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CURRENT OPINION

Can the Real Opportunity Cost Stand Up: Displaced Services, the Straw Man Outside the Room

Simon Eckermann · Brita Pekarsky

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Abstract In current literature, displaced services have been suggested to provide a basis for determining a threshold value for the effects of a new technology as part of a reimbursement process when budgets are fixed. We critically examine the conditions under which displaced services would represent an economically meaningful threshold value. We first show that if we assume that the least cost-effective services are displaced to finance a new technology, then the incremental cost-effectiveness ratio (ICER) of the displaced services (d) only coincides with that related to the opportunity cost of adopting that new technology, the ICER of the most cost-effective service in expansion (n), under highly restrictive conditions—namely, complete allocative efficiency in existing provision of health care interventions. More generally, reimbursement of new technology with a fixed budget comprises two actions; adoption and financing through displacement and the effect of reimbursement is the net effect of these two actions. In order for the reimbursement process to be a pathway to allocative efficiency within a fixed budget, the net effect of the strategy of reimbursement is compared with the most cost-effective alternative strategy for reimbursement: optimal reallocation, the health gain maximizing expansion of existing services financed by the health loss minimizing contraction. The shadow price of the health effects of a new technology, $\beta_c = \left(\frac{1}{n} + \frac{1}{d} - \frac{1}{m}\right)^{-1}$, accounts for both imperfect displacement (the ICER of the displaced service, $d < m$, the ICER of the least cost-effective of the existing services in contraction) and the allocative inefficiency ($n < m$) characteristic of health systems.

Key points for decision makers

The opportunity cost of reimbursement (adoption and displacement to finance) for new technology in an allocatively inefficient health budget is the net effect of optimal contraction and expansion of existing programmes.

The average incremental cost-effectiveness ratio of displaced services coincides with the opportunity cost of adoption only when there is complete allocative efficiency—a condition that is not met in any health budget with current market failure in provision of evidence and institutional bias towards patented technologies.

Research into evidence of the least and most cost-effective services, in addition to the services that are actually displaced, is necessary in order for new technology adoption decisions to promote allocative and displacement efficiency.

1 Introduction

As late as 2005, prominent health economists noted that while there was some agreement that the cost-effectiveness threshold should ideally represent the opportunity cost, this was not a straightforward concept to apply to the decision

S. Eckermann (✉)
University of Wollongong, Wollongong, NSW, Australia
e-mail: seckerma@uow.edu.au

B. Pekarsky
University of South Australia, Adelaide, SA, Australia

to adopt new technologies [1]. Drummond et al. [1: 331] concluded that “a way forward is to estimate society’s WTP for a QALY empirically” and that more attempts would be made to estimate this value in the near future. In 2006, Barrett et al. [2] used the example of the National Institute for Health and Care Excellence (NICE) approval of trastuzumab to illustrate that the health gains from a new technology were achieved at the cost of health effects displaced to finance that technology; the net gain to the population of trastuzumab was the gain to these patients less the loss to patients whose services were displaced to finance its additional costs. In 2007, UK health economists began to argue that the decision for reimbursement of new technologies by NICE should be informed by the incremental cost-effectiveness ratio (ICER) of displaced services, given the context of a fixed budget [3–7]. In 2013, a 2-year study funded by the Medical Research Council (UK) estimated the average incremental cost effectiveness of historically adopted services and characterized the result as:

> “an empirically-based and explicit quantification of the scale of opportunity costs the NHS faces when considering whether the health benefits associated with new technologies are expected to offset the health that is likely to be forgone elsewhere in the NHS” [8: xi].

The authors also noted that the social willingness to pay (WTP) for a quality-adjusted life-year (QALY) would not lead to “maximization of health” if budgets were fixed [8: 12].

The logic underlying a threshold being the ICER of displaced services, where these are the least cost-effective services, was argued by Griffin et al. [6: 24] in two parts, as follows:

(A) “Identifying the marginal programmes that would be displaced (i.e. the least cost-effective programme of those currently funded) and quantifying their cost and health outcomes determines the shadow price of the budget constraint.”

(B) “The incremental cost per QALY gained (the incremental cost effectiveness ratio [ICER]) of new treatments are commonly compared to some stated threshold, λ, which should, in principle, represent the inverse of the shadow price of the budget constraint.”

This argument is then combined to suggest that “The new treatment should be reimbursed if the change in health offered by the new treatment option exceeds the health forgone due to displacement of the marginal programme(s)” [6: 24].

In addition to suggesting the ICER of displaced services as the threshold, Griffin et al. [6] explicitly assert that the least cost effective of the currently funded programmes would be displaced—that is, displacement is assumed to be optimal. In relation to the UK health system, McCabe et al. [4: 737] presumably invokes this assumption implicitly without referring to displacement, in making assertions such as:

> “From the beginning NICE’s use of cost-effectiveness analysis has been perceived as a means of promoting the efficient use of available NHS resources. The cost-effectiveness threshold ought thus to be the cost per QALY of the least efficient funded treatment (i.e. the intervention with the highest cost per QALY).”

> and:

> “If the function of NICE is to substitute more efficient interventions for less efficient ones, it can do this through specifying a working cost-effectiveness threshold reflecting the Institute’s estimate of the ICER of the least cost-effective activity undertaken by the NHS.”

More recently, displaced services have more generally been suggested by Sculpher and Claxton [7: 133] to represent the opportunity cost of new programmes or technology, in arguing that:

> “…the threshold should represent the health outcomes forgone due to the displacement of existing services to fund any additional cost of new programmes and technologies (i.e. it should reflect opportunity cost).”

Further, in 2013, a group of UK health economists published a report that subtly modified this position [8]:

> “Given NICE’s remit, it is the expected health effects (in terms of length and quality of life) of the average displacement within the current NHS (given existing budgets, productivity and the quality of local decisions) that is relevant to the estimate of the threshold.”

Strictly, the above positions represent four distinct definitions of the threshold value for health effects:

1. the least cost-effective current programme, assuming that this is the programme that is actually displaced to finance the additional costs of the new technology [3, 6];
2. the least cost-effective programme, regardless of whether it is displaced [4];
3. the ICER of the services actually displaced to finance that technology regardless of the ICER of that displaced service relative to other services [5, 7];
4. the average ICER of National Health Service [NHS] services displaced historically [8].

The authors are consistent on the position that the decision threshold should represent the opportunity cost of adoption or the shadow price of the budget constraint. The context in which the authors consider the application of the thresholds is consistent with respect to an assumed fixed budget but varies with respect to the objective functions relevant to a reimbursement authority: maximizing the population's health [3, 6, 7]; maximizing the health gain (assumed to be the health gain as a consequence of reimbursement) [7: 133]; and a NICE specific objective of ensuring that the Technology Appraisal Programme has a net health benefit—the ICER of the new technology is less than the ICER of the displaced services [4, 5, 9]. The objective function associated with the study presented by Claxton et al. [8: 12] appears to be maximizing the population's health. The authors consistently conclude that further investment should be made into estimates of the average ICER of displaced services and improving the efficiency of disinvestment. The authors are also consistent in their implicit characterization of adoption vis-à-vis displacement; adoption is the substitution of a technology with its more effective alternative for a group of patients, whereas displacement (contraction or disinvestment in an existing programme or technology) is the substitution of a technology or programme with a less effective but less costly technology or programme in order to release funding. Adoption might or might not have additional costs and is naturally within the remit of organizations that assess new health technologies for the purpose of reimbursement. The authors differ as to whether the average ICER of displaced services that they nominate as the decision threshold applies conditionally (only with the least cost-effective services displaced) or unconditionally (regardless of whether displacement is optimal).

If we initially restrict our consideration of displacement to optimal displacement, where displaced services are the least cost effective of current services, a common threshold value is argued for across the first three threshold definitions above, and had additionally adoption been historically efficient, then it would also apply to the fourth definition. In the following sections, we critically examine such arguments, showing why they fail to provide a threshold value consistent with opportunity cost in a health care system with allocative inefficiency.

2 Do Displaced (Least Cost-Effective) Services Represent Opportunity Cost?

Does holding new interventions accountable to a threshold value relative to the 'least cost-effective activity' or any displaced intervention reflect the opportunity cost of funding new technology and promote efficiency and optimal allocation of budgets? We restrict ourselves, as in recent displacement literature [3–8], to cases where displacement of programmes to finance investment is assumed to involve a health loss—replacing a programme with a less effective and less costly alternative. For example, in displacing programmes to release, say, $10 million to fund adoption, there might be a health loss of 200 QALYs. Under a displacement definition of the threshold value, the new technology would need to have a health gain of more than 200 QALYs and an ICER of up to $50,000 per QALY to be adopted. However, this loss of 200 QALYs is not the opportunity cost of using the $10 million in funds released by displacement to fund new technology. In general, for any given funding made available to invest in a health system, whether from new funding or optimal displacement of existing services, the opportunity cost of investing that funding in any new technology is the most cost-effective expansion of the use of existing or other new technology and services [9, 10]. In this example, the $10 million expansion of the most cost-effective existing programme in expansion could result in an additional health gain of 1,000 QALYs—this is the opportunity cost of using these funds to finance the new technology. If the new technology produces less additional health effects than this and is adopted, there would be an economic loss, even if it is more cost effective than the displaced service.

We now consider why the logic trail in the two-stage argument for a threshold of displaced services, characterized as the least cost-effective programme of those currently funded, presented in Griffin et al. [6], leads to such results and fails to reflect the opportunity cost. While, in isolation, each part of the two-stage argument by Griffin [6: 24] has some merit, the combined two-stage argument misrepresents the opportunity cost as the lowest-value alternative—the shadow price of the budget constraint in contraction (the budget is reduced) rather than the highest-value alternative estimated by the shadow price of the budget constraint in expansion [9]. Hence, if the end of part B of the two-part argument from Griffin et al. [4] had appropriately added 'in expansion', it would be clear that the opportunity cost estimated by the shadow price of the budget constraint in expansion differs from that in part A, which is an estimate of the shadow price of the budget constraint in contraction. This distinction is critical in the context of a fixed budget where there is allocative inefficiency. If there is allocative efficiency, then a contraction of the budget by $10 million (achieved by displacing the least cost-effective service in contraction) followed by a $10 million expansion of the same programme (as now the most cost-effective programme in expansion), would result in change in total health effects. However, for an allocatively inefficient budget, the programme that is contracted to release funds will be less cost effective than the programme that is expanded, and there will be a gain in overall health possible from the budget.

We have thus far shown that where displacement is optimal, the opportunity cost of adopting new technology is the most cost-effective expansion of current programmes, which has an ICER below that of the least cost-effective service to be contracted in the presence of allocative efficiency. Only if there additionally were complete allocative efficiency would the health gains possible from the most cost-effective programme in expansion, following optimal contraction, also coincide with the health effects lost from displacement [10]. Hence, only if complete allocative as well as displacement efficiency were assumed would the opportunity cost of investing in new technology coincide with the health effects of displaced services. We now consider opportunity costs where displacement is suboptimal.

3 Opportunity Cost of Reimbursement: Allowing for Suboptimal Displacement

Reimbursement compromises two actions: adoption and financing (displacement if the budget is fixed). The net population effect of this strategy of reimbursement is the additional health effects from adoption, less the health loss from displacement. The opportunity cost to the strategy of reimbursement is the maximum health forgone by not implementing the most cost-effective alternative strategy to reimbursement. In an allocatively inefficient health care system, this strategy is optimal reallocation. Optimal reallocation is the strategy of expanding the most cost-effective existing or new programmes or technologies and financing this by displacing the least cost-effective programmes or technologies in contraction. Pekarksy [10: 81–110] shows that allowing for allocative inefficiency in a health budget and suboptimal displacement in financing of new technology within a budget-constrained health system, the shadow price for the health effects of a new technology is:

$$\beta_c = \left(\frac{1}{n} + \frac{1}{d} - \frac{1}{m}\right)^{-1},$$

where n and m are the ICERs of the most and least cost-effective activities currently funded in expansion and contraction, respectively, and d is the ICER of services displaced to finance the additional cost of the new technology. This coincides with a threshold value of n (the ICER of the most cost-effective expansion of current technology) where there is efficient displacement ($d = m$) but also where there is allocative efficiency ($n = m$), as $\beta_c = d = n = m$ given displacement comes from a set of options with an ICER between n and m.

However, where there is allocative inefficiency ($n < m$) and inefficient displacement ($d < m$), the health shadow price is less than n [10]. This finding points to the potential to improve displacement as well as undertake the most cost-effective expansion of current programmes. The opportunity cost or highest-value alternative to the strategy of reimbursement of new technology is optimal reallocation: optimal displacement of the least cost-effective current programmes and adoption of the most cost-effective expansion of current technology and programmes. If there is imperfect displacement ($d < m$), then a threshold ICER based on displaced services has a value d below m. However, inefficiency in displacement ($d < m$) also implies allocative inefficiency ($n < m$), given that displaced services come from the current set of services and hence $n \le d < m$. Hence, even if the displaced service were the most cost effective currently (i.e. $d = n$), this threshold value would still be above the shadow price, $\beta_c = \left(\frac{1}{n} + \frac{1}{d} - \frac{1}{m}\right)^{-1}$, which accommodates the opportunity cost of reimbursement representing both optimal displacement and adoption actions. The health shadow price falling below n in the presence of inefficient displacement highlights the need within a budget-constrained health system to address inefficient displacement of services as well as investing in the most cost-effective expansion of existing services or new technology, to move towards allocative efficiency [10].

Regardless of which health system is considered, it should be clear that conditions for efficiency in allocation and displacement ($n = d = m$) required for the ICER of displaced services to coincide with that of the most cost-effective expansion of current technology are not currently met in practice. Complete allocative efficiency is a very strong assumption within health systems that contradicts imperfect information and lack of perfectly competitive market conditions more generally in health care [11]. Health systems in practice only have the ability to move resources with contraction and expansion at the margins and require time, information and consideration of critical decision contexts to optimally inform such decisions [9, 13–17].

The divergence between d and β_c in the presence of allocative inefficiency ($n < m$) also clarifies that the coincidence of d with n where there is complete allocative efficiency ($n = m = d$) should not be confused with a threshold of d providing a pathway for reaching allocative efficiency. Indeed, with pricing up to a threshold characteristic of strategic behaviour by profit-maximizing manufacturers [10: 112–137], use of the ICER of displaced services as the threshold might be expected to largely tread water. That is, if d approaches m, displacement is increasingly optimal but there are no gains to the population's health if firms continue to price strategically at the threshold. Further, if a displaced services rule (displaced services are the least cost effective) were consistently applied, then new technologies adopted and priced up to the threshold of an ICER for displacement would be the next in line to be displaced and face costs of reversal. Costs of reversal include the unamortized cost of adoption (upfront capital costs, training, learning by doing) at the point of reversal but also the direct costs of conveying and reversing public health messages and associated practice changes with additional political costs [12–17]. These costs are characteristically significant with new health technology under uncertainty in decision making associated with available evidence and the potential to better inform decision making with additional research. This is especially the case if new technologies are cycled through with a threshold rule related to the displaced services' ICERs, as over time the net negative health impacts could easily arise in allowing for the cost of reversal faced. Such costs of reversal and cycling through of new technologies are not expected with a reimbursement and pricing rule using comparison with the most cost-effective current technologies. Further still, displaced services are often unpatented or unpatentable services, and the market fails to provide evidence of effectiveness or cost effectiveness, leaving them vulnerable to being assessed as though they were the least cost-effective services [10]. In reality, they may be highly cost effective, in which case the net effect of investment and displacement with pricing up to a displaced threshold can again easily result in health loss from reimbursement in practice.

Consequently, the additional consideration of practical decision contexts, such as the cost of adoption and reversal over time and market failure for evidence in displacement, serve to reinforce the central message of this paper: that the incremental cost per unit effect (ICER) of new technology should be compared in reimbursement with the health shadow price [10]. The need for research and institutional processes supporting best expansion (investment) and contraction (disinvestment) of existing technologies and programmes is appropriately highlighted. Importantly, estimating the ICER for the best expansion of current technologies or services has no greater information requirements than identifying the least cost-effective technologies or services to be displaced. Both require programme budgeting and marginal analysis (PBMA)-like processes [18–20] to evaluate the marginal cost effectiveness of current technology used in practice, which, like health technology assessment of new technologies, should be informed by efficient and robust research. Indeed, the proposed method points towards PBMA principles but allows for new as well as existing technologies. The feasibility of combinations of allocative and displacement inefficiency, the health shadow price reflecting the opportunity cost of reimbursement under these alternative conditions, and implications for threshold values and research required to provide a pathway towards allocative and displacement efficiency are summarized in Table 1.

Critically, evidence emerging of displacement inefficiency also implies allocative inefficiency and points to the need for the opportunity cost in displacement and adoption

Table 1 Allocative efficiency and displacement conditions and their implications for opportunity cost (OC) and threshold values

	Allocative efficiency ($n = m$)	Allocative inefficiency ($n < m$)	Implications for OC and economic threshold values
Displacement efficiency ($d = m$)	($n = m = d$) Complete allocative efficiency and displacement of least cost-effective services Only with this combination does the health shadow price $\beta_c = \left(\frac{1}{n}+\frac{1}{d}-\frac{1}{m}\right)^{-1} = d$ and only because $n = m = d$ at this point	($n < d = m$) Displacement of least cost-effective services The health shadow price $\beta_c = \left(\frac{1}{n}+\frac{1}{d}-\frac{1}{m}\right)^{-1}$ is n with perfect displacement—that is, when $d = m$	While the health shadow price would be n with efficient displacement, current market failure in generating evidence of the least cost-effective services for displacement suggests displacement inefficiency (implications below)
Displacement inefficiency ($d < m$)	Allocative efficiency and displacement inefficiency cannot arise together, as $d < m$ contradicts $n = m$ given $n \le d \le m$	($n \le d < m$) Health shadow price $\beta_c = \left(\frac{1}{n}+\frac{1}{d}-\frac{1}{m}\right)^{-1}$ associated with the OC with allocative and displacement inefficiency is less than n	Current literature pointing to displacement inefficiency ($d < m$) also implies allocative inefficiency ($n < m$) The health shadow price reflecting the OC of reimbursement (adoption and displacement) is less than n, with research required into optimal expansion and contraction of the health system and actual contraction (n, m and d) for a pathway to allocative and displacement efficiency

and associated research to be reflected in providing a pathway to allocative, and implicitly displacement, efficiency. In the absence of full information for current technologies, establishing an economically meaningful threshold requires research into best bets for expansion of current technologies, the contractions that most effectively generate additional funds (least loss of health effects) and evidence of what is currently displaced (probably inefficiently). Candidates for best expansion of current services and technologies include extending existing cost-effective technologies with better implementation of existing technologies in practice [21, 22], which could be better access for the existing target population and/or access to additional target populations.

If the objective of the health care system is purely to maximize health and the budget is fixed and currently allocatively inefficient, then:

1. expansion should be directed towards strategies with the greatest marginal health gain (MHG) per dollar,[1] regardless of whether they are expansion of existing or new technologies, and financed by;
2. the most effective contractions, regardless of whether they are patented or unpatented programmes.

More generally, the marginal effects of expansion or contraction can be assessed in terms of their impact on health outcomes, equity and other arguments in the social welfare function [20].

Consideration should be given to the possibility that while the market produces evidence of the ICER of a new technology, it fails to produce evidence of the ICER of the expansions or contractions of unpatented programmes, and there is little incentive for patent holders to produce evidence that could lead to their technology being displaced because it is the least cost effective. The health shadow price provides a framework to start addressing the failure of institutions to evaluate unpatented as well as patented programmes in several respects—first by ensuring that the health effects from the new technology are compared with their opportunity cost, and second by creating values for parameters n, d and m in addition to the ICER of a new technology, there is an incentive for value-of-information methods to be applied with existing technology.

Value-of-information principles and methods allowing for relevant decision contexts [12–17, 23] and robust methods for comparison in practice [24–27] are pointed to in optimally allocating research funding to identify best bets for investment and disinvestment. Maximizing expected value relative to cost, or return on investment, from research enables efficient processes in research design and allocation of funding between investing in research and reimbursement in practice. However, it should be stressed that efficiency in optimizing health outcomes from any given health system budget with existing and new technology and optimizing the process of research to inform this relies on economically meaningful threshold values for effects.

4 Discussion: Historical Lessons

The pre-eminent role given to the WTP and, more recently, d as the decision threshold for new technologies is at odds with the restrictive conditions under which they represent the opportunity costs: an ever expanding health budget and allocative efficiency, respectively. The failure to recognize the second restrictive condition appears to have its origins in a misinterpretation of the critical ratio of Weinstein and Zeckerhauser [28]. A critical ratio was shown to arise whereby the critical ratio cut-off represents the shadow price of the constrained resource in terms of benefits forgone. At the point where this solution occurs, the shadow price in contraction coincides with the opportunity cost but only because all services at the margin theoretically at this point have the same marginal cost effectiveness in expansion and contraction. However, the theoretical equivalence of the opportunity cost and the shadow price from displaced (strictly, contracted) services at the singular point where there is complete allocative efficiency should not be confused with a mechanism for getting to this point in practice. The misinterpretation of Weinstein et al. [28] is critical, as rather than providing a pathway to optimization, pricing of new interventions consistent with that of displaced interventions perpetuates allocative inefficiency in provision of health care and stops the search for the best expansion of current interventions.

5 Conclusion

The use of the average ICER of displaced services as the threshold for the reimbursement of new technologies within a fixed budget does not lead to an increase in the population's health if new technologies are strategically priced at the threshold by their patent holders. Hence, adoption of new technologies under this rule with threshold pricing can change the source of health gains predominately towards patented technologies and away from non-patented technologies, but would not improve overall

[1] One should note that health technology assessment has traditionally considered the average cost and effects of new technology measured incremental to a comparator. Using such average cost and effects in undertaking incremental analysis, there is an implicit assumption of constant returns to scale. However, more generally, in expanding or contracting current services, an appropriate consideration is at the margin.

health from the current budget. Further, given characteristic allocative inefficiency in health care, even if displacement to finance new service is optimal—that is, the least cost-effective currently funded service is displaced—this threshold does not provide an economically meaningful constraint on adopting new technology. Critically, comparison with the least cost-effective displaced services only coincides with the opportunity cost of adoption, the best expansion of current or new technology or programmes, where there is complete allocative efficiency in the health system. Where there is suboptimal displacement in financing the additional cost of the new technology and/or allocative inefficiency, the opportunity cost of reimbursement (adoption and financing) is the net effect of the best alternative strategy: optimal reallocation from the least to the most cost-effective service. The shadow price of the health effects of the new technology is the health shadow price: $\beta_c = \left(\frac{1}{n} + \frac{1}{d} - \frac{1}{m}\right)^{-1}$ [10]. The health shadow price provides a pathway towards health system allocative efficiency, which points to the need for research on the most cost-effective expansion of current technology (n) as well as the least cost-effective technology in contraction (m) and the cost effectiveness of services that are actually displaced to finance new technologies (d).

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