare functions. Such indexes may rely more or less on individual preferences depending on whether one trusts individual preferences or on whether one gives precedence to non-paternalism or to the dominance principle in the comparison of life vectors. Correlatively, the impressive progress recently observed in the measurement of subjective well-being appears promising, not only for the construction of welfarist indexes of hedonic utility or satisfaction but also for the construction of non-welfarist indexes reflecting individual preferences.

Three schools of thought underlie the various approaches discussed in this paper. The *welfarist* approach is interested in promoting hedonic utility or satisfaction. It is especially influential in the studies of happiness discussed in Section 6. The *liberal* approach seeks to give people what they want, reasoning in terms of resources or opportunities. It motivates much of the theory of social choice and fair allocation analyzed in Section 4 as well as the capability approach presented in Section 7, but it can also be linked to the older tradition of welfare economics discussed in Section 2 (with intertemporal extension in Section 3), even though this may have been far from transparent to the concerned authors at that time. The *perfectionist* approach, which considers that well-being can be measured independently of individual preferences, underlies the objective measures which are encountered in the field of social indicators (Section 5) or in some variants of the capability approach. Because these three schools of thought are prominent in modern culture and public debates, and will stay with us for a long time, it

[76] See, e.g., Anderson (1999).

[77] See, e.g., Basu and Lopez-Calva (forth.).

probably makes sense to assign economists the task of thinking rigorously about the alternatives to GDP that each approach may inspire and of developing concrete proposals for each of them. Moreover, each approach has its strengths and weaknesses in the perspective of developing an alternative to GDP.

The main advantage of an objective measure is that it may be relatively simple to implement and is immune to the vagaries of people's subjectivity. Its main weakness lies in the hard choice of a weighting system to trade off the various components of the index of well-being, whether it is constructed at the individual (which is definitely preferable) or directly at the social level. The other two approaches seek to remedy this difficulty by relying on individuals' subjective views. The welfarist approach seeks a direct measure of subjective utility (hedonic utility or cognitive satisfaction) and recent developments in empirical methods have transformed this feature from a handicap into an advantage. The main weakness of the welfarist approach is that direct measures of utility often fail to reliably track inequalities in material and social conditions, reflecting how people feel rather than how well they are or even what they want. The liberal approach is by definition anchored on what people want, and this may be its main advantage in comparison to the other two approaches, for those who value this ideal. Its main weakness lies in the multiple possibilities for interpersonal comparisons that are still competing within this approach. Even a narrowly defined approach such as the equivalent income measure is still imprecise about how to determine the reference levels for many non-income dimensions of life.

Even if no approach is without weakness, it appears from the literature surveyed here that substantial progress has been made and can be pursued in the three branches, with concrete proposals being actually offered for each of them. Serious alternatives to GDP are around the corner. However, it seems desirable to abandon the preconception that one can find a unique consensual measure of well-being, and necessary to accept that there will not be a single alternative. It is also worth emphasizing that, at least for two of these approaches (the perfectionist and the liberal) and possibly for the third one as well, total income or consumption remains a relevant component or determinant of social welfare that should appear in informative decompositions — provided the other components are displayed as well.

Appendix: Decomposing welfare

We present a variant of the decompositions proposed by Graaff (1977), Jorgenson (1990) and Slesnick (1998). The ingredients of the decomposition are illustrated in Figure A.1. The P curve is the production frontier (i.e., any aggregate bundle on or below this curve can be produced), the S curve is the Scitovsky frontier for allocation $(x_1, \ldots, x_n)$ (i.e., any aggregate bundle on or above this curve can be distributed so as to give every $i = 1, \ldots, n$ his satisfaction at x_i), and the B curve is the Bergson frontier for allocation $(x_1, \ldots, x_n)$ (i.e., any aggregate bundle on or above this curve can be distributed so as to yield as much social welfare as at $(x_1, \ldots, x_n)$ — equivalently, this is the indifference curve for function W^* defined in (1), at the level $W^*(X)$). The straight lines with negative slope represent bundles of equal value at prices p^*.

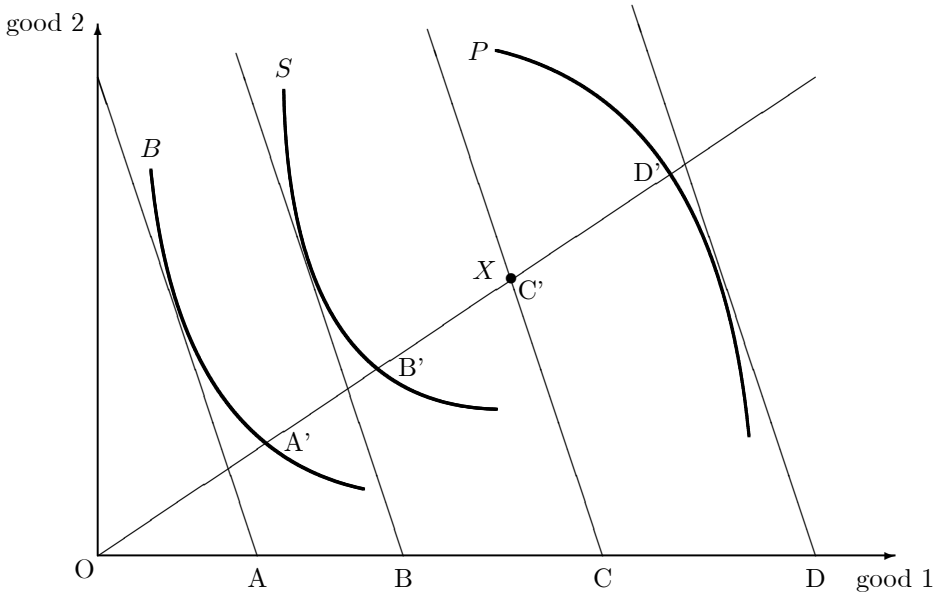

Figure A.1

We need to define the following functions. First, V^m measures the maximum value attainable in the production set $\mathbf{P}$ delineated by the P curve:

$$V^m(x_1, ..., x_n) = \max p^* (y_1 + ... + y_n) \quad \text{s.c. } (y_1, \ldots, y_n) \in \mathbf{P}.$$

Second, $\hat{V}^m$ computes the same but restricts attention to aggregate bundles that are proportional to X :

$$\hat{V}^m(x_1, ..., x_n) = \max p^* (y_1 + ... + y_n) \quad \text{s.c. } (y_1, \ldots, y_n) \in \mathbf{P},\ (y_1, \ldots, y_n) \text{ proportional to } X.$$

One has $\hat{V}^m(x_1, ..., x_n) = p^*X$ if and only if X is on the production frontier, and therefore $\hat{\chi} = p^*X/\hat{V}^m(x_1, ..., x_n)$ — corresponding to OC'/OD' in Fig. A.1 — is an index of productive efficiency, while $\chi = p^*X/V^m(x_1, ..., x_n)$ — OC/OD in Fig. A.1 — is an index of productive efficiency in terms of value at p^* prices.

Third, V^e measures the minimal expenditure needed to maintain every individual's satisfaction:

$$V^e(x_1, ..., x_n) = \min p^* (y_1 + ... + y_n) \quad \text{s.c. } u_i(y_i) \geq u_i(x_i)\ \forall i = 1, ..., n.$$

Fourth, $\hat{V}^e$ restricts attention to aggregate bundles that are proportional to X :

$$\hat{V}^e(x_1, ..., x_n) = \min p^* (y_1 + ... + y_n)$$
$$\text{s.c. } u_i(y_i) \geq u_i(x_i)\ \forall i = 1, ..., n,\ (y_1, \ldots, y_n) \text{ proportional to } X.$$

One has $\hat{V}^e(x_1, \ldots, x_n) = p^*X$ if and only if $(x_1, \ldots, x_n)$ is Pareto efficient in the set of all its redistributions, and therefore $\hat{\varepsilon} = p^*X/\hat{V}^e(x_1, ..., x_n)$ — corresponding to OB'/OC' in Fig. A.1 — is an index of distributive efficiency, while $\varepsilon = p^*X/V^e(x_1, ..., x_n)$ — OB/OC in Fig. A.1 — is an index of distributive

efficiency in terms of total expenditure (this index equals one if and only if the allocation is efficient and is supported by p^*).

Fifth, let $\hat{V}$ be the twin function of Pollak's social expenditure function V when attention is restricted to aggregate bundles that are proportional to X :

$$\hat{V}(x_1, ..., x_n) = \min p^* (y_1 + ... + y_n)$$
$$\text{s.c. } W(u_1(y_1), ..., u_n(y_n)) \geq W(u_1(x_1), ..., u_n(x_n)),\ (y_1, \ldots, y_n) \text{ proportional to } X.$$

One has $\hat{V}(x_1, \ldots, x_n) = p^*X$ if and only if $(x_1, \ldots, x_n)$ is socially optimal in the set of all its redistributions, and $\hat{V}(x_1, \ldots, x_n) = \hat{V}^e(x_1, \ldots, x_n)$ if and only if the distribution of welfare in $(x_1, \ldots, x_n)$ is socially optimal when the aggregate bundle is the smallest fraction of X (i.e., $\hat{\varepsilon}X$) that makes this distribution of welfare possible. Therefore $\hat{\eta} = \hat{V}(x_1, ..., x_n)/\hat{V}^e(x_1, ..., x_n)$ — corresponding to OA'/OB' in Fig. A.1 — is an index of equity, while $\varepsilon = V(x_1, ..., x_n)/V^e(x_1, ..., x_n)$ — OA/OB in Fig. A.1 — is an index of equity in terms of total expenditure.

These functions being defined, one can then decompose $V(x_1, ..., x_n)$ into relevant terms referring to productive efficiency, distributive efficiency and equity. Total expenditure at p^* value appears as an intermediate summary of the terms involving productive efficiency.

$$V(x_1, ..., x_n) = \underbrace{V^m(x_1, ..., x_n) \times \hat{\chi} \times \frac{\chi}{\hat{\chi}}}_{= p^*X} \times \hat{\varepsilon} \times \frac{\varepsilon}{\hat{\varepsilon}} \times \hat{\eta} \times \frac{\eta}{\hat{\eta}}.$$

The ratios $\chi/\hat{\chi}$ and $\varepsilon/\hat{\varepsilon}$, which are no greater than 1, measure the additional efficiency loss that would appear under the possibility of working with expenditures at p^* value (e.g., as for a small country facing international prices p^*) rather than with the actual production set $\mathbf{P}$ and fractions of X.

For allocations with aggregate consumption proportional to X, $\hat{V}$ is another acceptable measure of social welfare. It can be decomposed as follows:

$$\hat{V}(x_1, ..., x_n) = \underbrace{\hat{V}^m(x_1, ..., x_n) \times \hat{\chi}}_{= p^*X} \times \hat{\varepsilon} \times \hat{\eta}.$$

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