Health care evaluation, utilitarianism and distortionary taxes

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Abstract

Cost Utility Analysis (CUA) and Cost Benefit Analysis (CBA) are methods to evaluate allocations of health care resources. Problems are raised for both methods when income taxes do not meet the first best optimum. This paper explores the implications of three ways that taxes may fall short of this ideal. First, taxes may be distortionary. Second, they may be designed and administered without reference to information that is used by providers of health care. Finally, the share of tax revenue that is devoted to health care may be suboptimal. The two methods are amended to account for these factors. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

Cost Utility Analysis (CUA) and Cost Benefit Analysis (CBA) provide alternative approaches to allocating publicly funded health care. However, problems are raised for both approaches when taxation falls short of the first best optimum. In this paper, the implications of these problems are examined in a model in which

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funding for health care is raised by income taxes. The purpose of the paper is to suggest modifications to the standard versions of the CUA and CBA allocation rules.

In the following discussion, the standard CUA rule will be said to be satisfied when the marginal utility of a treatment to a patient divided by its marginal cost is equated across all types of treatment and all types of patient. It will be assumed that an appropriate cardinal and interpersonally comparable measurement of utility is available. As a consequence, the following discussion will deal with an ideal version of CUA, rather than with actual practice using Quality Adjusted Life Years. Similarly, an ideal CBA will be assumed, without reference to any particular methods. The standard CBA criterion will be said to be satisfied when the marginal willingness to pay (WTP) is equal to marginal cost, for all types of treatment and patient.

In a first best world, these two rules are equivalent. They are both satisfied by the allocation of health care that is optimal from a utilitarian perspective. However, with distortionary redistribution, different consumers of health care cannot be expected to have the same marginal utility of income. It is well known that this provides a problem for the standard form of CBA (e.g. Donaldson, 1996). Furthermore, income taxes introduce an externality from some types of health care. In particular, provision of health care sometimes allows patients to return to work. Any resulting increase in tax revenues and reduction in welfare expenditures are benefits of the treatment. Modifications which account for this benefit have been suggested to the standard forms of CBA (Johannesson, 1996) and CUA (Olsen, 1994; Meltzer, 1997). However, these suggestions do not incorporate the role of distortionary redistribution.

Two further complications will also be addressed in this paper. First, it will be assumed that neither income taxes nor welfare benefits can be conditioned on all the information about individuals’ health states that is available to providers of health care. Second, the possibility will be considered that the tax-funded budget for health care is not set at the optimal level. If the political process does not deliver the welfare maximising budget for health care, then this may have implications for the allocation of care within this budget.

In the following section, the normative framework is presented. First best versions of the CUA and CBA rules are derived in Section 3. In Sections 4 and 5, some obstacles to ideal taxation are introduced, and amendments are proposed to the two rules. Conclusions are drawn in the final section.

2. The model

In order to apply the utilitarian framework, assumptions are made about individual welfare. The welfare of individual i, in health state h, is affected by the types and quantities of health care that he or she receives. Let $z_{hi}$ be the vector of
health care quantities received by $i$ in $h$. Apart from health care, there are many other factors which also affect welfare. But only those that will be endogenous in the following analysis need to be accounted for. In order to allow for the possibility that redistribution is monetary rather than in-kind, both income and labour supply will be endogenous. Let $M_{hi}$ be the post-tax income that $i$ receives in state $h$, and $L_{hi}$ be the corresponding hours of work. An individual’s welfare is increasing in $M_{hi}$ because it affords greater consumption, but decreasing in $L_{hi}$. $M$ can be thought of as a composite consumption good. It is not necessary to assume that individuals know which medical treatments will increase their welfare, but after they have received treatment they do know the combinations of $M$ and $L$ that maximise their utility. Assume that each individual’s welfare can be represented with the expected utility formulation, and so $i$’s expected utility is $\sum_j \pi_j U(z_j, M_{hi}, L_{hi})$, where $\pi_{hi}$ is the probability that $i$ is in state $h$. In accordance with utilitarianism, social welfare will be assumed to be

$$\sum_j \pi_j U(z_j, M_{hi}, L_{hi}),$$

where $j$ is a compound subscript over both persons and states.\(^1\)

Although this utilitarian objective is fairly natural, it is not the only possibility. One alternative is to use a more general social welfare function. This would lead to a straightforward generalisation of the results for CUA, but more complicated results for CBA.\(^2\) Another possibility is to eschew welfarism altogether. According to a common interpretation of CUA, only the utility consequences of longer life or improved health should be accounted for. For example, Williams (1981) suggests that valuation of health benefits should not depend on the income of the beneficiary. Consequently, it could be argued that income should be ‘laundered’ out of utility functions for the purposes of CUA. However, the discussion below deals with external benefits that are not mediated through health gains. As Gerard and Mooney (1993) argue, an objective function which only values health is not appropriate for decisions for which some opportunity costs are not foregone health gains. Consequently, the standard utilitarian approach will be followed.

However, some acknowledgement will be made of the practice of not taking income into account. It will be assumed that the providers of health care do not know the incomes of patients and, consequently, cannot apply an allocation rule that makes reference to individuals’ incomes. This means that there must be at least two government institutions. One agency provides health care and does not

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\(^1\)In this formulation, health care does not affect the probabilities of different (pre-treatment) health states. However, $U^{hi}$ can itself be interpreted as the expectation of post-treatment utility, with the conditional probabilities of the possible outcomes of treatment suppressed.

\(^2\)It would no longer be possible to interpret the revised CBA rules of Section 5 in terms of ex ante willingness to pay.
observe incomes. However, there are other agencies that are concerned with monetary redistribution, and which do observe incomes.

The health care agency is assumed to be the only source of health care. It provides a range of care without charge. Although this agency does not observe incomes, and cannot fully identify citizens' characteristics, it does observe some medical symptoms. This allows the agency to classify citizens. Let \( \Omega_s \) be the set of possible people with symptom \( s \). Because the agency cannot discriminate between different members of \( \Omega_s \), they all receive the same allocation of health care — \( z_s \).

As the agency cannot observe all relevant characteristics of citizens, it does not have enough information to infer their marginal utilities or WTPs for treatment. However, decisions about the allocation of health care can be made with reference to the expected values of marginal utility or WTP — conditional on the observed symptoms. If someone has symptom \( s \), the expected marginal utility of treatment \( z' \) for that person (from the point of view of the health care agency, given observation of \( s \)) is

\[
E(U^j | j \in \Omega_s) = \frac{1}{\sum_{j \in \Omega_s} \pi_j} \cdot \sum_{j \in \Omega_s} \pi_j \cdot U^j(z_s, M_j, L_j),
\]

where \( U^j \) is the partial derivative of \( U^j \) with respect to \( z'_r \). The expected marginal WTP for \( z' \), for people with symptom \( s \), is \( E(WTP^j | j \in \Omega_s) \), or

\[
\frac{1}{\sum_{j \in \Omega_s} \pi_j} \cdot \sum_{j \in \Omega_s} \pi_j \cdot WTP^j(z_s, M_j, L_j) = \frac{1}{\sum_{j \in \Omega_s} \pi_j} \cdot \sum_{j \in \Omega_s} \pi_j \cdot \frac{U^j(z_s, M_j, L_j)}{U^d(z_s, M_j, L_j)}.
\]

3. First best allocation rules

Assume that it is feasible to use lump sum taxes to redistribute income, and that such taxes are chosen to maximise aggregate utility. The utilitarian resource allocation problem is to maximise Eq. (1) subject to a resource constraint. This constraint ensures that tax revenue is sufficient to cover expenditure on health care. An individual’s contribution to tax revenue is the difference between her pre- and post-tax incomes. Her pre-tax income is \( w_j \cdot L_j \) where \( w_j \) is her wage.

With constant marginal costs \( c_r \) for each kind of health care \( z' \), the problem is

\[
\max \sum_{s, j \in \Omega_s} \pi_j \cdot U^j(z_s, M_j, L_j) + \lambda \sum_{s, j \in \Omega_s} \pi_j \left( w_j \cdot L_j - M_j - \sum_r c_r \cdot z'_r \right).
\]
The first order condition for \( z_s' \) (the quantity of treatment \( r \) per person with symptom \( s \)) implies that for any symptoms (\( s \) and \( s' \)) and treatments (\( r \) and \( r' \))

\[
\frac{1}{c_{r'}} E[U_{j'} | j \in \Omega_j'] = \frac{1}{c_{r'}} E[E_{j'} | j \in \Omega_j'] ,
\]

so long as \( z_s'^+ > 0 \) and \( z_{s'}'^+ > 0 \). This is the CUA allocation rule. It requires that the expected marginal utility of treatment per dollar spent is the same for all forms of treatment and all symptoms. If income is redistributed optimally, then the CBA rule is also satisfied. To see this, combine Eq. (5) with the first order condition with respect to \( M_j \) (assuming that \( M_j > 0 \ \forall j \)), to show that

\[
E[WTP_j | j \in \Omega_j'] = c_{r'}, \quad \forall s,r \text{ s.t. } z_s'^+ > 0 .
\]

Eq. (6) is the standard CBA allocation rule. It states that the expected marginal (ex post) WTP for \( z' \) (given symptom \( s \)) is equal to the marginal cost.

One difference between the two rules is that the CUA rule only specifies the allocation of resources within a budget, and the CBA rule also prescribes the optimal level of the budget itself. A second difference is the unit that benefits are measured in. CUA measures benefits in “utils” and the CBA rule measures benefits in monetary terms. However, as both the CUA and CBA allocation rules are satisfied in the optimal allocation, it does not matter which of the two units of measurement is used. The two allocation rules are consistent in this case, because lump sum redistribution with taxes and benefits leads to equalisation of different peoples’ marginal utility of income. With this ideal income distribution, the marginal utility of treatment and the marginal WTP for treatment only differ by a scaling factor common to all citizens. If there is to be a divergence between the two allocation rules, redistribution cannot be so successful.

It is worth noting that there is an alternative CBA rule that is valid under first best assumptions, and which does not depend on the marginal utility of income being equalised across people and symptoms. The idea is to divide \( U_{j'} \) by a constant. When \( U_{j'} \) is not constant across \( j \), \( E[U_{j'}] \) can be used. This is the expected marginal utility of income, where the expectation is taken over all individuals and symptoms. The resulting expression \( E[U_{j'} | j \in \Omega_j'] / E[U_{j'}] \) is an ex ante WTP rather than an expected ex post WTP. However, the perspective is ex ante not only to learning one’s health state, but also to learning which individual one is. It represents the marginal rate of substitution between \( z_s' \) and \( M \), for someone behind a Rawlsian veil of ignorance.

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3 Weaker conditions can also imply the consistency of the two rules. An example is the condition that the expected value of the reciprocal of the marginal utility of income, and the covariance between this reciprocal and the marginal utility of treatment, are constant across symptoms \( s \).
The reformulated CBA rule is
\[
\frac{E[U_j | j \in \Omega_j]}{E[U_j]} = c_j \quad \forall s, r \text{ s.t. } z_j^r > 0.
\] (7)

This is consistent with a suggestion by Pauly (1996) and with a result that Pratt and Zeckhauser (1996) derive for interventions that reduce the risk of death. Effectively, Eq. (7) suggests that insurance be provided against low incomes as well as medical need.

4. Distortionary taxation and CUA

It is a well-established result that first best allocation rules may not be optimal in second best environments. When government agencies have imperfect information about individuals, redistribution will generally be distortionary. The allocation of goods and services may be able to counteract some of this distortion. If some types of consumption affect labour supply, then there is value in allocating consumption to counteract the distortions due to taxes and welfare benefits (e.g. Munro, 1992; Gahvari, 1995). Although the implications for the CUA rule have not been examined in previous work, it is reasonable to suppose that it should be amended to reflect these effects. Furthermore, the budget for health expenditure may not be set optimally. Results for both optimal and suboptimal budgets will be presented. Finally, it will be assumed that the government agencies responsible for monetary redistribution do not have access to all of the information available to providers of health care.

It would be impractical for tax authorities to design separate tax schedules for people in different health states. However, there is some scope for monetary redistribution in the form of welfare benefits that depend on health status. It will be assumed that the social welfare agency has some information about individuals’ health states, albeit less information than the health care agency has. Health care providers can observe that \( j \in \Omega_j \), and the other agencies observe that \( j \in \Gamma_k \), where \( s \in \Gamma_k \).

Welfare benefits and income tax schedules will be coordinated with each other. But the composite schedules that result will be assumed to be linear relationships between disposable income and earnings,
\[
M_j = \alpha_k + (1 - t_k) \cdot w_j \cdot L_j, \quad \forall k, j \in \Gamma(k)
\] (8)

where \( t_k \) is the (constant) effective marginal tax rate faced by those individuals who are classified as members of \( \Gamma_k \). The resource constraint is
\[
\sum_{j \in \Omega_j} \sum_{k \in \Gamma_k} \pi_j \cdot \left( t_k \cdot w_j \cdot L_j - \alpha_k - \sum_{r} c_r \cdot z_j^r \right) \geq 0.
\] (9)
Each citizen makes his or her labour supply decision in order to maximise utility, given the parameters of the tax schedule and the allocation of $z$. The first order condition of this choice implies that the marginal rate of substitution between labour time and income is equal to the post-tax wage. Let the utility maximising choice of pre-tax income by $j$ (where $\Omega(j) \subseteq \Gamma_j$) be $L_j = L'(\alpha_k, t_k, z_j)$.

The utilitarian planning problem is

$$\max \sum \sum \sum \pi_j \cdot U'(z_s, \alpha_k + (1 - t_k) w_j \cdot L_j, L_j)$$

$$+ \lambda_{RC} \cdot \sum \sum \sum \pi_j \cdot \left( t_k \cdot w_j \cdot L_j - \alpha_k - \sum \sum \pi_j \right)$$

$$+ \sum \sum \sum \lambda_j \cdot \left( L_j - L'(\alpha_k, t_k, z_j) \right).$$

The first order conditions for $z_j$ and $L_j$ can be used to construct the following expression.

$$\frac{E[U'|j \in \Omega_j]}{c_j - t_k \cdot \frac{\partial L'}{\partial z_j} | j \in \Omega_j} = \lambda_{RC} \quad \forall r, k, s \in \Gamma_k. \quad (10)$$

This condition amends the standard CUA rule (Eq. 5) by acknowledging the external benefits of increased labour supply. The expected marginal utility of treatment, divided by its marginal cost, is still equated across treatments and symptoms. But now a more comprehensive measure of marginal cost is used. The opportunity cost of treatment is the direct cost minus the resulting increase in tax revenues. The amended rule reverts to the standard CUA rule if $z_j$ does not affect labour supply. This will be the case if the marginal rate of substitution between $M$ and $L$ is independent of health care. This result is general and does not depend on either the linearity or the optimality of the income tax schedule. It is proved for an arbitrary tax schedule in the appendix.

**Proposition.** If $(\partial \text{MRS}_{LM} / \partial z_j) = 0, \forall j, r$, then the standard CUA allocation rule is satisfied in the optimal allocation of health care.

It is not plausible that this condition always will be satisfied. Medical care does sometimes affect labour supply, by treating those who are prevented from working by ill health.

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4 In conjunction with the individuals’ first order conditions for their labour supply decisions.

5 The internal benefits are included in the marginal utility of treatment. This conforms with method 2 of Garber and Phelps (1997, p. 15).
Although Eq. (10) is a counterpart to Eq. (5), it was derived under more demanding assumptions. In the previous section, the validity of the CUA rule could be established without making reference to the goals of the redistributive arm of the state. As long as no distortionary taxes are levied, the CUA rule can be derived even if (lump sum) redistribution does not maximise aggregate utility. This is in contrast to the CBA rule, the validity of which is contingent on the utilitarian objective being pursued by the agencies that set and administer taxes and welfare benefits. However, in the current section, some assumption about taxes and welfare benefits is necessary even for the CUA rule.

It was assumed that tax rates and the health care budget were set optimally. The implication is that an extra dollar of tax revenue and an extra dollar for the health budget have equal social value. When this assumption is relaxed, Eq. (10) must be modified to reflect the relative social value of extra tax revenue as compared to extra health care funding. In particular,

\[
E\left[U'_j | j \in \Omega_j \right] = c_r - \mu \cdot t_k \cdot E\left[w_j \cdot \frac{\partial L_j}{\partial z_j} | j \in \Omega_j \right] 
\]

should be equalised (for all \( \forall k, s \in \Gamma_k \) and all \( r \)), where \( \mu \) is the relative social value of tax revenue. This result is derived in Appendix A.

5. Distortionary taxation and CBA

Although distortionary redistribution introduces a modest modification to the CUA rule, more substantive changes are necessary to the standard CBA rule. Redistribution cannot generally deliver a marginal utility of income that is constant across individuals and symptoms. Consequently, the rationale for Eq. (6) is not applicable. In general, relatively more health should be allocated to those with high marginal utility of income plausibly those with low incomes than Eq. (6) suggests. However, Eq. (7) is phrased in terms of ex ante WTP, and provides a more promising benchmark.

If a CBA rule is to determine the size of the health care budget as well as allocation within the budget, the derivation of the rule will require more information than for a CUA rule. Such information could be provided by first order conditions with respect to \( \alpha_k \) or \( t_k \), the parameters of the tax and benefit schedules. Using the conditions for \( \alpha_k \), for all \( k \), and taking expectations over \( k \), the following rule can be shown to be valid.

\[
\frac{E\left[U'_j | j \in \Omega_j \right]}{E\left[U'_j | j \in \Omega_j \right]} = \frac{c_r - t_k \cdot E\left[w_j \cdot \frac{\partial L_j}{\partial z_j} | j \in \Omega_j \right]}{1 - E\left[t_r(j) \cdot w_j \cdot \frac{\partial L_j}{\partial \alpha} \right]}.
\]
This condition reflects two effects that were not accounted for in Eq. (7). The first is the effect of treatment on tax revenues and the second is the effect of the basic benefit level \( \alpha_k \). If treatment leads to increased labour supply or if leisure is a normal good, then the cost threshold for justified health care expenditure is less demanding than Eq. (7) would suggest (i.e. the threshold is less than \( c_r \)).

An alternative condition can be found by using the first order conditions for \( t_k \) (for all \( k \)) rather than \( \alpha_k \). If marginal tax rates are chosen optimally, then when the optimal level of \( z^*_j \) is chosen, ex ante WTP for \( z^*_j \) will equal the following expression,

\[
1 + \frac{\text{cov}(U'_j, Y_j)}{E[U'_j] \cdot E[Y_j]} \cdot \left( \frac{E[Y_j]}{E[Y_j] + E[Y_j \cdot \varepsilon_{L_j}]} \right) \cdot \left( c_r - t_k \cdot E_\Omega \left[ w_j \cdot \frac{\partial L_j}{\partial z^*_j} \right] \right),
\]

where \( s \in I_k \), \( Y_j = w_j \cdot L_j \) is \( j \)'s income and \( \varepsilon_{L_j} \) is her elasticity of labour supply with respect to the marginal tax rate.

Both of the modified CBA conditions can be interpreted as cost thresholds for ex ante WTP. Treatment would be justified up to the point at which ex ante WTP has fallen to the level of the threshold. Examination of both conditions suggests that a lower cost threshold is associated with (i) treatment being strongly complementary to labour, (ii) leisure being a strongly normal good, (iii) a strong (negative) correlation between income and the marginal utility of income, and (iv) a weak elasticity of labour supply with respect to the marginal tax rate.

6. Conclusion

Both the CUA and the CBA rules require modification if taxes are distortionary. The CUA rule should be phrased in terms of the overall opportunity cost of treatment. This means that a new term, reflecting the impact of treatment on tax revenues and welfare benefit expenditures, should be subtracted from the direct cost of treatment. If the health care budget is not set optimally, then a weight \( \mu \neq 1 \) should be applied to this new term. The CBA rule should generally be phrased in terms of an ex ante marginal willingness to pay, and should reflect the impacts on labour supply of both treatment and taxes.

The general point that overall opportunity cost should be used in allocation rules has been made previously by Olsen (1994), Johannesson (1996) and Meltzer (1997). However, these authors have not attributed the externalities of increased labour supply to distortionary taxes. In particular, Meltzer focuses on intertempo-
ral rather than interpersonal (and uncertainty) concerns and so does not emphasise redistribution or the distinction between internal and external costs.

By the same token, the present paper abstracts from some factors that are relevant to the opportunity costs of treatment that have been emphasised by other authors (e.g. Labelle and Hurley, 1992; Meltzer, 1997). Furthermore, the focus of the current paper on labour market effects was confined to labour supply. If demands for various types of labour are not perfectly elastic, then treatment that affects labour supply will also have an impact on wages. Consequently, there is considerable scope for extending the analysis further.

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Appendix A

A.1. Proof of the proposition

Assume that the CUA rule is not satisfied. Consider an incremental budget neutral change in $z'_r$ and $z'_X$. In such a change, $c_r \cdot \sum_{j \in \Omega} \pi_j \cdot d z'_r = c_r \cdot \sum_{j \in \Omega} \pi_j \cdot d z'_X$. If $MRS_{j_{|X}}$ is globally unaffected by $z'_r$ and $z'_X$, then $j$'s indifference curves in $(L,M)$ space are unaffected. But then the labour supply will be unchanged. However, the objective function changes by $\sum_{j \in \Omega} \pi_j \cdot U_{j_{|r}} \cdot d z'_r + \sum_{j \in \Omega} \pi_j \cdot U_{j_{|X}} \cdot d z'_X$ where $c_r \cdot \sum_{j \in \Omega} \pi_j \cdot d z'_r = c_r \cdot \sum_{j \in \Omega} \pi_j \cdot d z'_X$. Therefore, the change in aggregate utility is

$$\frac{E[U_j | j \in \Omega_r]}{c_r} - \frac{E[U_j | j \in \Omega_{r^*}]}{c_r} \cdot \left( \sum_{j \in \Omega} \pi_j \cdot c_r \right) \cdot d z'_r.$$

As the CUA rule is not satisfied, this will be positive for an appropriate incremental change. Therefore, the present allocation is not optimal.

A.2. The CUA rule when the health care budget is not set optimally

The health care budget is set at $R$. If (expected) tax revenue (with $\alpha^o_s$ and $t_k$) is above $R$, then the surplus is divided with a proportion $\theta$ going to an increased
budget for health care and the remainder going to uniform lump sum tax refunds \((\alpha_k - \alpha_k^o)\). The problem is
\[
\max \sum_{k} \sum_{s \in \Gamma_k} \sum_{j \in \Omega_s} \pi_j \cdot U'(z, \alpha_k + (1 - t_k) w_j \cdot L_j) \\
+ \lambda_{HB} \cdot \left( R + \theta \sum_{k} \sum_{s \in \Gamma_k} \sum_{j \in \Omega_s} \pi_j \cdot (t_k \cdot w_j \cdot L_j - \alpha_k^o - R) \right) \\
- \sum_{k} \sum_{s \in \Gamma_k} \sum_{j \in \Omega_s} \pi_j \cdot L_j \\
+ \lambda_{TR} \cdot \sum_{k} \sum_{s \in \Gamma_k} \sum_{j \in \Omega_s} \pi_j \\
\cdot \left( (1 - \theta) \cdot (t_k \cdot w_j \cdot L_j - \alpha_k^o - R) - \left( \alpha_k - \alpha_k^o \right) \right) \\
+ \sum_{j} \lambda_{TR} \cdot \left( L - L' \left( \alpha_k, t_k, z_j \right) \right)
\]
The first order condition with respect to \(z_j^s\) (and \(L_j\)) implies the following condition.
\[
E\left[ U_j^s | j \in \Omega_s \right] \\
c_j - \left( \theta + \frac{\lambda_{TR}}{\lambda_{HB}} \cdot (1 - \theta) \right) \cdot t_k \cdot E\left[ w_j \cdot \frac{\partial L_j}{\partial z_j^s} | j \in \Omega_s \right] \\
= \lambda_{HB} \quad \forall r, k, s \in \Gamma_k.
\]
If \(R\) is less than the tax take and \(\theta\), and is chosen optimally (\(\forall k\)), then \(\lambda_{TR} = \lambda_{HB}\), in which case, this condition reverts to Eq. (5).

References

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