



# Measuring the importance of efficiency in the equity-efficiency trade-off in health care decision making

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## ABSTRACT

Empirical evidence indicates that people consider sharing of health resources to be of importance even in the absence of the attributes commonly associated with equity (age, social class, ethnicity, disease severity or location). This poses a challenge for measurement. If government is to secure quantitative advice concerning the equity-efficiency trade-off then methods are needed which allow the expression of preferences for sharing per se in addition to other preferences.

The present paper reports the results of a survey which tested a technique for achieving this. The survey did not include any of the attributes usually associated with equity but was designed to quantify the respective importance of life expectancy, outcome egalitarianism, and resource sharing in respondent's decision making and to observe the changing importance of cost per life year (efficiency) as the other attributed varied. Results are of significance because they indicate the irreducible lower limit to the willingness to trade-off efficiency for equity in the context of life extending programs.

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# Measuring the importance of efficiency in the equity-efficiency trade-off

## 1 Introduction

The need for an equity efficiency trade-off is formalised in Welfare Theory through the inclusion of the (Samuelson-Bergson) Social Welfare Function (Little 1960; Graaff 1967; Gold, Siegel et al. 1996). In the health economics literature concern over distributional fairness was highlighted by Wagstaff (1991) and debate over the meaning of equity was triggered shortly afterwards by Culyer and Wagstaff (1993). One outcome of this was a recognition that in economic evaluation studies benefits may require importance weights which incorporate equity concerns. Empirical studies of these have been reviewed by Dolan (2005) and egalitarian motivations discussed by Tsuchiya and Dolan (2009).

The reasons suggested for departing from maximum efficiency usually relate to group attributes and characteristics of the individual or their health state. The most visible example in the first category is the additional expenditure in many countries to achieve geographic equity. As a second example, different socioeconomic (SES) groups have different health status and the same principle – equal access for equal need – may be used to justify importance weights favouring the least healthy SES groups. To operationalise this Williams (1997) assumed a particular willingness to pay for the achievement for health equality and, in combination with data on class differences in mortality and QALY life expectancy in the UK, constructed social indifference curves –effectively a social welfare function (SWF) – between the life expectancies of different social classes. From these, social importance weights were derived which could, in principle, be applied to the benefits from different health programs.

At the individual level, a person's age has received particular attention with relevant considerations classified as 'utilisation', 'egalitarian', 'health maximising' or 'productivity ageism' (Tsuchiya 1999; Tsuchiya 2003). Others have argued that some attributes which would reduce the cost effectiveness of a person's treatment should be ignored. Suggested attributes include permanent disability and chronic illnesses which limit a person's capacity for health gain because of the individual's limited capacity for good health (Nord et al. 1995; Dolan and Cookson 2000; Ubel et al. 2002),

In the third category, a case has been made for the special treatment of illnesses which have a particular horror for the public, the so-called 'Rule of Rescue' (McKie and Richardson 2003). Empirical studies have also found a social preference for programs which do not leave patients in severe health states (Nord 1999; Gyrd-Hansen 2004). This is not simply because greater health

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benefits may be obtained when a patient is in a severe health state. The results suggest that the social benefit is additional to the benefit of health improvement as judged by the individual's own assessment of the health states before and after treatment. (For example, a health program moving a patient from health state 0.1 to 0.2 – on a personal utility scale – would receive greater social support than one moving a patient from 0.8 to 0.9). The relevant empirical studies have been reviewed by Richardson et al. (2010) where evidence is also presented that the severity effect applies not simply to patients who are in a severe state before treatment but also to patients who are left in a severe state after treatment.

A common feature of all of the attributes which have justified an equity-efficiency trade-off is that they have limited applicability. Socio economic status and age, for example, are attributes which may or may not be relevant in a particular comparison. Similarly the severity of health states may be the same before and after treatment with efficiency differing because of costs.

The argument for an equity-efficiency trade-off, however, need not depend upon particular attributes. Hurley notes the argument that: 'People suffer the misfortune of ill health for reasons beyond their control and should not have to suffer excessively because of fate', (Hurley 2000 p87). Irrespective of the true level of control, the belief that this is so and that the community should assist individuals who are subject to random misfortune creates a case for an equity-efficiency trade-off irrespective of particular attributes. If this argument was empirically important it would imply that the population would not seek maximum efficiency but would prefer sharing of available resources with the share influenced but not completely determined by efficiency and other equity considerations. .

Consistent with this Nord and Richardson et al. (1995) found that the public did not seek to minimise cost per life or life year. A random sample of 544 Australians was asked whether they agreed or disagreed with a number of paired statements which included the following:

Amongst patients who are equally ill, those who can be helped at low cost should have priority over those who can be helped at high cost because this will allow more people to be helped when money is limited.

It is unfair to discriminate against those who happen to have high-cost illness. Priority should therefore not depend on the cost of treatment (except in cases where costs are extremely high).

Only 19 per cent supported the first and 81 per cent supported the second argument. Because of the possibility that people had little opportunity to reflect upon their answers, a sub-group (119) were interviewed. Initially, the two propositions were repeated emphasising the limited budget. Secondly, interviewers conducted a structured argument which challenged the individual's logic and pointed out that less health would be achieved with the second option. Thirdly, a numerical example was given to illustrate this point and, finally, the individuals were asked to allocate a budget between several options that varied in cost per life saved and which clearly showed the mortality consequences of the allocation. Generally, individuals did not change their views. Only 6 percent allocated resources to the health maximising option in the final stage.

In Spain, Abellan-Perpiñán and Prades (1999) conducted a similar exercise asking individuals to allocate a budget between two options, A and B, where the cost of achieving outcome B was double that of achieving outcome A. Respondents did not allocate all of the resources to option A as predicted by economic theory but allocated them in the ratio 1:2 so that the cost disadvantage of option B was exactly offset. Similar results were obtained in a different context by Ubel and Lowenstein (1996), who asked respondents to allocate resources, (a limited number of transplant organs) between patients with different prognoses for survival. Rather than allocating entirely to

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the health maximising group with a good prognosis, respondents shared organs between groups. Similar results were found in the UK by Ratcliffe (2000).

In a survey designed to examine egalitarian motivation Tsuchiya and Dolan (2009) asked members of the public to rank combinations of benefits to two individuals which would either increase the equality of outcomes measured as life expectancy (outcome egalitarianism) or the equality of the incremental benefits (gain egalitarianism). Results again demonstrated a willingness to sacrifice total benefits to obtain equity and a preference for outcome (over gain) egalitarianism.

Most recently McKie et al. (2010) conducted a series of structured group discussions to examine the normative basis for public rejection of prioritising only on the basis of health maximisation. Following the study by Nord, Richardson et al.(1995), respondents were asked to allocate a limited budget to different groups of hospital patients and to consider the reasons for their decision. The authors rejected the possibility that results reflected due conceptual confusion or a misunderstanding of the issues. Respondents gave coherent explanations for their decisions based upon notions of fairness, giving all groups a 'chance', and not removing 'hope'.

These studies all suggest that the public does not support health maximisation even in the absence of equity relevant attributes. Questions which require clarification relate to the magnitude of the equity-efficiency trade-off under different circumstances and its inclusion in policy decision making. The present study focuses upon these questions. Its specific objectives were threefold. First it sought to test a method, analogous to discrete choice modelling, for simplifying the respondent decision process while simultaneously conveying a significant amount of relevant information including information relating to sharing. Second, and using these methods, it sought to investigate the relative importance of cost effectiveness as life expectancy and sharing varied. Finally, it sought to demonstrate how the data may be used to inform policy. The methods used are described in Section 2 below. Results are presented in Section 3 and discussed in Section 4. The section includes a consideration of how the methods described here might be used for policy decision making.

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## 2 Methods and data

Respondents to a survey were asked to allocate increasing resources to one of several options which increased life expectancy for different individuals by different amounts. Efficiency could be maximised by allocating resources to the individual who received the greatest gain. Persisting with this strategy as resources were progressively increased would generate increasing pressure for a trade-off in order to share benefits with those whose treatments were less cost effective.

To achieve a social perspective, respondents were asked to imagine that they were allocating resources on behalf of the Australian national health scheme, Medicare. Initially they were told that they could allocate only \$10,000 to one of four patients and that this would extend patient's lives by 12, 8, 6 or 4 years respectively. Patients were all 25 years old and, without care, faced immediate death. The \$10,000 budget could not be shared. Only 1 patient could receive the resources. After allocating the \$10,000 to a patient a second question was asked. Respondents were told that an additional \$10,000 was available at the same point in time. They were asked to allocate this to one of the four patients, one of whom now had a guaranteed allocation of \$10,000 and three of whom faced immediate death. After allocating the additional resources to one of the four patients the procedure was repeated until the exercise was finished.

Respondents were reminded on several occasions that the different budgets represented different amounts which might be available at one point in time; that the budget was changing from question to question but that the patients did not change, ie all were 25 years old and all faced death unless they received an initial allocation of resources. After a cumulative allocation ensuring a life expectancy of 48 years patients were removed from the choice set and the exercise was ended when the respondent no longer had a choice to make. The order in which resources were allocated was recorded for analysis.

The volume of information to be presented to respondents could potentially cause cognitive overload. To mitigate this problem an important part of the study design was a simple, visual presentation of information. Respondents were initially shown the visual prop in Figure 1a in which the four bolded rectangles indicate the relative length of life which might be obtained by four patients who faced immediate death. Respondents were asked to indicate (click on) the patient who should receive the initial \$10,000. If patient 1 was selected, Figure 1a was replaced by Figure 1b which indicated that patient 1 had a life expectancy of 12 years but that this could be extended to 24 years. Respondents were then asked to allocate an additional \$10,000 to one of the four patients. In the on-line version of the questionnaire only the bolded rectangles appeared on the screen.

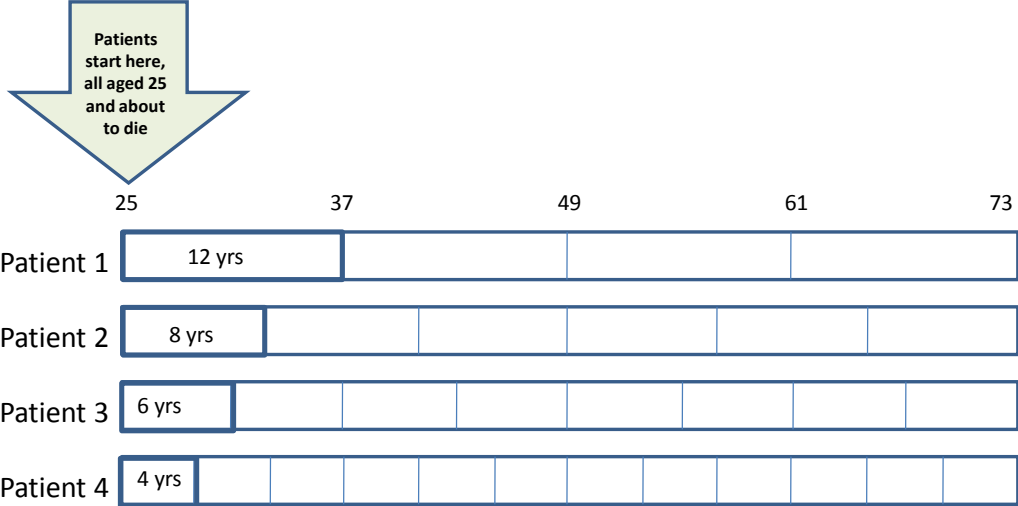
The result of these procedures was that choices were made with a visual representation of (a) each patients' life expectancy which varied with the number of services previously selected; (b) the benefits of receiving the additional resources (life years gained); (c) the opportunity cost (life years to another patient); (d) the share of additional life years received by each patient; and (e) the patient's share of the total resources allocated. Nevertheless each question required a straight forward discrete choice involving the allocation of incremental resources to a single patient.

Two possible sets of results from a respondent are illustrated in Figures 2a and 2b. The first (Figure 2a) is the ordering of someone who maximised the number of life years gained. Patient 1 would always receive priority over Patient 2 over Patient 3 over Patient 4. This is very close to the orthodox economic prediction, with some variation caused if time discounting was taken into account. In contrast, the second result (Figure 2b) is the ordering of an extreme 'outcome

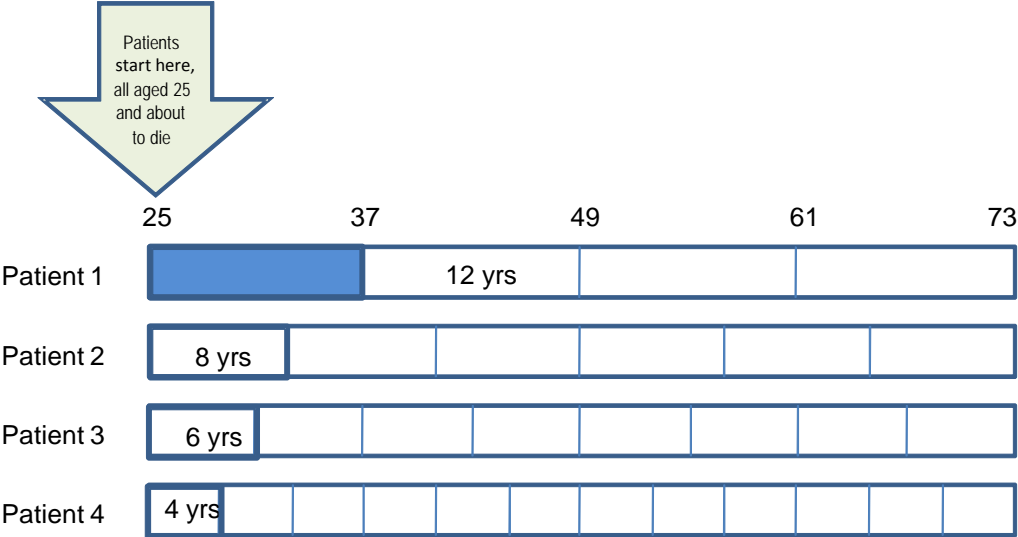


egalitarian' who allocated resources to the patient with the shortest life expectancy and, in cases where patients had equal life expectancy, to the patient gaining most life years. This is tantamount to Rawls' 'maximin' principle of justice which would require budgetary allocation be made to the most underprivileged patient.

**Figure 1 Web-based allocation exercise**



**1a. The diagram represents 4 patients, all aged 25 facing immediate death. Whichever block is selected will extend that patient's life for the number of years indicated in that block.**



**1b. When a block is clicked, it fills with colour and the next block becomes available. The patient will now live until the end of the filled block**

**Figure 2 Possible ordering of responses**

Patient 1	1	2	3	4								
Patient 2	5	6	7	8	9	10						
Patient 3	11	12	13	14	15	16	17	18				
Patient 4	19	20	21	22	23	24	25	26	27	28	29	30

**2a orthodox economic ordering**

Patient 1	1	9	16	24								
Patient 2	2	7	12	17	22	27						
Patient 3	3	6	10	14	18	21	25	29				
Patient 4	4	5	8	11	13	15	19	20	23	26	28	30

**2b Extreme egalitarian ordering**

Initially, paper versions of the questionnaire were used for piloting the exercise. These were administered to members of the Monash Centre for Health Economics and to students. Postal versions of the final questionnaire were then sent to a cross section of the public. Subsequently, a web-based version of the questionnaire was developed. This was first used to target selected groups (including academic economists and the general public). Subsequently a commercial panel company<sup>1</sup> was employed to obtain web respondents. This allowed the targeting and imposition of quotas on particular cohorts of the population in order to obtain representative respondents with respect to age, gender and education.

In order to assess people’s comprehension of the exercise respondents were asked to write brief comments and, in particular, the reasons for their prioritising decisions. Two criteria were used for discarding results. The first was a comment indicating that respondents misunderstood the exercise. The second was a sequence of choices which did not start with Patient 1. Since the four individuals in the exercise were described as being identical there is a compelling reason for assigning resources to the patient who receives greatest benefit. In principle, a respondent could have adopted a ‘lottery’ criterion and, for ethical reasons, assigned resources at random. However, other survey evidence suggests that most people believe this to be inappropriate and the judgment was made that such results were more likely to reflect misunderstanding than unusual respondent values. Comments made by these respondents largely confirmed this judgement.

<sup>1</sup> Research Now.

Results were used initially to describe the magnitude of the equity-efficiency trade-off by survey respondents. An index was created to compare the number of years respondents 'purchased' with their budget with the maximum number of years that they might have purchased given the options available. Secondly, the cumulative services and life years given to each patient were calculated for each budget and compared as the budget increased. Thirdly, the probability that an individual would receive a service was estimated as a function of the cost of the service, the individual's life expectancy and the share of the budget already received.

### 3 Results and analysis

#### 3.1 Data

In total 626 responses were obtained, 391 online and 235 from the paper survey. Respondents indicated little difficulty with comprehension or with completing the questions but 82 (13.7 percent) were removed from the analysis on the basis of their comments. The most common reason for misunderstanding was that people equated more costly treatments with a more serious illness and greater suffering (despite statements indicating the contrary). A small number also assigned different ages to different patients. Misunderstanding and deletion was less common with paper survey respondents (7.2 percent) than with online respondents (16.4 percent).

The final dataset consisted of 218 responses from the initial paper survey and 326 responses from the web. The demographic and educational characteristics of the sample are reported in Table 1 along with the number of respondents which would perfectly reflect the demographic and educational characteristics of the Australian population. Because of the methodology it was possible to obtain a good match between the total (paper plus web based) respondents and age and educational status of the Australian population recorded by the last census (2006) by the Australian Bureau of Statistics (ABS).

**Table 1 Respondents to the Sharing questionnaire and numbers representing the Australian population**

Age	18-24	25-44	45-65	65+	Total	Rep*number
Male						
High School	13	15	12	15	55	59
Trade	12	28	30	13	83	109
TAFE	3	9	8	3	23	29
Uni/College	18	37	38	10	103	69
Sub Total	46	89	88	41	264	266
Rep* number (M)	45	95	81	45		
Female						
High School	10	14	20	25	69	72
Trade	7	19	14	3	43	59
TAFE	2	14	15	5	36	42
Uni/College	31	48	35	6	120	96
Sub Total	50	95	84	39	268	269
Rep*number (F)	46	94	84	46	279	
Total Respondents	96	184	172	80	532	
Rep* Total	90	186	165	90	532	

**Note:** 12 missing responses to gender.

**Key:**

Rep number\* = number achieving an exact representation of the 2006 Australian population recorded by ABS census data.

### 3.2 Sharing indices

In the first analysis indices were constructed using equation 1 which indicates the proportion of potential life years people sacrificed when allocating resources. The index was constructed by summing the number of years obtained each time a decision was made and dividing this sum by the sum of the years which would have been obtained if a person had made the most 'efficient' choice and allocated resources to the patient whose treatment would gain most life years.

$$\text{share} = \left( \sum_{i=1}^n \text{Years}_i \text{ Allocated} \right) / \left( \sum_{i=1}^n \text{Possible Years}_i \text{ Allocated} \right) \quad \dots \text{ equation 1}$$

n = final click when choice was possible

Thus, for example, if an individual had followed the efficient ordering in Figure 2a for the first four decisions, the index numerator would have increased by 12 + 12 + 12 + 12. As these were also the maximum years available for the choices, the denominator of the index would have increased by 12 + 12 + 12 + 12 producing an overall index of 48/48 = 1.00. In contrast, the first four choices of the 'outcome egalitarian' in Figure 2b would have added 12 + 8 + 6 + 4 (= 30) to the numerator and 12 + 12 + 12 + 12 to the denominator. If the index had been calculated at this point (ie after 4 iterations of the exercise) its value would have been 30/48 = 0.625.

By construction, the 'efficient' allocation (Figure 2a) results in an index of 1.00. After the maximum possible iterations the index for the egalitarian allocation equals 0.58.

Results for different age, sex and education cohorts are shown in Table 2. The average index for the full sample was 0.625. This implies that individuals sacrificed 37.5 percent of life years to achieve their preferred allocation. The index differs from the egalitarian score by only 10 percent of the gap between the egalitarian and the efficiency scores (0.42). Indices were stable by demographic cohort with only the upper two educational groups differing significantly. But the lack of a consistent pattern suggests that this was a chance result. The 34 academic economists in the sample scored 0.655 – 63 percent greater than the amount by which the average person exceeded the egalitarian score, but still 0.345 away from the efficient score of 1.00.

**Table 2 Sharing indices: average values\***

A	Age	Mean	se	N
	18-24	0.625	.010	96
	25-44	0.627	.006	184
	45-65	0.624	.008	172
	65+	0.641	.011	80
No significant differences between means				
B	Education	Mean	se	N
	High school	0.620	.007	124
	Trade	0.624	.009	126
	TAFE	0.600*	.011	59
	Uni/college	0.640*	.007	227
	Total	0.626	.004	532
	Economists	0.655	.019	34
*differ at .01 confidence level				
Note: 8 missing observations on highest level of education attained				

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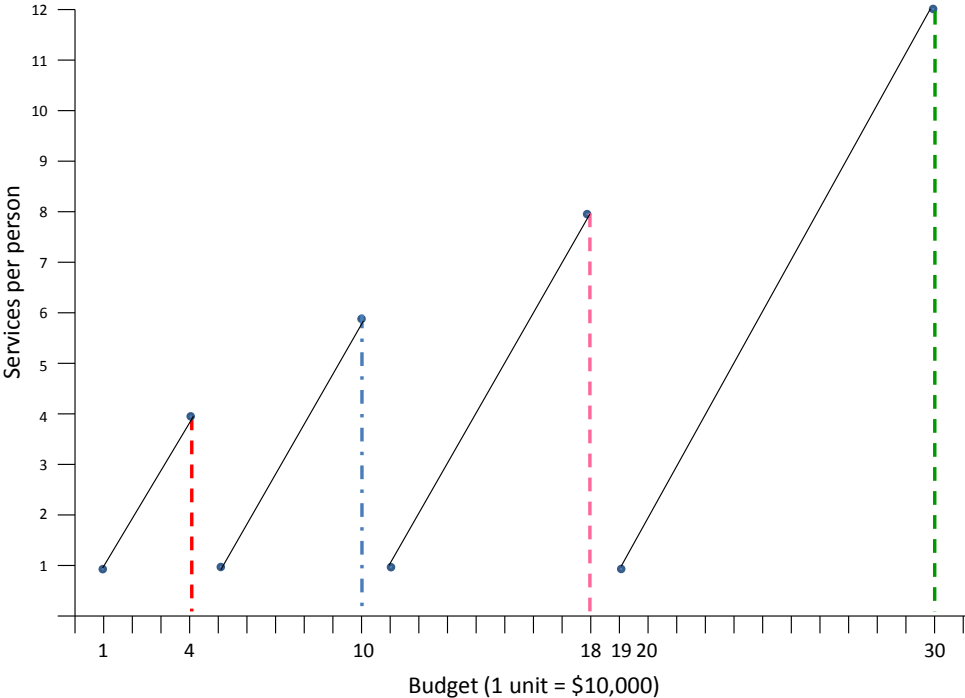
### 3.3 Allocation as the budget increases

In the second analysis the cumulative number of services assigned to each patient and the resulting life years were plotted against the budget. As a contrast, Figures 3a and 3b display the results from the efficient and egalitarian orderings shown in Figures 2a and 2b. With an efficient allocation (Figure 2a) the entire budget would be allocated to the first patient until they received the maximum number of services (4) and life years (48). The subsequent allocation would be strictly in the order: patient 2, patient 3, patient 4. Time discounting would possibly cause some deviation in the latter years but this effect would be small as the differences in the effectiveness of the services are large. The egalitarian allocation is more complex (Figure 3b) but the salient feature is an immediate allocation for less efficient services before an additional allocation to the more efficient services.

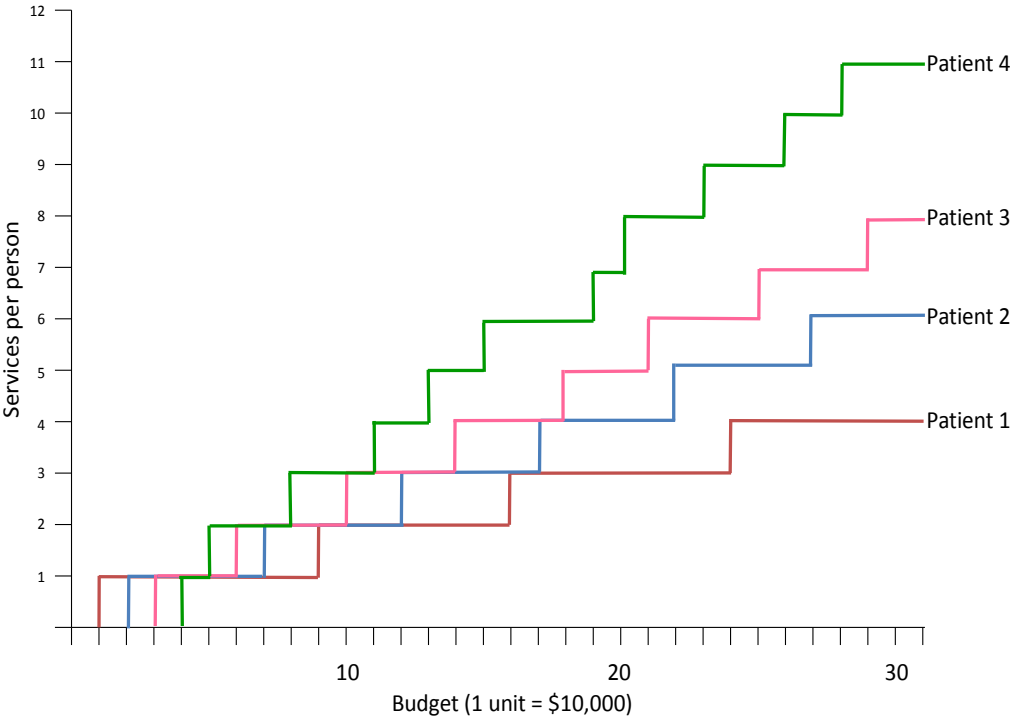
Figure 4a plots the average value of the cumulative services actually allocated to each patient as the budget rises. Consistent with the previous results the pattern is closer to the egalitarian than to the economic allocation. As the budget rises from 1 to 4 (ie \$10,000 to \$40,000), patients 1, 2, 3 and 4 were allocated services by 100, 75, 70 and 69 percent of the respondents respectively. After the budget has risen to 15, patient 1 only received 3 of the most cost effective services and 20 percent of respondents had still not allocated the final service to patient 1 when the budget had risen to 27. Before this, other services were funded concurrently with the most cost effective service.

Despite this result, the cost per service was still influential. This is more clearly seen in figure 4b which plots the average value of the cumulative life years which would be gained from the services shown in Figure 4a. Data for total and incremental life years are given in Table 3. At any level of the budget below 25, the number of life years received per patient declines with the cost per life year and the difference is significant. With a budget of 15, patient 1 receives 2.14 times the number of life years (34.9 versus 16.3 respectively). The 4 patients receive half their potential life years when the budget reaches 5, 8, 13 and 18 respectively.

**Figure 3 Allocation of services as the budget increases**

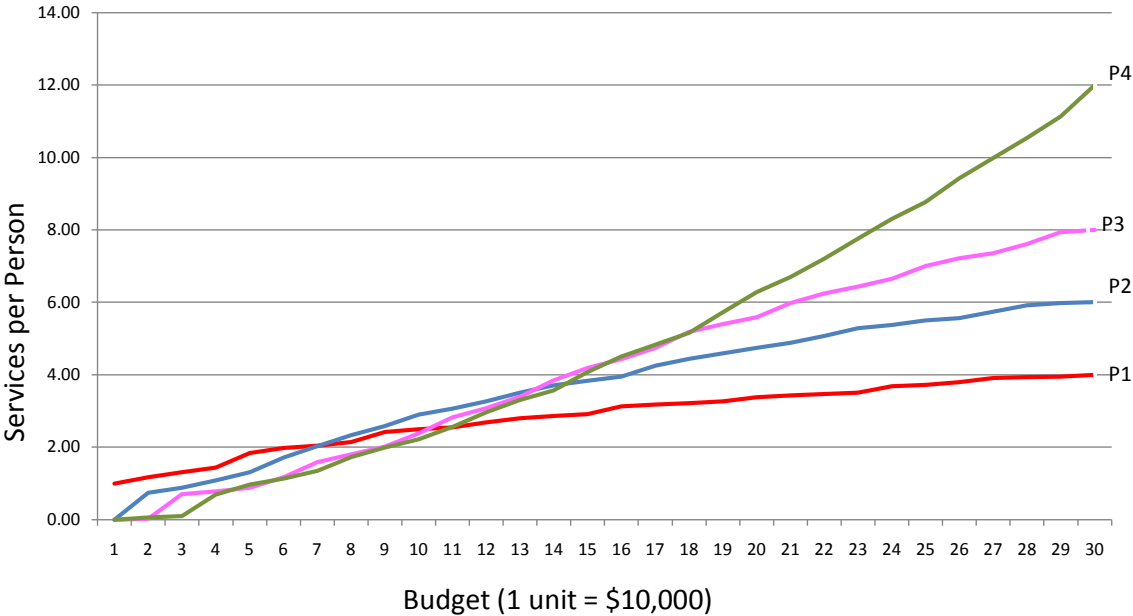


**3a The efficient allocation of services per person as the budget increases**

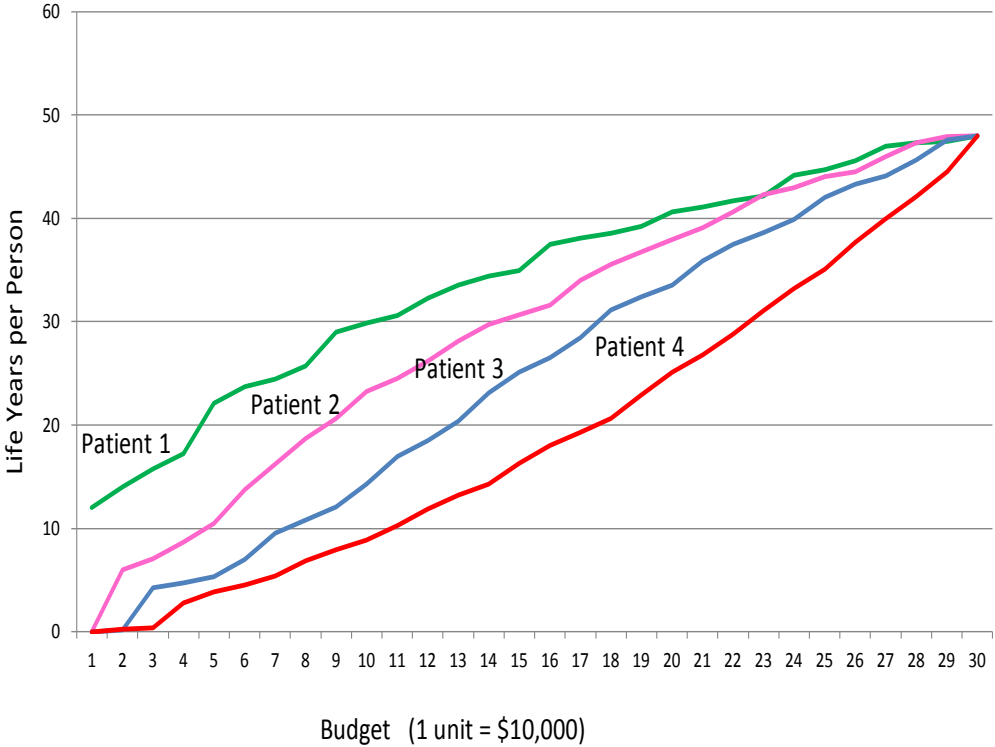


**3b The egalitarian allocation of services**

**Figure 4 Results: allocation per patient as the budget rises**



**4a Services per patient as the budget rises**



**4b Life years per patient as the budget rises**

**Table 3 Allocated life years by cost per life year and budget**

Cost/ LY (N)	Total Life Years (N)				Incremental Life Years (N)			
	0.083	0.125	0.167	0.25	0.083	0.125	0.167	0.250
<b>Budget</b>								
1	12	0	0	0	12	0	0	0
3	15.8	7.0	4.21	0.4	3.8	7.0	4.2	0.4
5	22.1	10.5	5.3	3.9	6.3	3.4	1.1	3.5
10	29.9	23.2	14.3	9.0	7.8	12.8	9.0	5.0
15	3.50	30.6	25.1	16.3	5.1	7.4	10.8	7.4
20	41.0	38.0	33.5	25.1	5.6	7.3	8.4	8.8
25	44.7	44.0	42.0	35.1	4.1	6.1	8.5	9.9
30	48	48	48	48	3.3	4.0	6.0	12.9

\* (life years gained per allocation of \$10,000)

### 3.4 Probability of receiving a service

The results above reflect a varying mix of influences: a changing budget, different life expectancies and relative life expectancies and a changing share of resources for each patient. To separate the effects, the probability of a patient receiving a service was predicted using logit analysis. Data were used to construct the following variables.

Service = 1 if a patient received a budget allocation  
= 0 otherwise

Budget = Cumulative number of clicks (each click represents a budget allocation of \$10,000 to one of the four patients)

Cost / LY = 1 / (life years obtained with \$10,000)

LE = life expectancy = cumulative life years to be obtained from the previously allocated budget

Rel LE = relative life expectancy: life expectancy minus the average life expectancy of the patients in the choice

Share = the patient's share of the total (dollar) budget

Summary statistics for these variables are reported in Table 4. When the full dataset is used there are 41,361 observations (initially 4 per 'click' – one for each patient, one of whom receives a service, 3 of whom do not – decreasing to 3 then 2 as the choices facing respondents decline).

'Service' was predicted by the remaining variables. To increase flexibility, the quadratic form of LE, Rel LE and Share were included in some regressions.



**Table 4 Summary statistics**

Full dataset (30 observations)	n	Mean	sd	Min	Max
Budget (\$10,000)	41361	13.2	7.7	1	30
Cost/LY (\$10,000)	41361	0.162	0.06	0.083	0.25
LE	41361	21.4	9.3	0.0	40
Rel LE	41361	1.76	8.1	-29.5	33.0
Share		0.25	0.14	0	1
Observations 1-10	n	Mean	sd	Min	Max
Budget (\$10,000)	15160	5.980	2.581	2	10
Cost/LY	15160	0.156	0.0615	0.083	0.25
LE	15160	9.898	8.808	0	40
Rel LE	15160	-0.051	7.500	-30	20.5
Share	15160	0.247	0.158	0	1
Observations 11-30	n	Mean	sd	Min	Max
Budget (\$10,000)	22864	19.203	4.785	12	30
Cost/LY	22864	0.165	0.060	0.083	0.25
LE	22864	29.197	9.635	0	40
Rel LE	22864	-3.131	8.581	-33	29.5
Share	22864	0.254	0.087	0	0.75

Results are reported in Table 5. In regression 1, cost/LY is consistently significant but its significance level is relatively low and the variable has relatively little explanatory power. Nevertheless it is sufficiently important to contradict the hypothesis that cost is unimportant and that people follow a maximin or Rawlsian principle with respect to life expectancy.

**Table 5 Logit results: All valid observations. Dependent variable: received services = 1**

Equation Variable	1		2		3		4	
	b	z	b	z	b	z	b	z
Budget/10,000	1.32	(36.2)	1.33	(36.4)	1.59	(38.9)	1.50	36.3
Cost/LY	-1.08	(-4.75)	-0.93	(-4.03)	-1.20	(5.33)	-1.90	-7.92
LE	-0.07	(34.8)	-0.05	13.1	-0.10	(-36.3)	-0.03	-8.46
(LE) <sup>2</sup>			-0.0007	-9.7			-0.002	-19.6
Rel LE					-0.03	(15.1)	0.01	5.2
(Rel LE) <sup>2</sup>							-0.003	24.3
Constant	-1.06		-1.25		-0.93		-1.28	
N	41,361		41,361		41,361		41,361	
LR chi 2	1957		2053		2183		2986	
Log like	-23.375		-23.327		-23.262		-22.860	
Pseudo R <sup>2</sup>	0.040		0.042		-0.045		0.06	

The dominating variable and in each of the subsequent results is LE, life expectancy. As it increases there is a reduced probability of receiving resources or, conversely, those in greatest need as defined by their life expectancy are most likely to receive resources. Conversely the coefficient is stable across regressions. Increasing the flexibility of the functional form by the introduction of the quadratic term (LE)<sup>2</sup> – regression 2 – improves the fit but the effect is small.

When life expectancy is omitted (regression 3) relative life expectancy becomes significant but this is largely because the two variables are highly correlated. However it remains significant when it is introduced in combination with life expectancy (regression 4). The non linear effect is to increase the likelihood of a service outside the range 0 < Rel LE < 3.4. The introduction of 'share',

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the variable measuring the percentage of the budget received by a person did not improve the explanatory power of the regressions and is not reported in Table 4.

The relative importance of variables is illustrated in Figures 5-7 which use the results from equation 1. Each figure plots the probability that a patient will be allocated the incremental resources at a given iteration of the exercise. A random allocation would result in a probability of 0.25 (as there are 4 patients). The figures indicate the deviation from this as independent variables change.

Figure 5a plots the probability that the 10<sup>th</sup> increment to the budget will be received by an individual as their life expectancy increases. The negative relationships indicate that, all else equal, a person's probability of receiving a service decreases as their life expectancy increases. The probability increases as life expectancy falls and the 'urgency' of treatment increases. The effect is quantitatively large. With the top line, where cost per life year is 0.05, as life expectancy falls from 40 to 0 the probability of receiving a service rises from 0.07 to 0.55. The bottom line in Figure 5a represents the probability that a service will be received by a patient in the same circumstances but with a cost per life year of 0.3. A decrease in life expectancy from 40 to 0 now increases the probability from 0.05 to 0.48. The sixfold difference in cost per life year reduces the probability by 0.02 and 0.07 respectively at these points.

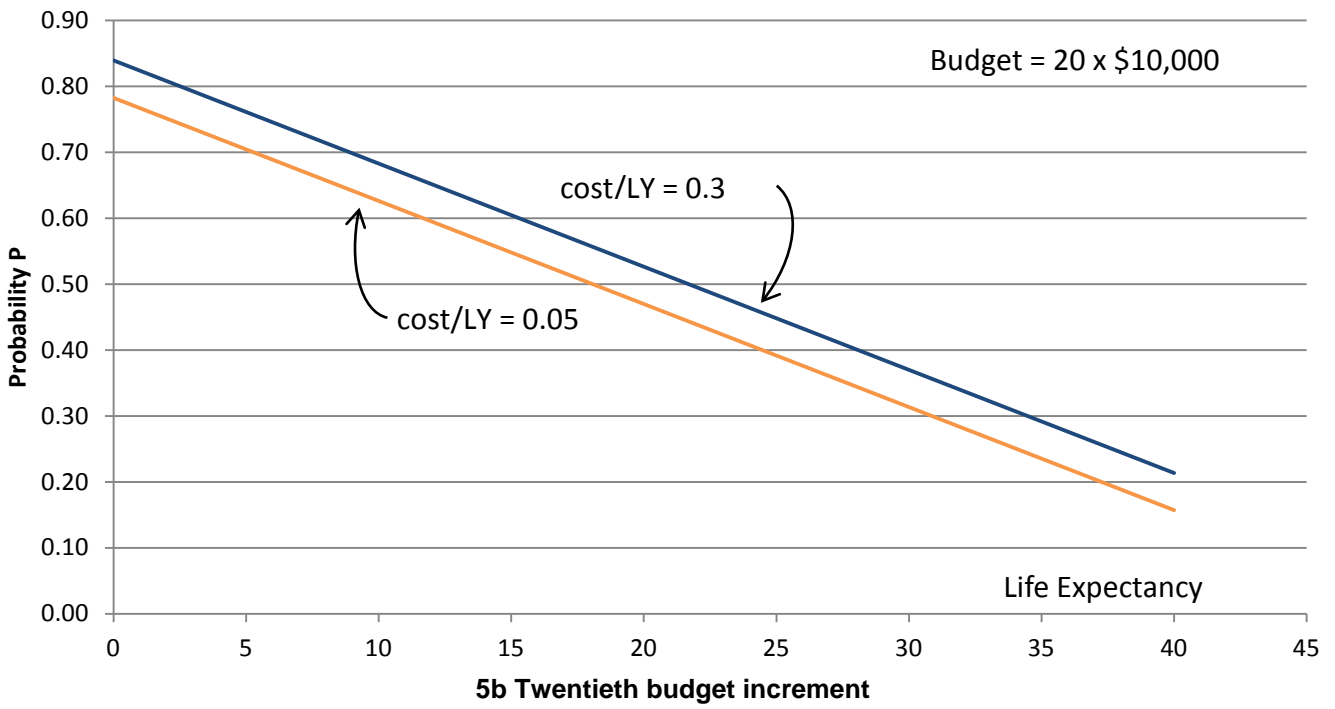
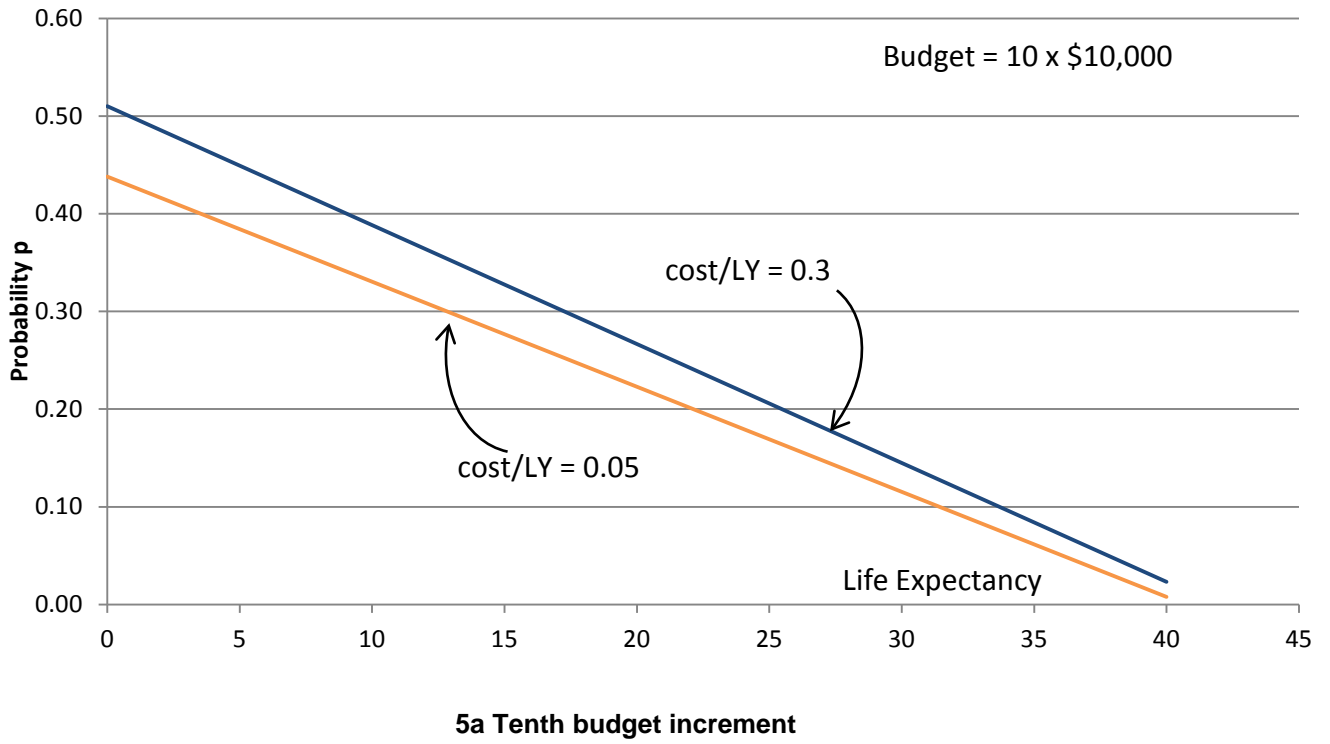
As the budget increases, the lines in Figure 5a shift vertically upwards. At the 20<sup>th</sup> income increment to the budget – figure 5b – the probability of a service for a person facing immediate death rises from about 0.2 to about 0.8. This reflects the increasing pressure to share with a non-recipient as other patients receive more. The vertical distance between the 2 lines in figure 5b indicates that the sixfold increase in cost per life year reduces the probability from 0.82 to 0.78.

Figure 6 illustrates the budgetary effect explicitly. Figure 6a indicates the probability that an individual with a life expectancy of 0 will receive resources as the budget increases. The top line again applies to a patient with a cost per life year of 0.05 and the bottom line to a patient with a cost per life year of 0.3. In both cases when the budget is low and each of the four patients has a low life expectancy, the probability of a service is close to the random level of 0.25. When the budget is 35 (x \$10,000) a life expectancy of 0 for a patient indicates that all previous resources have been received by the other three patients. The probability that the neglected patient receives a service rises to 0.95. The effect of the sixfold increase in cost per life year shown by the bottom line is to reduce the probability from 0.27 to 0.22 when income is 1 (x \$10,000) and from 0.95 to 0.93 when income is 30 (x \$10,000).

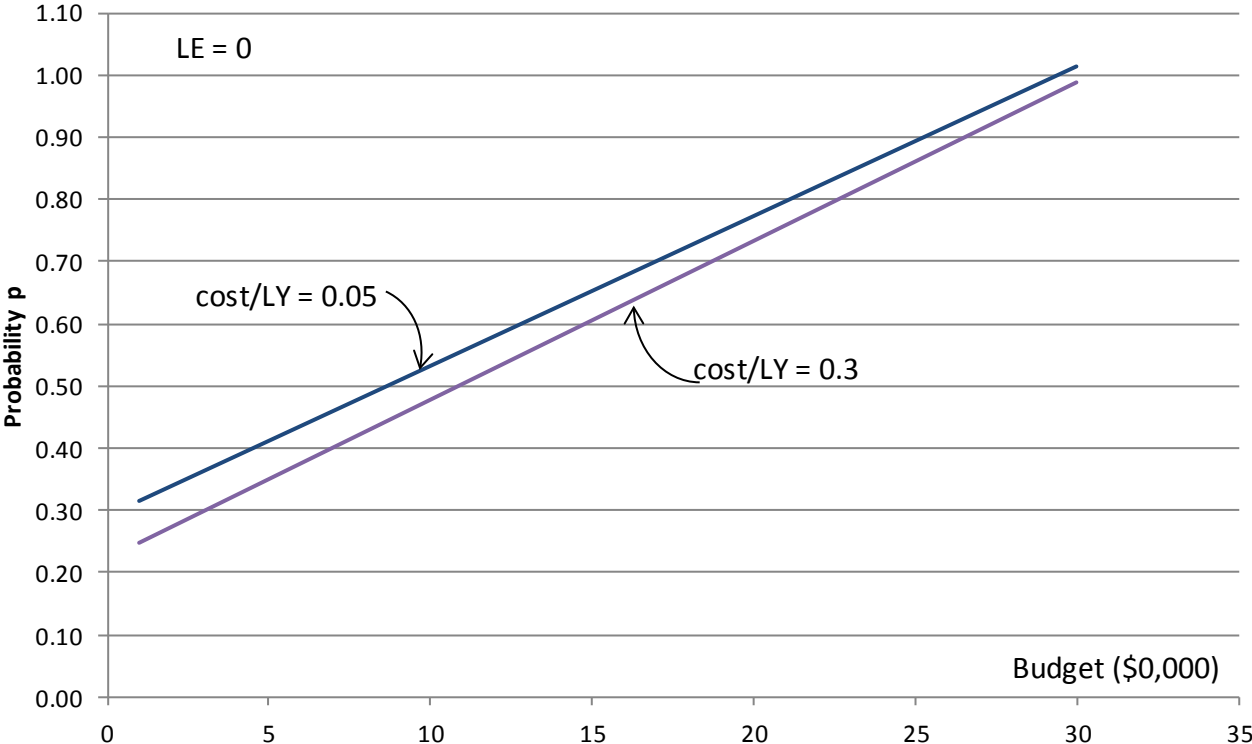
Figure 6b depicts the same relationships as in Figure 6a but with LE increased to 30. The effect of this is to reduce the probability of a service: a person who has already received a larger share of the resources is less likely to receive the incremental resources. Conversely, there must be an increase in the budget at which there is the same probability of a service. Thus, while Figure 6a indicates a 0.5 probability of a service at the 10<sup>th</sup> budget increment, this probability is only reached in Figure 6b at the 25<sup>th</sup> increment.

Figure 7 places cost per LY on the horizontal axis and plots the probability of a service when LE = 5 (top line) and 20 (bottom line). Figure 7a applies to the 10<sup>th</sup> income increment and 7b to the 30<sup>th</sup>. Both figures reveal the relatively small effect of cost per life year upon probabilities. Decreasing LE raises the probability substantially. With the 30<sup>th</sup> budget increment, individuals with a LY of only 5 – ie those who have not received a significant share – are almost certain to receive the resources (p = 0.9-0.92). Even those who have (only) been 'allocated' a LE of 20 are likely to receive services (p = 0.75-0.8).

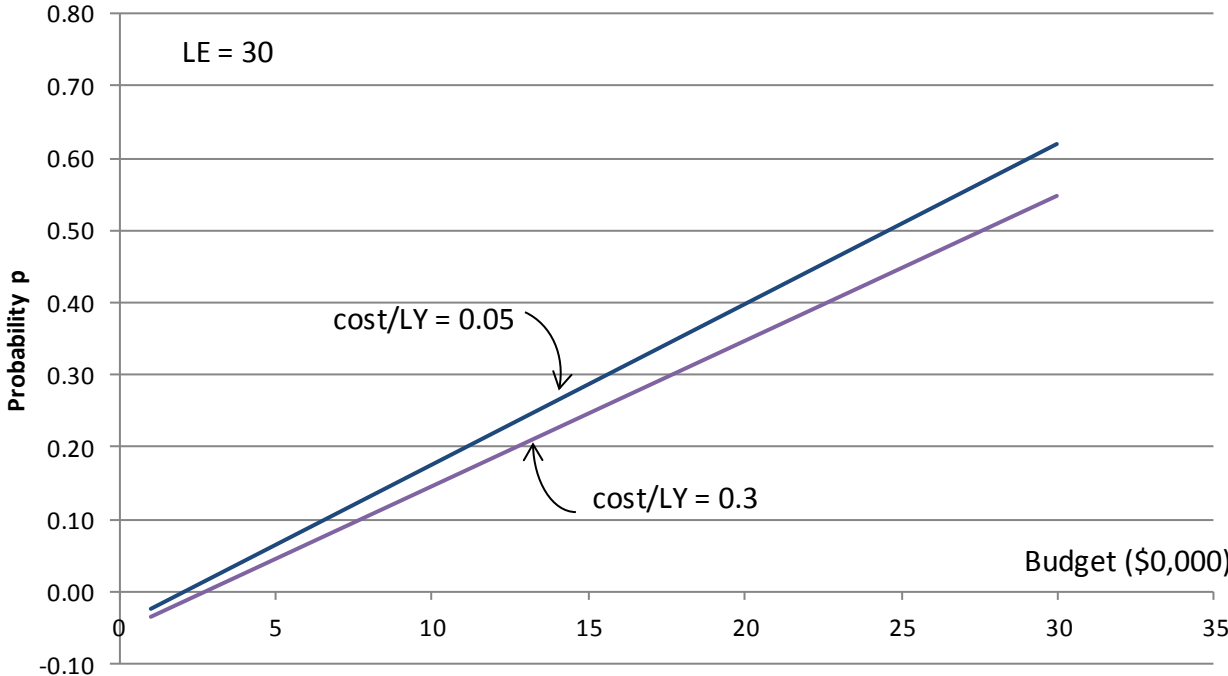
**Figure 5 Probability of incremental services with increasing life expectancy**



**Figure 6 Probability (p) of incremental service with increasing budget**

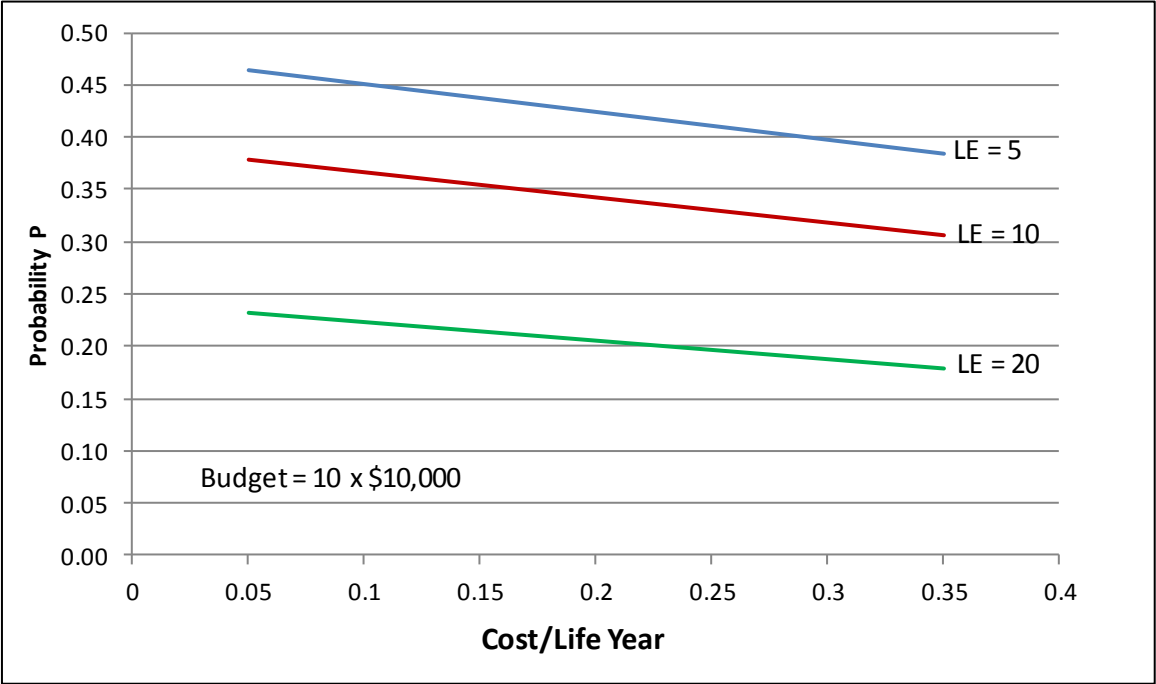


**6a Life expectancy of zero**

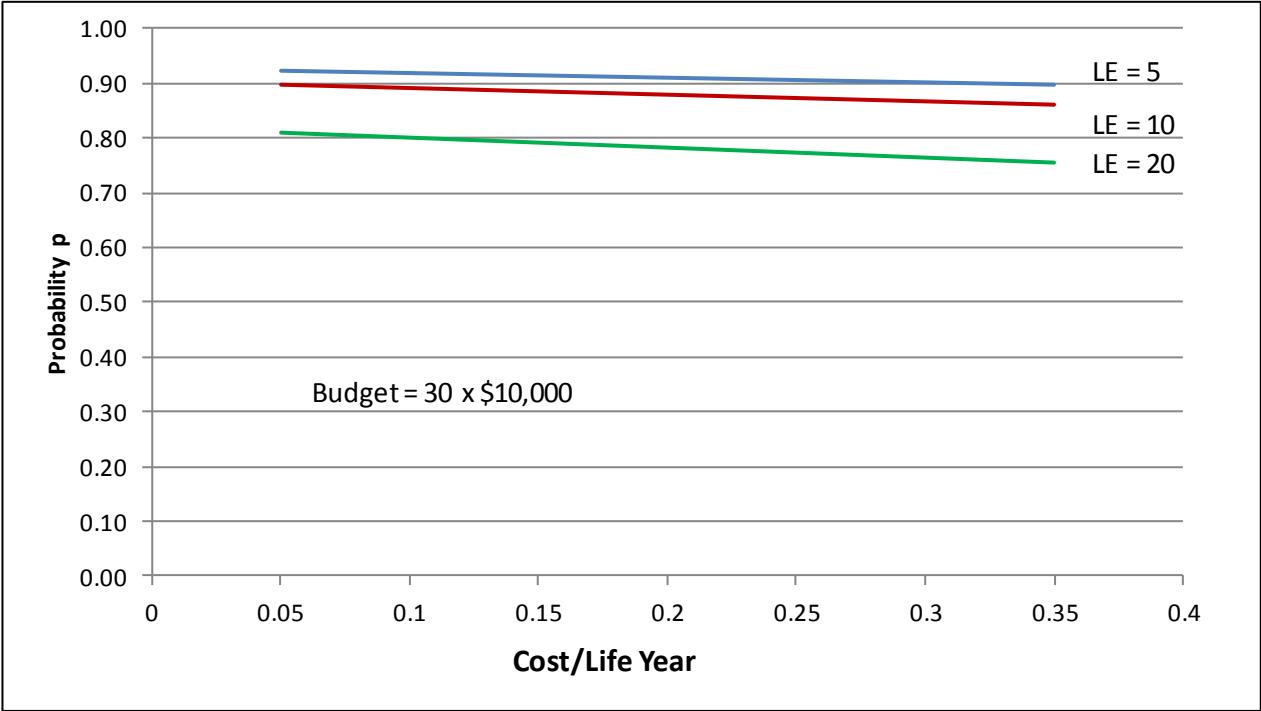


**6b Life expectancy of thirty**

**Figure 7 Probability of incremental service with decreasing cost per life year**



**7a Tenth income increment**



**7b Thirtieth income increment**

**Table 6 Logit results: split sample results. Dependent variable: received services = 1**

Equation Variable	Choices 2-10						Choices 11-30					
	1A		2A		3A		1B		2B		4B	
	b	z	b	z	b	z	b	z	b	z	b	z
Budget/10,000	1.20	(13.3)	1.64	(16.8)	1.63	(8.47)	1.23	(25.3)	1.81	(30.1)	1.98	(32.1)
Cost/LY	-4.71	(-10.7)	-6.30	(-13.5)	-6.35	(-13.5)	3.11	(10.96)	2.95	(10.1)	1.17	(3.78)
LE	-0.08	(-19.2)		-0.15	-0.14	(-11.0)	-0.07	(-25.4)	0.06	(9.03)	0.21	(22.1)
(LE) <sup>2</sup>			0.002	(11.5)	0.002	(6.39)			-0.003	(-20.8)	-0.006	(-33.0)
Rel LE					0.003	ns					-0.02	(6.03)
(Rel LE) <sup>2</sup>					0.001	(2.9)					-0.004	(30.5)
Constant			-0.04		-0.07		1.98		4.0		-5.7	
n	15,160		15,160		15,160		22,864		22,864		22,864	
LR chi 2	438		560		569		1766		2120		3433	
Log like	-8344		-8282		-8278		-13911		-12,792		-12,136	
Pseudo R <sup>2</sup>	0.025		0.03		0.033		0.06		0.07		0.12	

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Coefficients in Table 5 and equation 1 are based upon a wide range of values for each variable. Initially the life expectancies of patients are the same. Subsequently they may differ very substantially. For this reason the stability of the results was tested by splitting the sample after 10 iterations and creating two similar sized datasets. Regressions 1A, 2A, 4A and 1B, 2B, 4B in Table 6 report results from the first and second dataset respectively and include the same independent variables as regressions 1, 2, and 4 in Table 5.

Coefficient signs in Regressions 1A, 2A, 4A are consistent with the previous results. However the magnitude of the coefficients and their significance levels change. The coefficient on cost/LY increases by a factor of 4 in regression 1A and by a factor of 6 in regression 2A. The coefficient on life expectancy is stable but the t statistic falls in regression 1A from 34.8 to 19.2.

In contrast, in regressions 1B, 2B, 4B the sign on the cost variable changes from negative to positive: there is a greater probability of individuals receiving resources when their cost is higher. The perverse result is probably a 'catch up' effect. After 10 iterations inequalities have arisen favouring low cost patients, and resources are consequently given to these with a high cost in compensation. In contrast with the results from the previous data set, relative life expectancy (Rel LE) exerts an independent effect. Those with a lower Rel LE are significantly more likely to receive additional resources. The probable reason for the difference is that after 10 iterations, discrepancies in life expectations and relative life expectations have become more apparent and important.

Comparing the two split samples it is clear that the role of efficiency changes. Initially, when life expectancies are similar it plays a role *albeit* not the dominating role in respondents' choices. When life expectancies are very different, efficiency becomes unimportant and the full explanatory power of the analysis depends upon the fairness variables.

Using regression 1A from the first of the split datasets, increasing cost per life year by 200 percent, from its minimum to its maximum value, is offset by a 9.8 year reduction in life expectancy (with the budget at its mean value). For the full dataset (regression 1) a similar increase is offset by a 2.5 year reduction in life expectancy and, in the second split dataset, increasing cost per life year does not reduce the likelihood of a service.

## 4 Discussion

The importance of sharing has been convincingly demonstrated in other contexts by the two person 'Ultimatum game'. In this, the first person proposes a division of a sum of money between the two players and the second player accepts or rejects the division. Rejection results in both players receiving nothing and means that the second player selects a personal income loss. Despite this, the result observed over a very large number of populations is that 'unfair' sharing by the first player results in a rejection by the second (Beinhocker 2006). The strength of the result varies with context (Bicchieri and Zhang 2010). However as the content of the game always involves personal loss in the face of unfair sharing it is unsurprising that when there is no personal loss and only an impersonal allocation of resources that sharing should be of importance to individuals. The small number of relevant studies confirms that this is true in the context of health resources. The present study sought to quantify the importance of this sharing motive as a number of contextual variables changed.

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The major strength of the study design is that the benefit and the opportunity cost of choices and the extent of sharing are visible and clear. Contextual variables are easily changed. The edit procedures resulted in relatively few deletions and comments indicated that respondents found the exercise to be relatively clear and easy. Disease severity and patient characteristics are easily included in the design.

The web-based method for gathering data used in this study has the disadvantage of only selecting those who have enrolled for such an exercise and, consequently results in a self selected group. Self selection, however, is inevitable in social surveys and the web-based approach may obtain a representative profile which was obtained by age, gender and education. It is, further, highly implausible that people's allocation of resources to patients should systematically differ with their interest in completing web-based surveys.

The principle conclusion from the present study is that, even in the absence of other socially relevant characteristics, respondents preferred to share resources between patients rather than to maximise life years, and that this motivation was quantitatively dominating in decision making.

Sharing does not imply a random allocation but one with a more equal distribution of resources or outcomes than would occur with an exclusive focus upon efficiency. In the equity-efficiency trade-off which is usually envisaged, sharing is based upon some patient attribute – age, severity of illness, etc. The present study eliminated these attributes and retained a single unavoidable consequence of any allocation from a finite budget, namely, that the opportunity cost of a gain by one person is a foregone gain by another, both measured here by additional years of life.

Results sit uncomfortably with usual Welfare Theory. While the theory allows an equity-efficiency trade-off, the reason for equitable treatment is usually envisaged as being independent of allocative efficiency, and the final, optimal allocation lies somewhere on the efficiency frontier. In the present case the achievement of efficiency – allocating to particular individuals – creates inequity and the final optimal allocation is not on the frontier.

The question of why results differ from the predictions of Welfare Theory is beyond the scope of the paper as it draws upon the larger literature concerning the deficiencies of Welfare Theory (see, for example Rice (1998) Richardson and McKie (2007)). However one element in the model is of particular importance in the present context. This is the assumption that benefits can be redistributed to compensate losers. Consequently, maximising net present value – producing on the efficiency frontier – can potentially maximise social welfare as a redistribution can achieve Pareto improvement. Following Kaldor-Hicks, economists have accepted that a state should be considered superior to another if there is the potential for Pareto improvement. In this respect Welfare Theory treats health as if it were 'disembodied' like cars, TVs and other physical products and can be redistributed after production. However, health benefits are embodied in individuals and may not be redistributed in this way. Efficiency, defined by minimum cost per life year or QALY, cannot therefore be separated from equity and when these goals are simultaneously evaluated our respondents indicated that the latter was quantitatively most important.

Despite the limitations of Welfare Theory, the type of trade-off favoured by respondents is consistent with broader economic theory which commonly encounters conflicting, inextricable objectives. Individuals routinely trade-off benefits when their budget is fixed: less of one goal is achieved in order to obtain more of another. In the present case the same problem is encountered but the goals are equity and efficiency and the trade-off must be determined by social, not private, preferences. Historically these have been unequal partners, with the connotation of objectivity associated with the former and subjectivity with the latter. Possibly for



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this reason the quantification and inclusion of equity in economic evaluation studies has been neglected and evaluation in practice has become almost exclusively concerned with achieving efficiency (Richardson and McKie 2007). The connotation of subjectivity probably arises because equity, as a general concept, denotes something normative. However this does not prevent positive analyses into public preferences with respect to well defined objectives which may (or may not) correspond with the public's notion of fairness. In the present study, life expectancy, relative life expectancy and budget share are as precisely defined and as readily measured as cost per life year. Results indicate that life expectancy, but not budget share was an important objective for respondents.

The dominating importance of outcome egalitarianism found in the study suggests the need for a review of the criteria for selecting services and to the data collected for this task. Two approaches have been illustrated in the results section. The first is to replace the fixed funding threshold for a QALY with a threshold which is a function of the relevant variables. In the simple community of four patients used in the present study the logit results may be used to construct league tables where the threshold is determined, not by a fixed cost per QALY but by a 50 percent probability that an individual would be allocated a service. The present study included only life expectancy, relative life expectancy and budget share in the production of probabilities. Subsequent analysis may include variables reflecting other personal and medical characteristics of a service as determinants of the threshold.

The second approach draws upon the second analysis earlier which tracked the preferred allocation of life years as the budget increased. Generalising from this analysis, the health entitlement of an individual ('life expectancy' or 'Quality Adjusted Life Years') may be made a function of the variables found to be relevant to the entitlement ('cost per life year', relative life expectancy and the budget in the present study). In this approach the focus is upon the treatment of individual patients and their entitlement, rather than upon 'disembodied' costs and benefits of services which may or may not lead to an acceptable level of sharing. By focusing upon minimum acceptable treatment this approach is more aligned with current practice of medicine.

## 5 Conclusions

Maximising efficiency by minimising cost per QALY divides patients into two groups: those whose treatments are efficient and those whose treatments are inefficient. This raises a question of equity: is it fair to discriminate against those who are unlucky in having an illness where science has not found an efficient intervention? Results here and elsewhere indicate that people consider the issue to be important and would trade-off efficiency to mitigate the personal consequences of having an illness with a high treatment cost to effectiveness ratio.

The consistency and strength of the preferences reported here across different groups, including professional economists, suggests that our results should not be surprising. What is, perhaps, surprising is that such a quantitatively important part of people's preferences should have received so little attending in economics. The evidence presented here calls into question the efficiency focus of evaluation theory and practice in the health sector. Efficiently produced benefits cannot be 'disembodied' from individuals and re-distributed. When this was made explicit our respondent's preferences were dominated by the fairness of the distribution of services as measured by the equality of life expectancy. Considerations of efficiency were secondary.

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The results have significant implications for the practice of economic evaluation. They suggest that the population would be strongly opposed to the use of simple QALY league tables for the maximisation of health benefits and that they would be opposed to any formula which 'abandoned' patients because of the cost ineffectiveness of their treatment. The relative importance of efficiency and equity found in the study suggests that the primary focus of economic evaluation should not be the determination of efficient services, but the determination of the fair share of resources for patients. Incremental resources are likely to be shared according to a formula which includes economic efficiency but is dominated by other fairness related variables.

Present policy takes account of some of these considerations but in an ad hoc fashion. Evidence suggests that policy makers are more likely to fund high cost per QALY services when the probability of death is higher or there are no substitute services. This is despite an economic theory which is primarily concerned with efficiency and a practice which typically provides little information relevant to the fairness of decisions. Our study suggests the need for a reconsideration of the importance of the various dimensions of fairness both in theory and practice and that, especially in the context of a publicly funded health service, fairness and its measurement should be the central, not peripheral, concern of the evaluation framework.

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