Response to “Future costs and the future of cost-effectiveness analysis”

The discussion over how to correctly account for future costs in medical cost-effectiveness analysis has proven remarkably persistent. The paper by Lee revisits some of this ground from both a theoretical and empirical perspective. Although I am not convinced by Lee’s main conclusions, I found reading his paper a useful reminder of the complexity of thinking about the issue of future costs in medical cost-effectiveness analysis.

Lee’s analysis begins in Section 2 of the paper, where he begins by replicating the Garber–Phelps analysis of whether future costs need to be included in a cost-effectiveness analysis when there is a period-specific budget constraint such that consumption equals earnings minus medical care in each period. As with the original Garber–Phelps analysis of this model with a period-specific budget constraint, Lee finds that including future costs does not change the conditions for optimal resource allocation. As I pointed out in my 1997 paper (Meltzer, 1997), however, this is a trivial finding that results from the strong and unrealistic assumption that net resource use (consumption plus medical expenditures minus earnings) is zero in each period because of the imposition of a period-specific budget constraint. Since the medical and non-medical consumption of older persons on average far exceeds their market productivity (earnings) this is not just a very strong assumption from theoretical perspective but also false empirically to a quantitatively significant degree.

In the last paragraph of this section, Lee also argues that this result carries over to a model that does allow intertemporal substitution. In the Phelps and Garber paper, this argument was made in Section 3.2 that relaxed the assumption of a period-specific budget constraint they first developed in Section 3.1 of their paper. The reason for the discrepancy in the findings between my 1997 paper and the Garber and Phelps paper is that the analysis they used in Section 3.2 of the paper that aimed to analyze the model with intertemporal substitution implicitly assumed that future net resource use was zero by applying a condition that was derived from the model in Section 3.1 of their paper in which future net resource was assumed to be zero by adopting a period-specific budget constraint.

In this last paragraph of the second section of the Lee paper, this argument that including future costs in cost-effectiveness analysis does not change its implications is based on a brief discussion of intertemporal resource allocation when a consumer can borrow and lend at a fixed interest rate. The argument fails at several levels. First, it does not do more than assert that the optimality conditions (and resulting resource allocation) are unchanged by merely restating the result Eq. (4) from Lee’s model with no future net resource use. Moreover, the argument is in error because it fails to correctly distinguish between conditional and unconditional resource use. Specifically, the utility function is written in terms of survival probabilities and consumption conditional on survival, while the budget constraint is written ignoring survival probabilities completely. It is precisely the changes in survival probabilities that generate the need to include future costs in the context of non-zero future net resource use. Thus, Lee has erroneously assumed away one of the two essential factors that drive changes in future costs—changes in survival. In the model that incorporated survival probabilities that I published in my 1997 paper, it is clear that the budget constraint depends on survival probabilities. Some readers may find it useful to consider that, in a market-based model of intertemporal resource allocation in which consumers can reallocate consumption across periods of uncertain survival, the prices of moving consumption across states that differ in their likelihood of occurring would depend on the probabilities of those states. Thus the prices of intertemporal conditional resource reallocation would change as survival probabilities change. Whether one thinks of this from a market perspective or as simple resource allocation problem, the key point is that the effect of the probability of survival on the cost of consumption conditional on survival is neglected in Lee’s model in this key section of his paper.

Section 3 of Lee’s paper seems to argue that if the inclusion of future costs is appropriate, then doing so could alter the optimal allocation of resources. I basically agree with this conclusion.
Section 4 of the paper contains two strains of argument, one theoretical and one empirical. Lee addresses the empirical argument first, which in essence argues that the empirical analysis in my 1997 paper incorrectly calculated the net resource use of individuals by calculating it as consumption plus medical expenditures minus earnings when I should have instead used income rather than earnings. Using this line of argument, Lee argues that the more appropriate measure of the costs of life extension among the elderly is their net dissavings, which is, of course, much smaller than the net resource use measure that I use because of the substantial magnitude of public and private pension payments and asset income among the elderly. Following this argument, even if future net resource use belongs in cost-effectiveness analysis, it is so small as to be quantitatively insignificant.

The error here is failing to keep track of what costs are real and what costs are merely transfer payments. In my model, I focused on real expenditures (consumption, medical spending), and real measures of productivity (earnings). This is appropriate for a societal perspective on costs and effectiveness (Gold et al., 1996). Lee’s approach, in contrast, mixes real expenditure measures with income measures that also include transfer payments. Transfer payments are not relevant from a societal perspective.

Section 4 also includes a theoretical discussion of two different approaches to modeling intertemporal resource allocation. Lee terms these as annuity models and conditional models. Lee appears to define a conditional model as one in which consumption is written down in terms of consumption conditional on survival where the annuity model is something different than that. Unfortunately, he never really defines this annuity model clearly, although he states that the Model I used in my 1997 paper is an example of one. As best as I can gather, the essence of the annuity model as Lee sees it is that the consumption cost is not viewed as being conditioned on survival. This is not the case for the model I described in my 1997 paper since all measures of resources use that I described are conditional on survival, so I have difficulty making sense of Lee’s argument.

Nevertheless, it is worth noting that the model he does describe in Eq. (15) as a conditional model appears to be in error. The savings (s) in year 1 passes savings directly dollar for dollar as consumption into year 2 with no account made for the probability of survival to period 2 \((S^1(M^1))\).

\[
U(y - s - pm^0, H(M^0)) + S^1(M^1)U(y + s - pm^1, H(M^1))
\]

This implies that s dollars of savings in year 1 results in s dollars of increased consumption conditional on survival in year 2. In contrast to Lee’s assertion that this is a well-formed characterization of the expected utility maximization problem of intertemporal resource allocation under uncertainty, this does not make sense since it does not reflect the fact that passing consumption from the certain present to the uncertain future conditional on survival results in more than s in savings being available on a per survivor basis in period 2. For example, in a two-person economy in which there is a fight to the death battle between the two in period 1 so that only one lives to period two \((S^1(M^1)=1/2)\), a savings of s in period 1 for each individual would result in the availability of \(s/S^1(M^1)=s\) in year 2 whereas Lee’s formulation has consumption increase in period 2 only by s. The corrected version of equation 15 would be:

\[
U(y - s - pm^0, H(M^0)) + S^1(M^1)U \left(y + \left(\frac{s}{S^1(M^1)}\right) - pm^1, H(M^1)\right)
\]

The difference between these two models is key to the future costs debate specifically because the inclusion of the survival probability within the period 2 utility function as part of the \((s/S^1(M^1))\) term shows how changes in survival probabilities change the amount of consumption that must be foregone in any given period individuals are alive to spread available resources over all those periods for all survivors. For example, ignoring production in added periods of life, as the probability of survival rises, consumption must be reduced in each period. This is the key reason that it is necessary to account for future costs that occur when a medical intervention extends life.

Because it can be confusing to think about uncertain events in terms of probabilities and notation concerning conditional events can be confusing, it may be useful to some readers to examine essentially the same problem in terms of interventions that extend the survival of a population of people with certainty and to be completely explicit about notation with respect to living and dead states. To do this, imagine an economy with \(N_1\) persons living in period 1 and \(N_2\) (m) of these persons surviving to period 2, where m is medical spending in year 1 that increases (with certainty) the number of people living into period 2 so \(N_2(m) > 0\). Let consumption in period 1 be \(c_1\) and consumption among the living in period 2 be \(c_{2Living}\) and consumption among the dead in period 2 be \(c_{2Dead}\). Also let utility in period 1 be \(U(c_1)\) and utility in period 2 be \(U_{2Living}(c_{2Living})\) for people who are alive and \(U_{2Dead}(c_{2Dead})\) for people who are dead. Assuming without loss of generality that \(U_{2Dead}(0) = 0\) and assuming that additional consumption does not provide utility to people when they are dead, \(U_{2Dead}(c_{2Dead}) = 0\) for all values of \(c_{2Dead}\). If we also ignore discounting and weight the welfare of all persons equally, then the social welfare function in the population is:

\[
N_1U(c_1) + N_2(m)U_{2Living}(c_{2Living}) + (N_1 - N_2(m))U_{2Dead}(c_{2Dead})
\]

Since \(U_{2Dead}(c_{2Dead}) = 0\), this simplifies to

\[
N_1U(c_1) + N_2(m)U_{2Living}(c_{2Living})U(c_{2Living}).
\]
Assume also that this economy has $I$ units of good available for consumption or medical care so that the budget constraint is

$$N_1(c_1 + m) + N_2(m) c_{2Living} + (N_1 - N_2(m)) c_{2Dead} = I. \quad (5)$$

Examining this problem it is easy to see the intuitive result that $c_{2Dead} = 0$, since consumption when dead provides no utility so it is possible to simplify the budget constraint to: $N_1(c_1 + m) + N_2(m)c_{2Living} = I$. Writing this as a LaGrange maximization problem yields:

$$\text{Max } N_1U(c_1) + N_2(m)U_{2Living}(c_{2Living}) + \lambda(I - N_1(c_1 + m) - N_2(m)c_{2Living}). \quad (6)$$

Maximizing with respect to $c_1$, $m$, $c_{2Living}$, and $\lambda$ yields:

$$U'(c_1) = \lambda. \quad (7)$$

$$N_2(m)U_{2Living}(c_{2Living}) = \lambda(N_1 + N_2(m)c_{2Living}) \quad (8)$$

$$U_{2Living}(c_{2Living}) = \lambda. \quad (9)$$

$$I = N_1(c_1 + m) + N_2(m)c_{2Living}. \quad (10)$$

Eqs. (7) and (9) show that people equalize consumption in the two periods in which they are alive, and equation 10 simply recovers the budget constraint. Eq. (8) is the critical one for the allocation of medical expenditures. This easily rearranged to yield the cost-effectiveness ratio:

$$\frac{N_1 + N_2(m)c_{2Living}}{N_2(m)U_{2Living}(c_{2Living})} = \frac{1}{\lambda}. \quad (11)$$

The denominator is the gain in utility that comes from increasing the number of people living in period 2. The numerator reflects costs. The first term ($N_1$) reflects the direct medical costs of increasing $m$ for the $N_1$ persons alive in period 1 to receive the medical care. The second term ($N_2(m)c_{2Living}$) is the cost of consumption in period 2 for the $N_2(m)$ increase in persons alive in period 2 because of the additional expenditures on $m$. This is the essential element of accounting for future costs in medical cost-effectiveness analysis.

Another point worth responding to is Lee’s interesting remark that an annuity model would not suggest that a patient facing a fatal illness would shift consumption to the present, for example through a once in a lifetime “trip to the Orient”. I find this hard to address in the context of an annuity model since I am not sure Lee has defined the concept clearly, but I would add that there should be no “trip to the Orient” effect in any model that assumes full intertemporal resource allocation; in a world with full insurance, a rational individual would smooth consumption across all health states unless there was some sort of state-dependence operating through the utility function. Barring such state dependence, the “trip to the Orient” would not be utility maximizing if insurance were available.

Section 4 also contains a paragraph arguing that death does not cancel all “cash flows”. He writes, “Taxes need to be paid, the house still exists, the car payment remains due, mutual fund dividends still accrue…” It is not clear to me why this is useful for Lee’s argument, but none of these seems to provide a fundamental problem for the framework in my 1997 paper: (1) taxes are transfer payments and therefore not relevant and (2) returns from hard assets such as a house, car, or mutual funds do continue to accrue even if the individual dies but are consumed by other individuals. In short, none of these present exceptions to the basic model I described in my 1997 paper that describes the utility function and budget constraint in terms of real consumption, medical expenditures, and earnings.

I have little to add about Lee’s analysis in Section 5 since his findings are basically identical to those of both the Phelps–Garber paper and my 1997 paper. The analysis of Section 6 on health maximization essentially mirrors the earlier discussion, with the exception that there is no connection between consumption and well being, so that the effects of resource use at one point in time influence well being at other times only through their effects on health expenditures.

**Conclusion**

I continue to be convinced that models of intertemporal resource allocation to maximize utility under uncertainty imply that all future costs net of earnings should be included in cost-effectiveness analysis. Despite this, I agree with Lee that it is important to be clear about the conditional nature of consumption variables under uncertainty when discussing this. This can be done with varying degrees of complexity ranging from a simple perspective of an $N$ person economy in which only a smaller number of persons live to a second period (see above, and Meltzer, 2006 for a very simple algebraic example with a two person economy), to a more complex model such as that I used in the body of my 1997 paper, to a full Arrow–Debreu type model of contingent consumption that I analyzed in the Appendix to that paper. I believe that careful analysis using all these approaches continues to support the inclusion of future costs in medical cost-effectiveness analysis.
References


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