



Health care input constraints and cost effectiveness analysis decision rules

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ABSTRACT

Results of cost effectiveness analyses (CEA) studies are most useful for decision makers if they face only one constraint: the health care budget. However, in practice, decision makers wishing to use the results of CEA studies may face multiple resource constraints relating to, for instance, constraints in health care inputs such as a shortage of skilled labour. The presence of multiple resource constraints influences the decision rules of CEA and limits the usefulness of traditional CEA studies for decision makers. The goal of this paper is to illustrate how results of CEA can be interpreted and used in case a decision maker faces a health care input constraint.

We set up a theoretical model describing the optimal allocation of the health care budget in the presence of a health care input constraint. Insights derived from that model were used to analyse a stylized example based on a decision about a surgical robot as well as a published cost effectiveness study on eye care services in Zambia.

Our theoretical model shows that applying default decision rules in the presence of a health care input constraint leads to suboptimal decisions but that there are ways of preserving the traditional decision rules of CEA by reweighing different cost categories. The examples illustrate how such adjustments can be made, and makes clear that optimal decisions depend crucially on such adjustments.

We conclude that it is possible to use the results of cost effectiveness studies in the presence of health care input constraints if results are properly adjusted.

1. Introduction

Health economic evaluations aim to inform decision-making about new health care technologies in order to make more efficient use of scarce resources (Drummond et al., 2015). Although the starting point for economic evaluations is that resources are scarce and thus that there is a limit to what can be spent on health care, other constraints besides the health care budget might be relevant in this context (Hauck et al., 2016; Vassall et al., 2016). Consequently, while in the long run many constraints can (in theory) be resolved by a more efficient allocation of resources, ignoring such constraints in economic evaluation might seriously hamper the usefulness and credibility of economic evaluations in health care decision making (Eddama and Coast, 2008). In the short-run, there are numerous constraints involved, consisting of supply-side (e.g. workforce shortages), demand-side (e.g. obstacles of access to healthcare) and healthcare system constraints (e.g. regulatory constraints). One particular type of constraints relevant for economic evaluations are constraints related to health care inputs. Constraints related to health care inputs usually are an indicator of market failure which may be caused by the fact that markets for health care inputs are heavily regulated with the aim to solve problems of information

asymmetry (Dranove, 2011; Nicholson and Propper, 2011; Scott Morton and Kyle, 2011). As a result, markets for health care inputs are often characterized by monopsony buyers and/or monopoly producers. Monopoly producers usually force prices to be too high (which is often the case in medicines) and monopsony employers may force prices of labour to be too low. Consequently, the market price or market salary of inputs for economic evaluations do not reflect true opportunity costs which violates the standard model of cost effectiveness analysis (Drummond et al., 2015).

While previous research has focused on the impact of constraints on estimates of costs and benefits of health care interventions (Hauck et al., 2016; Vassall et al., 2016) it is not always realized that such constraints may also influence how optimal decisions conditional on those estimates should be made. The default decision rules of cost effectiveness analyses where cost effectiveness ratios are compared to a threshold level of cost effectiveness, are derived from an optimization problem with only one constraint: the health care budget (Karlsson and Johannesson, 1996; Weinstein and Zeckhauser, 1973). The theory behind this is that most constraints can be resolved and the only relevant constraint in the long run is the health care budget. However, as some constraints can be persistent and difficult to resolve in some settings,

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the rather abstract long run view typically taken in cost effectiveness in which the only constraint is the health care budget might not be the most appropriate view (Adang, 2008; Van de Wetering, Woertman and Adang, 2012). Often, decision makers have to take many constraints as given and do not have the discretion to relax those constraints (Adang, 2008; Eddama and Coast, 2008; Hauck et al., 2016; Van de Wetering et al., 2012). For instance, decision makers making decisions about technologies within a single disease programme often need to make use of highly specific health care inputs which might be constrained and decisions about expanding or contracting certain health care services might crucially depend on the availability of such constrained health care inputs. For example, treatment for anxiety and depression consists mainly of pharmacological treatments and talking therapies. In many settings, human resources (ie therapists) are constrained, since training therapists takes time and money (and often therapists may have to pay the costs of their own training) (Haby et al., 2004). Even if talking therapies might seem more cost-effective in some circumstances, in the presence of a constraint on the number of therapists it might be more efficient to provide pharmacological treatments. More generally, in low and middle income countries (LMIC) there is often a lack of supply of skilled doctors and nurses which might influence costs and health effects of delivering a particular health care technology (Fulton et al., 2011; World Health Organization, 2006). Increasing the size and skills of the workforce is often not that easy (Wyss, 2004) and raising wages to increase the workforce in low income countries might have limited success as it is difficult to compete with wages in Western countries (Robinson and Clark, 2008). In these settings, human resource constraints limit the usefulness of CEA studies for decision makers as applying the standard decision rules could result in suboptimal decisions.

In case of multiple constraints, the default decision rules of cost effectiveness do not apply anymore and decision rules become more complex (Stinnett and Paltiel, 1996). As a solution to this, some studies have advocated the use of mathematical programming to arrive at an optimal allocation of resources in the presence of multiple constraints (Epstein et al., 2007; Feenstra et al., 2011; Stinnett and Paltiel, 1996). In these studies, numerous constraints were considered varying from demand and supply constraints to equity constraints. A drawback of mathematical programming is that the analytical capabilities for these techniques are substantial and that it is difficult to translate insights from such studies, in which usually lots of interventions are included, to simple cost effectiveness studies where only a few interventions are compared and central outcomes expressed in incremental cost effectiveness ratios (ICER). The goal of this paper is to show how health care input constraints may affect the decision rules of cost effectiveness analysis and to illustrate how results of CEA studies can be interpreted and used in case a decision maker faces a health care input constraint. As a starting point we take the most popular form of economic evaluation in which ICERS of interventions are estimated from a health care perspective and compared to a threshold level of cost effectiveness. The results of such incremental analyses are used to inform decision makers who usually have to take many constraints as given. Note that our analyses is closely related to the literature in cost benefit analyses that deals with estimating shadow prices in the presence of market failures (Drèze and Stern, 1990). Also note that in this paper a health care perspective is taken where the health care budget is assumed exogenous to the decision problem (Meltzer, 1997; van Baal et al., 2016). However, insights that we gain in this paper also apply if the perspective is broadened to a wider societal perspective.

2. Stylized example

To motivate the analysis, consider the following stylized but realistic example. A regional health authority at some time in the near future is planning investment in a fleet of surgical robots for some high-volume operation (say knee replacements). The robots require capital investment but will reduce inpatient admissions and outpatient

attendances, thus saving on staff time (Barbash and Glied, 2010; Hughes, Camp, O'hara, & Adshead, 2016). The health authority is constrained in terms of medical expertise. (Perhaps this may be because the country's medical schools do not train enough doctors and the country has historically made up the shortfall by importing doctors from low-income countries, but popular resistance to immigration now makes this impossible: but these details need not concern us.) The health authority has two options for how they conduct operations:

- Option T (traditional, non-robot supported surgery) produces operations at unit cost of \$10k of which \$8k consists of spending on human resources;
- Option R (robot supported surgery) produces operations at a unit cost of \$20k of which \$5k consists of spending on human resources.

Assume that operations produced by the traditional and robot-supported surgery are comparable in terms of quality of life, and specifically, that both produce 1 QALY. Assume also that the workforce can perform all said interventions, and that there is a waiting list: hence there is no shortage of patients to treat. If we have a health care budget of \$2m and we are not concerned about the shortage of medical staff we would simply invest the whole budget in T which results in 200 operations and hence 200 QALYs and \$1.6m would be spent on human resources. Now suppose the shortage of doctors means that only \$1m can be spent on human resources. What would then be the optimal allocation of resources? Spending the entire budget on T is not an option anymore because it is only possible to provide $1,000,000/8000 = 125$ patients T leaving a slack in the budget of \$750k. However, spending the entire budget on R is possible but results in even fewer operations (100). So, here the optimal solution is a mix of T and R. As is well-known (Crown et al., 2017), this can be found graphically (see Fig. 1). In this figure, the axes represent the number of units of T and R purchased. As both T and R produce the same number of operations and hence of QALYs, the total number of QALYs produced at point x is simply the Manhattan distance between x and the origin (i.e. the number obtained by counting along the T axis from the origin and then up in the vertical direction until x is reached). The feasible region is the area to the left of both constraints with the solid line representing the general constraint and the dashed line representing the human resource constraints. The optimal solution is the point A which corresponds to a mix of approximately 55 patients treated with the robot and about 90 patients being treated traditionally leading to 3200/22 or about 145 QALYs.

Now suppose that a new technology arrives on the marketplace – a new generation robot which partially automates surgery (as opposed to

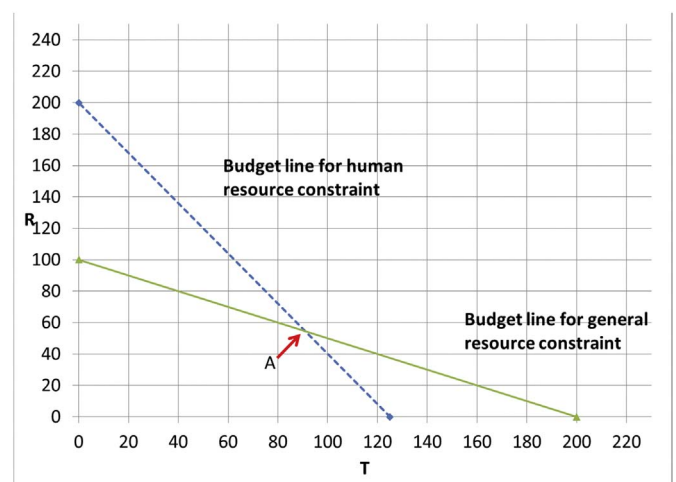


Fig. 1. Budget lines for interventions T and R given a total health care budget of 2m dollars and a human resource budget of 1m dollars.

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