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Population Ethics and the Value of Life

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Abstract

Public policies often involve choices of alternatives in which the size and the composition of the population may vary. Examples are the allocation of resources to prenatal care and the design of aid packages to developing countries. In order to assess the corresponding feasible choices on normative grounds, criteria for social evaluation that are capable of performing variable-population comparisons are required. We review several important axioms for welfarist population principles and discuss the link between individual well-being and the desirability of adding a new person to a given society.

Keywords: population ethics, neutrality, critical levels

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1. Introduction

Public policies frequently involve choices of alternatives in which the size and the composition of the population may vary. Examples are the allocation of resources to prenatal care and the design of aid packages to developing countries. In order to assess the corresponding feasible choices on normative grounds, criteria for social evaluation that are capable of ranking alternatives with different populations and population sizes are required.

Such criteria, which we call population principles, are extensions of fixed-population social-evaluation principles. The purpose of this paper is to discuss some of their properties. In particular, we examine the consequences and the mutual compatibility of several requirements regarding the addition of individuals to a given society.

The principles discussed in this paper are welfarist: the ranking of any two alternatives depends on the well-being of those alive in them only. Thus, knowledge of all those who ever live together with their levels of lifetime utility (interpreted as levels of lifetime well-being) is sufficient to establish a welfarist social ranking. Because of the importance of utility information, it is important to employ a comprehensive account of well-being such as that of Griffin [1986] or of Sumner [1996]. The interpretation of individual utilities as indicators of lifetime (as opposed to per-period) well-being is essential to avoid counter-intuitive recommendations regarding the termination of lives.

For an individual, a neutral life is one which is as good as one in which he or she has no experiences. Above neutrality, life, as a whole, is worth living; below neutrality, it is not. Following standard practice, we assign a utility level of zero to neutrality. It is possible to use other normalizations but, in that case, the definitions of the principles discussed here must be adjusted accordingly.

Same-number generalized utilitarianism ranks any two alternatives with the same population size by comparing their total or average transformed utilities. The transformation is increasing, continuous and preserves the zero normalization for a neutral life. If the transformation is strictly concave, the principle is strictly averse to utility inequality, giving priority to the interests of those whose utility levels are low. There are many ways of extending same-number generalized utilitarianism to a variable-number framework, and we call a population principle whose same-number subprinciples are generalized-utilitarian a same-number generalized-utilitarian principle.

Critical-level generalized utilitarianism (Blackorby, Bossert and Donaldson [1995, 1997] and Blackorby and Donaldson [1984]) is a class of same-number generalized-utilitarian principles. Each of its members uses the sum of the differences between transformed individual utility levels and a transformed fixed critical level to make comparisons.[1] If the

[1] Fixed critical levels are proposed by Parfit [1976, 1982, 1984].

critical level is equal to zero, classical generalized utilitarianism results. For each value of the critical-level parameter, a different principle is obtained.

Parfit [1976, 1982, 1984] criticizes classical utilitarianism (the special case of classical generalized utilitarianism where the transformation is the identity mapping) on the grounds that it implies the repugnant conclusion. A population principle implies the repugnant conclusion if and only if, for any population size, for any positive level of utility and for any level of utility strictly between zero and the specified level, there exists a larger population size such that an alternative in which everyone in the larger population has the lower level of utility is better than any alternative with the smaller population and the higher utility for everyone.[2] The higher utility level can be arbitrarily large and the lower utility level can be arbitrarily close to zero, the level that represents a neutral life. The generalized counterpart of classical utilitarianism suffers from the same problem.

The Pareto plus principle (see Sikora [1978]) extends the strong Pareto principle to variable-population comparisons. It requires the addition of an individual with a lifetime utility above neutrality to a utility-unaffected population to be ranked as a social improvement. In conjunction with several standard conditions, this axiom is inconsistent with avoidance of the repugnant conclusion. In addition, Pareto plus appears to rest on the idea that individuals who do not exist—potential people—have interests, a view that is not easy to defend. Thus, we accept violations of Pareto plus in order to be able to avoid the repugnant conclusion.

In this paper, we summarize some important aspects of welfarist population ethics that are discussed in detail in some earlier contributions. In addition, new results analyze some implications of Pareto plus and avoidance of the repugnant conclusion. Two impossibility theorems regarding the compatibility of Pareto plus and avoidance of the repugnant conclusion are presented. In response to those impossibilities, we discuss an alternative to Pareto plus, the negative expansion principle. It requires any alternative to be ranked as better than an expansion in which no one in the existing population is affected and an added individual is below neutrality.

In Section 2, we introduce population principles and, as a special case, same-number generalized utilitarianism. The notions of a neutral life and critical levels are discussed in Section 3. In addition, we examine the restrictions that are imposed on critical levels by the Pareto plus principle, avoidance of the repugnant conclusion and the negative expansion principle. Section 4 presents and discusses critical-level generalized utilitarianism and Section 5 concludes.

[2] Parfit's statement of the repugnant conclusion is somewhat weaker.

2. Population principles

A population principle ranks alternatives according to their social goodness. Each social alternative is a complete history of the world (or universe) and is associated with all information that may be relevant to the ranking. In particular, information about individual well-being is included. The social ranking is assumed to be an ordering, that is, a reflexive, transitive and complete at-least-as-good-as relation. Two alternatives are equally good if and only if each is at least as good as the other. An alternative is better than another if and only if it is at least as good and the converse is not true.

A utility distribution consists of the lifetime utility levels of all the people who ever live in the corresponding alternative. Because we consider anonymous principles only, it is not necessary to keep track of individual identities. Consequently, the utility levels in an alternative can be numbered from one to the number of individuals alive. Thus, if there are n people alive in an alternative, a utility distribution is an n-tuple $u = (u_1, \ldots, u_n)$ where each number in the list is the utility level of one of the members of society. The utility distribution $\mathbf{1}_n$ is a distribution where all n people alive have a utility of one.

We restrict attention to welfarist population principles.[3] A principle is welfarist if and only if there is a single ordering defined on utility distributions that can be used to rank all alternatives: one alternative is at least as good as another if and only if the utility distribution corresponding to the first is at least as good as the distribution corresponding to the second according to this ordering. In order to be a population principle, the ordering of utility distributions must be capable of different-number comparisons: any two distributions $u = (u_1, \ldots, u_n)$ and $v = (v_1, \ldots, v_m)$ are ranked, even if the population sizes n and m are different. Because we consider welfarist principles only, we formulate all axioms and principles in terms of the ordering of utility distributions.

In this section, we introduce properties of population principles that impose restrictions on same-number comparisons only. Our first requirement is anonymity: if we relabel the utility levels in a utility distribution u, the resulting distribution is as good as u. Such a relabeling is called a permutation of a utility distribution. A permutation of $u = (u_1, \ldots, u_n)$ is a utility distribution $v = (v_1, \ldots, v_n)$ such that there exists a way of matching each index i in u to exactly one index j in v such that $u_i = v_j$. For example, (u_2, u_1, u_3) is a permutation of (u_1, u_2, u_3).

Anonymity: For all population sizes n, for all utility distributions $u = (u_1, \ldots, u_n)$ and $v = (v_1, \ldots, v_n)$, if v is a permutation of u, then u and v are equally good.

[3] See, for example, Blackorby, Bossert and Donaldson [2002b] for a case in favor of welfarist social evaluation.

The strong Pareto principle is a fixed-population axiom. If everyone alive in two distributions u and v has a utility in u that is at least as high as that in v with at least one strict inequality, u is better than v.

Strong Pareto: For all population sizes n and for all utility distributions $u = (u_1, \ldots, u_n)$ and $v = (v_1, \ldots, v_n)$, if $u_i \geq v_i$ for all i with at least one strict inequality, then u is better than v.

It is possible to criticize strong Pareto on the grounds that increases in some or all utility levels may increase utility inequality. A weaker principle that avoids this objection is minimal increasingness. It applies to utility distributions in which all utility levels are equal and declares increases in the common level to be social improvements.

Minimal increasingness: For all population sizes n and for all utility levels b and d, if $b > d$, then $b\mathbf{1}_n$ is better than $d\mathbf{1}_n$.

Continuity is a condition that prevents the goodness relation from exhibiting 'large' changes in response to 'small' changes in the utility distribution. It rules out fixed-population principles such as lexicographic maximin (leximin).

Continuity: For all population sizes n, for all utility distributions $u = (u_1, \ldots, u_n)$ and $v = (v_1, \ldots, v_n)$ and for all sequences of utility distributions $\langle u^j \rangle_{j=1,2,\ldots}$ where $u^j = (u_1^j, \ldots, u_n^j)$ for all j,

(a) if the sequence $\langle u^j \rangle_{j=1,2,\ldots}$ approaches v and u^j is at least as good as u for all j, then v is at least as good as u;

(b) if the sequence $\langle u^j \rangle_{j=1,2,\ldots}$ approaches v and u is at least as good as u^j for all j, then u is at least as good as v.

A population principle is weakly inequality averse if and only if it ranks an equal distribution as at least as good as any distribution which has the same total utility.

Weak inequality aversion: For all population sizes n and for all utility distributions $u = (u_1, \ldots, u_n)$, $\left((\sum_{i=1}^n u_i)/n\right) \mathbf{1}_n$ is at least as good as u.

We conclude this section with a definition of same-number generalized utilitarianism. The members of this class of principles use the sum of transformed utilities to perform all same-number comparisons. The transformation applied to individual utilities is the same for everyone and it is continuous and increasing. Without loss of generality, we assume that the transformation preserves neutrality, that is, its value at zero is equal to zero. The principle is minimally inequality-averse if and only if the transformation is concave and strictly inequality-averse if and only if the transformation is strictly concave. The latter case gives priority to the interests of those whose levels of well-being are low (see Blackorby, Bossert and Donaldson [2002a], Parfit [1997], Broome [2003] and Fleurbaey [2003]). According to same-number generalized utilitarianism with a transformation g, a utility distribution $u = (u_1, \ldots, u_n)$ is at least as good as a distribution $v = (v_1, \ldots, v_n)$ with the same population size if and only if

$$\sum_{i=1}^{n} g(u_i) \geq \sum_{i=1}^{n} g(v_i).$$

It is easy to verify that same-number generalized utilitarianism satisfies all of the same-number axioms introduced in this section.

3. Population expansions

A life is worth living if and only if it is better, from the viewpoint of the individual leading it, than a life without any experiences.[4] Similarly, a life is not worth living if and only if it is worse than a life without experiences. A neutral life is one which is neither worth living nor not worth living. Following the standard normalization employed in population ethics, we associate a utility level of zero with a neutral life. Thus, if a person has a positive (negative) level of lifetime well-being, his or her life is (is not) worth living.

Because people who do not exist do not have interests or preferences, it does not make sense to say that an individual gains by being brought into existence with a utility level above neutrality. It makes perfect sense, of course, to say that an individual gains or loses by continuing to live because of surviving a life-threatening illness, say. Such a change affects length of life, not existence itself.[5] We therefore take the view that, unless an individual is alive in two alternatives, comparisons of individual goodness are meaningless.[6] We follow the standard convention and identify the value of a neutral life with a lifetime-utility level of zero.

The axioms introduced in the previous section are same-number axioms because they impose restrictions on same-number comparisons only. One way of establishing links between utility distributions of different dimensions is to assume that, for any distribution of any population size, there exists a level of utility—the critical level—which, if experienced by an additional person, leads to a distribution that is equally good, provided that the utilities of the common population are unchanged. The following axiom postulates the existence of a critical level for every utility distribution.

[4] See Broome [1993].

[5] For further discussions, see Blackorby, Bossert and Donaldson [1997], Heyd [1992, Chapter 1], McMahan [1996] and Parfit [1984, Appendix G].

[6] See Broome [1993, 1999, Chapter 8], Heyd [1992, Chapter 1], McMahan [1996] and Parfit [1984, Appendix G].

Existence of critical levels: For all population sizes n and for all utility distributions $u = (u_1, \ldots, u_n)$, there exists a critical level c such that u and $(u, c) = (u_1, \ldots, u_n, c)$ are equally good.

A critical level c for a utility distribution u is a level of well-being c such that, if an individual with the critical level is added to u, all other utilities unchanged, the augmented distribution and the original are equally good. As an immediate consequence of strong Pareto and transitivity, each utility distribution can have at most one critical level. In that case, it is possible to define a critical-level function C which provides a critical level for every utility distribution. Thus, any distribution u and the distribution $(u, C(u))$ are equally good. It follows that the overall ordering of utility distributions is completely determined by the same-number orderings and the critical-level function.

Sikora [1978] proposes to extend the strong Pareto principle to variable-population comparisons. He calls the resulting axiom Pareto plus, and it is usually defined as the conjunction of strong Pareto and the requirement that the addition of an individual above neutrality to a utility-unaffected population is a social improvement. Because we want to retain strong Pareto as a separate axiom, we state the second part of the condition only.

Pareto plus: For all population sizes n, for all utility distributions $u = (u_1, \ldots, u_n)$ and for all positive utility levels a, $(u, a) = (u_1, \ldots, u_n, a)$ is better than u.

In the axiom statement, the common population in u and (u, a) is unaffected and, thus, in order to defend the axiom, it must be argued that a level of well-being above neutrality is better than non-existence. Thus, the axiom extends the Pareto condition to situations where a person is not alive in all alternatives that are compared. While it is possible to compare alternatives with different populations from a social point of view (which is the issue addressed in population ethics), it is questionable to make such a comparison from the viewpoint of an individual if the person is not alive in one of the alternatives. It is therefore difficult to interpret this axiom as a Pareto condition because it appears to be based on the idea that people who do not exist have interests that should be respected.

There is, therefore, an important asymmetry that applies to the assessment of alternatives with different populations. Although it is perfectly reasonable to say that an individual considers his or her life worth living if he or she is alive with a positive level of lifetime well-being, it does not make sense to say that a person who does not exist gains from being brought into existence with a life above neutrality: such a person cannot experience gains or losses.

The following result illustrates the requirements on critical levels imposed by Pareto plus, provided strong Pareto and existence of critical levels are satisfied. Not surprisingly, Pareto plus is equivalent to the requirement that all critical levels be non-positive.

Theorem 1: *Suppose that an anonymous population principle satisfies strong Pareto and existence of critical levels. The principle satisfies Pareto plus if and only if all critical levels are non-positive.*

Proof. Suppose all critical levels are non-positive. By existence of critical levels and strong Pareto, critical levels are unique and the critical-level function C is well-defined. By definition of a critical level, u and $(u, C(u))$ are equally good for all utility distributions u. Let a be a positive utility level. Because all critical levels are non-positive, it follows that $a > 0 \geq C(u)$ and, thus, $a > C(u)$. By strong Pareto, (u, a) is better than $(u, C(u))$ and, because $(u, C(u))$ and u are equally good, transitivity implies that (u, a) is better than u. Thus, Pareto plus is satisfied.

Now suppose there exists a utility distribution u such that the critical level $C(u)$ for u is positive. By definition, $(u, C(u))$ and u are equally good. Let a be such that $0 < a < C(u)$. Strong Pareto implies that $(u, C(u))$ is better than (u, a). Using transitivity again, it follows that u is better than (u, a) and, thus, Pareto plus is violated because a is positive. ■

Another property that imposes restrictions on variable-population comparisons is avoidance of the repugnant conclusion. A principle leads to the repugnant conclusion (Parfit [1976, 1982, 1984]) if population size can always be substituted for quality of life, no matter how close to neutrality the well-being of a large population is. That is, there are situations where mass poverty is considered better than some alternatives in which fewer people lead very good lives. We share Parfit's view regarding the unacceptability of the repugnant conclusion and we therefore require a population principle to avoid it.

Avoidance of the repugnant conclusion: There exist a population size n, a positive utility level ξ and a utility level ε strictly between zero and ξ such that, for all population sizes $m > n$, a utility distribution in which each of n individuals has the utility level ξ is at least as good as a utility distribution in which each of m individuals has a utility of ε.

An important criticism of Pareto plus is that all anonymous, weakly inequality-averse population principles that satisfy it lead to the repugnant conclusion. Similar theorems can be found in Blackorby, Bossert, Donaldson and Fleurbaey [1998], Blackorby and Donaldson [1991], Carlson [1998], McMahan [1981] and Parfit [1976, 1982, 1984].

Theorem 2: *There exists no anonymous population principle that satisfies minimal increasingness, weak inequality aversion, Pareto plus and avoidance of the repugnant conclusion.*

Proof. Suppose that an anonymous population principle satisfies minimal increasingness, weak inequality aversion and Pareto plus. For any population size n, let ξ, ε and δ be utility levels such that $0 < \delta < \varepsilon < \xi$. Choose the integer r such that

$$r > n\frac{(\xi - \varepsilon)}{(\varepsilon - \delta)}. \tag{1}$$

Because the numerator and denominator are both positive, r is positive. By Pareto plus, $(\xi\mathbf{1}_n, \delta\mathbf{1}_r)$ is better than $\xi\mathbf{1}_n$. Average utility in $(\xi\mathbf{1}_n, \delta\mathbf{1}_r)$ is $(n\xi + r\delta)/(n+r)$ so, by minimal inequality aversion, $[(n\xi + r\delta)/(n+r)]\mathbf{1}_{n+r}$ is at least as good as $(\xi\mathbf{1}_n, \delta\mathbf{1}_r)$. By (1),

$$\varepsilon > \frac{n\xi + r\delta}{n+r}$$

and, by minimal increasingness, $\varepsilon\mathbf{1}_{n+r}$ is better than $[(n\xi + r\delta)/(n+r)]\mathbf{1}_{n+r}$. Using transitivity, it follows that $\varepsilon\mathbf{1}_{n+r}$ is better than $\xi\mathbf{1}_n$ and avoidance of the repugnant conclusion is violated. ■

If weak inequality aversion is dropped from the list of axioms in Theorem 2, the remaining axioms are compatible. For example, a principle proposed by Sider [1991] which he calls geometrism satisfies minimal increasingness, Pareto plus and avoidance of the repugnant conclusion. It uses a positive constant k between zero and one which and ranks alternatives with a weighted sum of utilities: the j^{th}-highest non-negative utility level receives a weight of k^{j-1} and the l^{th}-lowest negative utility receives a weight of k^{l-1}. Critical levels are all zero and the repugnant conclusion is avoided but, because weights on higher positive utilities exceed weights on lower ones, the principle prefers inequality of positive utilities over equality (see Arrhenius and Bykvist [1995]).

If a population principle is same-number generalized-utilitarian, the inequality-aversion requirement of Theorem 2 can be dropped.

Theorem 3: *There exists no same-number generalized-utilitarian population principle that satisfies Pareto plus and avoidance of the repugnant conclusion.*

Proof. Suppose that a same-number generalized-utilitarian population principle satisfies Pareto plus. For any population size n, let ξ, ε and δ be utility levels such that $0 < \delta < \varepsilon < \xi$. Choose the integer r such that

$$r > n\frac{[g(\xi) - g(\varepsilon)]}{[g(\varepsilon) - g(\delta)]}. \tag{2}$$

Because g is increasing, the numerator and denominator of (2) are both positive and, therefore, r is positive. (2) implies that

$$(n+r)g(\varepsilon) > ng(\xi) + rg(\delta)$$

so, by same-number generalized utilitarianism, $\varepsilon\mathbf{1}_{n+r}$ is better than $(\xi\mathbf{1}_n, \delta\mathbf{1}_r)$. By Pareto plus, $(\xi\mathbf{1}_n, \delta\mathbf{1}_r)$ is better than $\xi\mathbf{1}_n$ and, by transitivity, $\varepsilon\mathbf{1}_{n+r}$ is better than $\xi\mathbf{1}_n$. Consequently, avoidance of the repugnant conclusion is violated. ■

We now show that anonymous population principles that satisfy strong Pareto, weak inequality aversion, existence of critical levels and avoidance of the repugnant conclusion must have at least one positive critical level.

Theorem 4: *If an anonymous population principle satisfies strong Pareto, weak inequality aversion, existence of critical levels and avoidance of the repugnant conclusion, then there exists a utility distribution u with a positive critical level.*

Proof. Suppose that an anonymous population principle satisfies strong Pareto, weak inequality aversion, existence of critical levels and avoidance of the repugnant conclusion. Then all critical levels exist and are unique. Now suppose that all critical levels are non-positive. Theorem 1 implies that Pareto plus is satisfied and, because strong Pareto implies minimal increasingness, Theorem 2 implies that avoidance of the repugnant conclusion is violated, a contradiction. Therefore, there must be at least one utility distribution u with a positive utility level. ■

A variant of Theorem 4 shows that same-number generalized-utilitarian principles that satisfy existence of critical levels and avoidance of the repugnant conclusion must have some positive critical levels. Because the proof uses Theorems 1 and 3 and is similar to the proof of Theorem 4, it is omitted.

Theorem 5: *If a same-number generalized-utilitarian population principle satisfies existence of critical levels and avoidance of the repugnant conclusion, then there exists a utility distribution u with a positive critical level.*

The negative expansion principle is the dual version of Pareto plus. It requires any utility distribution to be ranked as better than one with the ceteris-paribus addition of an individual whose life is not worth living.

Negative expansion principle: For all population sizes n, for all utility distributions $u = (u_1, \ldots, u_n)$ and for all negative utility levels a, u is better than $(u, a) = (u_1, \ldots, u_n, a)$.

If a population principle satisfies strong Pareto and all critical levels exist, this axiom requires them to be non-negative. Because the theorem is parallel to Theorem 1, it is not proved.

Theorem 6: *Suppose that an anonymous population principle satisfies strong Pareto and existence of critical levels. The principle satisfies the negative expansion principle if and only if all critical levels are non-negative.*

There are many population principles that satisfy minimal increasingness, weak inequality aversion, the negative expansion principle and avoidance of the repugnant conclusion. Among these are all of the critical-level generalized-utilitarian principles with positive critical levels.

The negative expansion principle does rule out some principles that avoid the repugnant conclusion, however. If average utility is negative, average utilitarianism approves of the ceteris-paribus addition of a person with a negative utility level above the average. If all critical levels exist, all same-number generalized-utilitarian principles with some negative critical levels are similarly ruled out. These include the number-dampened utilitarian principles (Ng [1986]) other than classical utilitarianism and their generalized counterparts (see Blackorby, Bossert and Donaldson [2003]).

4. Critical-level generalized utilitarianism

If strong Pareto is satisfied, a critical level represents a minimally acceptable level of utility such that the ceteris-paribus addition of a single individual with a greater lifetime utility is a social improvement. Because no one in the existing population is affected, it is natural to choose a constant critical-level function.

This choice is implied by adding a weakening of existence of critical levels and an independence condition to the same-number axioms introduced earlier. Existence independence requires the ranking of any two utility distributions to be independent of the existence (and, thus, the utilities) of individuals who have the same utility levels in both. A principle that satisfies this condition is capable of performing comparisons by restricting attention to affected individuals—the utilities of the unconcerned are irrelevant to establish the ranking of utility distributions.

Existence independence: For all population sizes n, m, r and for all utility distributions $u = (u_1, \ldots, u_n)$, $v = (v_1, \ldots, v_m)$ and $w = (w_1, \ldots, w_r)$, the utility distribution (u, w) is at least as good as the utility distribution (v, w) if and only if u is at least as good as v.

Existence of critical levels can be weakened to the following requirement. Unlike the stronger axiom, it requires the existence of only one critical level.

Weak existence of critical levels: There exist a utility distribution $u = (u_1, \ldots, u_n)$ and a utility level c such that u and $(u, c) = (u_1, \ldots, u_n, c)$ are equally good.

According to critical-level generalized utilitarianism, utility distribution $u = (u_1, \ldots, u_n)$ is at least as good as distribution $v = (v_1, \ldots, v_m)$ if and only if

$$\sum_{i=1}^{n} \left[g(u_i) - g(\alpha)\right] \geq \sum_{i=1}^{m} \left[g(v_i) - g(\alpha)\right],$$

where α is a fixed critical level. Without loss of generality, we can again assume that the continuous and increasing transformation g preserves the utility level representing neutrality, that is, it satisfies $g(0) = 0$. Classical generalized utilitarianism is obtained for the special case where the critical-level parameter α is equal to zero, the utility level representing a neutral life.

A subclass of the critical-level generalized-utilitarian class is the critical-level utilitarian (CLU) class in which the transformation g is the identity mapping. According to CLU, utility distribution $u = (u_1, \ldots, u_n)$ is at least as good as distribution $v = (v_1, \ldots, v_m)$ if and only if

$$\sum_{i=1}^{n}[u_i - \alpha] \geq \sum_{i=1}^{m}[v_i - \alpha],$$

where α is a fixed critical level. Classical utilitarianism is obtained when $\alpha = 0$.

The critical-level generalized-utilitarian (CLGU) principles are the only ones that satisfy the axioms anonymity, strong Pareto, continuity, existence independence and weak existence of critical levels. If the negative expansion principle is added, the fixed critical level must be non-negative and, if avoidance of the repugnant conclusion is added instead, the critical level must be positive. This result, which is proved in Blackorby, Bossert and Donaldson [1998], provides a strong case in favour of the CLGU principles with positive critical levels.[7] Because we consider the repugnant conclusion unacceptable, we add its avoidance to the list of axioms to obtain a characterization of the subclass of critical-level generalized-utilitarian principles with a positive critical level.

Theorem 7: *A welfarist population principle satisfies anonymity, strong Pareto, continuity, existence independence, weak existence of critical levels and avoidance of the repugnant conclusion if and only if it is critical-level generalized-utilitarian with a positive critical level α.*

If, in Theorem 7, avoidance of the repugnant conclusion is replaced with Pareto plus and the negative expansion principle, a characterization of classical generalized utilitarianism results.

[7] See also Blackorby, Bossert and Donaldson [1995] for an intertemporal formulation. An alternative characterization can be found in Blackorby and Donaldson [1984].

Theorem 8: *A welfarist population principle satisfies anonymity, strong Pareto, continuity, existence independence, weak existence of critical levels, Pareto plus and the negative expansion principle if and only if it is classical generalized-utilitarian.*

5. Conclusion

Parfit [1976, 1982, 1984] argues that the repugnant conclusion should be avoided and we concur. Because all reasonable population principles that satisfy Pareto plus lead to the repugnant conclusion (Theorems 2 and 3), we reject Pareto plus.

An ethically attractive alternative to Pareto plus is the negative expansion principle. It prevents the ceteris-paribus addition of a person whose life is not worth living from being ranked as a social improvement. It requires critical levels, if they exist, to be non-negative and, in addition, is compatible with avoidance of the repugnant conclusion. It also rules out some principles, such as average utilitarianism, that do not lead to the repugnant conclusion.

It is important that lifetime utilities rather than per-period utilities are considered if principles with positive critical levels are employed. This means that, contrary to a widespread misconception, the termination of a life does not change population size: instead, it changes the affected person's lifetime and may change her or his lifetime utility. Thus, a positive critical level does *not* recommend that a life with a lifetime utility between zero and the critical level should be terminated. Suppose we use critical-level utilitarianism with a critical level of two. Consider first a situation where two individuals are alive, one with a lifetime utility of four, the other with a lifetime utility of one. The sum of utility gains over the critical level is $(4-2)+(1-2)=1$. Now suppose terminating the second person's life would reduce her or his lifetime utility to zero. In this case, the relevant sum is $(4-2)+(0-2)=0$ and, thus, this alternative is worse. Note that, once a person exists, the person has full moral standing and his or her utility must count in the criterion for social evaluation. Suppose now that the first person is the only one alive and we ask whether a new person with a lifetime utility of one should be brought into being. The one-person society has a sum of utility gains of $(4-2)=2$ and if the second person is brought into existence, the corresponding sum is $(4-2)+(1-2)=1$ and, thus, it is better that the second (non-existing) person not be born. The different treatment of existing and non-existing individuals in this example cannot be obtained if the critical level is equal to zero.

The critical-level generalized-utilitarian principles with positive critical levels are not the only ones that satisfy anonymity, strong Pareto, continuity, existence of critical levels, avoidance of the repugnant conclusion and the negative expansion principle. However, all of the others that do necessarily violate existence independence. Because space constraints prevent us from examining them here, we refer the interested reader to Blackorby, Bossert and Donaldson [2003].

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