# Exercise 9: Health opportunity costs and final health (post-decision)

**Revised April 2021**

**Preliminary Notes**

# The training exercise materials are available here: <https://www.york.ac.uk/che/research/equity/handbook/>

# There are three relevant spreadsheets: “Ex 9 – student”, “Ex 9 – student short”, and “Ex 9 – solution”. The full exercise in the student file usually takes more than an hour to complete, while the short version usually takes less than an hour. Please open the relevant version and go through the worksheets filling in the relevant cells yourself. You can look at the solution file if you get stuck.

# When the spreadsheet is first opened a ‘Security Warning’ may be displayed below the menu bar.  Select ‘Enable this content’.

# This exercise was produced for the Handbook of Distributional Cost-Effectiveness Analysis by James Love-Koh and edited by Richard Cookson, with help from James Lomas, Jessica Ochalek and Ole Norheim.

# Introduction to the Exercise

This exercise builds on information from two previous exercises: one on estimating the baseline distribution of health in England by social group (Exercise 7) and one on modelling the benefits and costs of nicotine replacement therapy policy options by social group (Exercise 8). This exercise calculates the distribution of health opportunity costs and draws this information together with information from the two previous exercises to predict the effect of each option on health inequalities in the general population.

The first stage involves estimating the distribution of health opportunity costs. Health opportunity costs are the expected losses experienced by patients elsewhere in the health system resulting from the funding allocated to the new intervention, expressed in terms of health. This requires two pieces of information: (i) the rate at which the financial costs are converted into health losses (sometimes referred to as the cost-effectiveness threshold) and (ii) the social characteristics of individuals who are expected to incur these losses. Health opportunity costs can then be combined with the health benefits estimated in the exercise from chapter 8 to estimate the ‘net’ health effect of the intervention.

The second stage is to model the net health change for each of our ten social subgroups onto the baseline distribution of health from the exercise from chapter 7. Doing this for each decision option creates several new post-intervention health distributions, which can then be compared to the baseline level. Changes in inequality are then evaluated using some simple inequality metrics.

## Getting started – short version

Open the file *‘Ex 9 – student short.xlsx’* and select the <Outputs> worksheet.

You will then start calculating the distribution of net health benefits for the three options. The distribution of health opportunity costs has been pre-calculated for you in the previous two sheets, <HOC Calcs> and <HOC Summary>. If you like, you can familiarise yourself with these calculations. The distribution of health opportunity costs is calculated in cells W45-W54 at the bottom of the <HOC Calcs> sheet.

Now skip to the section ***“Calculating the net health benefits”.***

## Getting started – full version

Open the file ‘*Ex 9 - student.xlsx*’ and select the <HOC Calcs> worksheet. You will start by calculating the distribution of opportunity cost.

The cells that require completing in this exercise are shaded yellow. The <HOC Calcs> sheet contains the two sets of inputs required to estimate the health opportunity cost distribution: the proportion of overall health opportunity cost attributable to each disease area and the secondary utilisation statistics for each social subgroup.

The distribution of opportunity cost by disease area is estimated from a study of the English NHS by Claxton and colleagues. They estimated the relationship between health care expenditure and health outcomes by 21 different disease areas (programme budgeting categories). This allowed them to estimate the change in expenditure associated with a HALY at the margin of £13,000. The proportions in cells B9:V9 are the relative contribution of each care programme to the overall health effect estimated in their study.

The objective of this stage is to use the utilisation (hospital inpatient episodes) data to determine utilised is distributed across social groups within each disease area. We can then combine this with the total health opportunity cost for each disease area, then sum across the latter:

1. Calculate the social distribution of hospital inpatient episodes for each disease area in cells B30:V30. For each disease area the proportion of utilisation for each subgroup $s$ equates to: $Prop\_{s}=\frac{Util\_{s}}{\sum\_{s}^{}Util\_{s}}$

*Hint: Use absolute cell row references for the denominators (i.e. A$1). This will allow you to drag down the formulae from cell B30 into the other columns and rows.*

1. Multiply each proportion by the values in cells C9:V9.
2. Calculate the social distribution of opportunity cost in cells W45:W54 by summing across disease areas.

The worksheet <HOC Summary> plots the distribution you have just calculated, along with the distributions from some selected disease areas. What do you notice about the distribution you have estimated? Which disease areas are most influential in terms of determining the overall distribution? Why?

### **Calculating net health benefits – start here for the short version**

Open the worksheet <Outputs>. This worksheet features tables summarising the outputs from the previous exercises: the health benefits and cost impacts of each NRT strategy, the health opportunity cost distribution and the baseline health for each social subgroup.

The distribution of health opportunity costs calculated in the <HOC Calcs> worksheet is reproduced in the “Estimated” column of the <Outputs> sheet and then copied across to the “Live” column. There is also a blank “User defined” column. Later on, you can try entering a different distribution of health opportunity costs in the “User defined” column to see what happens. But for the time being ignore the “User defined” option and use the “Live” column for calculating health opportunity costs.

Now open <Net Calcs>, which uses these data to calculate the incremental net health benefits of each strategy. The incremental effect of a strategy depends on the strategy employed at baseline. For this task, we will complete the two strategies involving the ‘proportional universal’ NRT coverage. The calculations are made for the distribution by 10 social subgroups (2 sources of inequality).

1. Calculate the incremental health benefits in cells C7:D16. This is can be calculated from the table in worksheet < Outputs>, cells J7:J16.
2. Do the same for incremental total costs in cells C17:D17.
3. We can now convert these costs into health opportunity costs in cells C18:D18 using an estimate of the marginal productivity of the health system (i.e. the cost-per-HALY of forgone alternatives). This value is set in cell C2 in the <Equity impact> worksheet, but can be called directly using the cell name “mprod”.
4. Now distribute the total health opportunity costs to the 10 social subgroups in cells H7:I16 based on the distribution you estimated earlier in the exercise (and is shown in the top graph of the <HOC Summary> worksheet). (Hint: Use the “Live” column in cells J7:J16 of the <Outputs> sheet – this will allow you to enter a “User defined” distribution later on, and see how the results change).
5. Calculate the net health benefits for each subgroup in cells M7:N16. These distributions are summarised in the graph on the <Net Fig> worksheet. What do you notice?

### Calculating the health inequality impact

The net health benefits and baseline health estimates can now be combined to create post-policy health distributions on the worksheet <Final Dist> in cells D32:F41 and D55:F64. The differential levels of health benefit may in some instances change the rankings of the subgroups in the health distribution. We therefore create a new ranked distribution before calculating inequality changes.

1. Feed through the net benefit estimates into cells D32:D41 and D55:D64
2. Calculate the per person net health benefit in cells in the adjacent column
3. Add this to the baseline health in cells in the next column
4. Use the VLOOKUP function to populate the ranked post-intervention distribution table starting in column N (for subgroups, population fraction and post-intervention HALE)
5. Re-calculate the fractional ranks in cells in column P

*Hint: Recall that the fractional rank is the mid-point of the fraction of a group in the cumulative distribution. If groups A,B & C have fractions of 0.2, 0.3 and 0.4, respectively, their fractional ranks are: A=0.2/2, B=0.2+0.3/2, C=0.2+0.3+0.4/2*

Use the information in the table you have just created to estimate inequality measures for the post-intervention distribution in the <Equity Impact> worksheet.

NB In the short version of the exercise you do not need to fill in SII and RII calculations shown in iii and iv below: just calculate absolute and relative gaps between top and bottom groups, as shown in i and ii. The SII and RII indices are just more sophisticated versions of the absolute and relative gaps. They are modelled gaps, rather than observed gaps. They use linear regression to allow for the slope of the gradient in between the top and bottom groups.

Use the following formulae for the measures:

1. The absolute gap: $G\_{A}=H\_{T}-H\_{B}$
2. The relative gap: $\frac{H\_{T}}{H\_{B}}-1$
3. The slope index of inequality: $SII=\frac{Cov(H,r)}{Var(r)}$

*Note: This comes from a simple regression of HALE (*$H$*) on fractional rank* *(*$r$*). Use the COVARIANCE.P and VAR.P functions in Excel.*

1. The relative index of inequality: $\frac{SII}{\overline{H}}$

*Note: The weighted average HALE* $\overline{H}$ *can be obtained using the SUMPRODUCT function*

We are now in a position to compare the change in our inequality measures from baseline. Cells F27:I30 are set up to report the equity benefit. Since equity benefit is the measure that is plotted on the equity impact plane, these cells should yield a positive value if inequality has been reduced. The equity benefit and total health impact are then jointly plotted on equity impact plane.

1. Calculate the equity benefit of switching from no NRT to a proportional universal strategy in cells F29:I29

*Hint: For the measures in this exercise, a reduction in health inequality will cause a negative change in the index.*

1. Calculate the equity benefit of switching from a universal strategy to a proportional universal strategy in cells F30:I30. Note here we have a different baseline!
2. Calculate the total net health benefit of the strategies in cell K29:K30 using the net health benefits table in the <Net Calcs> worksheet
3. The equity impact planes on this worksheet use the SII as the equity benefit metric. Given that the inequality change at the population level is likely to be small, the SII change is scaled up by a factor of 10,000 in cells L29:L30.
4. Compare the SII and the absolute gap results. Are they similar? Why? (Hint: the SII is a modelled gap, which allows for the slope of the gradient in between the top and bottom groups).
5. The table below shows the results for the 5-subgroup socioeconomic distribution. How do the inequality impacts compare?
6. For the 10-subgroup distribution, the equity and health benefits should be plotted on the two charts at the top of the worksheet. Take a moment to interpret these results and to reflect on the resulting trade-offs between equity and total health impact when comparing these policies.
7. Curious as to how your results would change if the distribution of health opportunity costs were different? You can input your own distribution in the “User defined” column comprising cells L7:L16 on the <Summary Outputs> worksheet (NB make sure that they add up to one).