**Instructions for equity trade-off practical**

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**Link to spreadsheets (first half of this practical on dominance analysis):** [**https://www.york.ac.uk/che/research/equity/economic\_evaluation/**](https://www.york.ac.uk/che/research/equity/economic_evaluation/)

**Link to web-based tool (second half of this practical on social welfare functions):** [**https://shiny.york.ac.uk/dcea/**](https://shiny.york.ac.uk/dcea/)

**Note on spreadsheets**

1. There are two spreadsheets: “MSc Workshop Feb 2019 – student file” and “MSc Workshop Feb 2019 – solution file”. Please open the “student file” to start with and go through the worksheets filling in the relevant cells yourself. You can look at the solution file if you get stuck.
2. When the spreadsheet is first opened a ‘Security Warning’ may be displayed below the menu bar.  Select ‘Enable this content’.

**Introduction**

The objective of this practical is to learn how to evaluate distributions of lifetime health. The first half of the practical is a spreadsheet exercise on dominance analysis, and the second half is a web-based exercise on social welfare functions.

Both exercises are based on the illustrative example of Nicotine Replacement Therapy in England. Nicotine replacement therapy (NRT) to help people stop smoking or chewing tobacco is a classic example of a preventive healthcare intervention aimed at improving health and reducing health inequality. You are asked to imagine that the UK government is considering three national policy options for NRT in England:

1. No Public NRT: do not provide any public subsidy for nicotine replacement therapy
2. Universal NRT: offer free nicotine replacement therapy to all smokers
3. Proportional Universal NRT: Universal NRT with additional resources to encourage uptake in disadvantaged communities

We have calculated the distributions of lifetime health resulting from these three options. Your task is to evaluate which of these three distributions is best taking into account both efficiency in terms of sum total health and equity in the distribution of health.

**Part One: Spreadsheet Exercise on Dominance Analysis**

Open ‘MSc Workshop Feb 2019 – student.xlsx’ and select the <PD> worksheet.

You must complete the green cells.

Table 1 presents the distributions of individual average health-adjusted life expectancy (HALE) resulting from each of the three policy options – i.e. 1: No NRT, 2. Universal NRT and 3. Proportional Universal NRT. Each distribution is broken down by five socioeconomic groups, ranked from most deprived (1) to least deprived (5) fifths of the English population.

Figure 1 presents those distributions in a graph. The differences are too small to be seen in this graph, so we zoom in more closely on those differences in Figure 2. To get a better feel for the population level policy impacts, we also move from the level of individual average HALE to the level of population level total HALYs, by multiplying by population size.

*Pareto dominance (PD)*

Group-level Pareto dominance exists when, as the expected consequence of a decision, at least one group is better off and none are worse off.

i. Complete the green cells to fill in Figure 2, a bar chart that shows incremental differences in population total HALYs for policies 2 and 3 compared with policy 1 (No NRT).

ii. Compare each of the policies in terms of group-level Pareto dominance (i.e. whether the policy is better for at least one group and not worse for the others).

The Pareto principle indicates higher social welfare under policies 2 & 3 compared to policy 1, but 2 and 3 cannot be ranked. 3 performs better than 2 among the lowest two SES quintile groups but worse among the higher ones.

*First order stochastic dominance (FOSD)*

Open the <FOSD> worksheet.

First order stochastic dominance extends the Pareto principle by adding the anonymity principle that identity does not matter, only consequences. We can thus re-rank the groups in order of health before comparing the distributions of health consequences.

We also extend the analysis to look at North-South differences as well as socioeconomic differences. Table 1 gives distributions of health-adjusted life expectancy (HALE) at birth for the 10 groups (5 SES groups for both North and South England). Column 1 corresponds to the baseline distribution without public NRT, column 2 to the simulated distribution under universal NRT and column 3 to the simulated scenario of proportional universal NRT.

To establish whether there is (inverse) FOSD:

1. Rank the distributions in columns HALE 1, 2 & 3 of Table 1 from low HALE to high HALE. You should confirm that all three policies lead to the same ranking of groups.

*Hint: in cell C3, =RANK(E3,E$3:E$12,1)) change Es to Fs and copy down. Then check if the ranks change.*

1. Complete Table 2, which shows the cumulative distribution functions for all three policies against fractional rank (i.e. ranked cumulative population shares).

*Hint: the fractional rank is obtained by calculating the cumulative share of the 10 groups (from column group size in Table 1).*

*Hint: Use the VLOOKUP(…;…;…) command.*

1. Look at Figure 1, which shows cumulative distribution functions using a scatter diagram (HALE on the X axis, and fractional health rank on the Y axis).
2. Look at Figure 2, which shows the inverse cumulative distribution functions, for consistency with tests of generalized Lorenz dominance in subsequent worksheets (fractional health rank on the X axis, and HALE on the Y axis).
3. Because individual level differences are small, we cannot see where the inverse cumulative distributions cross. Therefore, we also plot the difference between the inverse cumulative distributions of HALE 3 vs HALE 1 and HALE 2 vs HALE 1 against the fractional health rank in Figure 3.
4. There is inverse First Order Stochastic Dominance of HALE 2 and HALE 3 over HALE 1 (the inverse cumulative distribution functions lie above HALE 1 at all ranks), but the inverse cumulative distribution functions of HALE 2 and HALE 3 cross. This means that the Pareto principle combined with the anonymity principle suffices to assign the lowest level of social welfare to HALE 1, but that HALE 2 and 3 cannot be ranked by this criterion alone.

*Hint: HALE 1 could never FOSD HALE 2 & HALE 3 because mean HALE is lower under scenario 1.*

1. See Table 3 for a summary of this information.

*Hint: the additional calculations required for Table 3 are provided in Table 4.*

*Lorenz dominance (LD)*

Select the <LD> worksheet.

To establish a welfare ordering of HALE 2 versus HALE 3, we need to impose additional normative principles. We will examine whether the principle of health transfers (and transitivity of social preferences) by itself suffices to achieve this. According to the health transfers principle, a hypothetical transfer of health from healthier to less healthy people ought to lead to a more equal health outcome. This is a central axiom of all inequality indices, and in the income inequality literature is known as the Pigou-Dalton principle. This also means that, for now, we neglect that HALE 2 has a higher mean than HALE 3 (i.e. we assign no normative significance to this difference). Another way to think about this assumption is that one is only concerned about (relative) inequality, which boils down to testing for Lorenz dominance.

1. Complete the line of equality column, which represents with the case where every group has the same HALE.

*Hint: the line of equality traces the fractional rank against itself. The fractional rank is derived from worksheet <FOSD>*

1. Construct the Lorenz coordinates. These are obtained as the cumulative shares of the three HALE distributions in table 2 of worksheet <FOSD>.

*Hint: Calculate population shares to facilitate the calculation of the cumulative shares.*

1. Look at the Lorenz curves in Figure 1 (cumulative share on Y axis and fractional rank on X axis).
2. To see where the Lorenz curves cross, look at Figure 2 which shows the differences from the Lorenz curve for HALE 1.

*Hint: We consider the differences from HALE 1 because the differences between policies are too small to see in Figure 1.*

1. We find that relative inequality is lowest in HALE 3 and highest in HALE 1, while HALE 2 is in between. This ranking is achieved by imposing the principle of health transfers and assuming that differences in the means are irrelevant. The latter is obviously a strong assumption.
2. The same information is provided in Table 2.

*Generalized Lorenz dominance (GLD)*

Select the <GLD> worksheet.

While the principle of health transfers suffices to rank HALE 2 and HALE 3 by relative inequality, it does not account for the differences in means and therefore does not establish a social welfare ordering. This can potentially be obtained by checking for generalized Lorenz dominance.

1. In Table 1, derive the generalized Lorenz coordinates. The fractional rank is obtained from worksheet <FOSD> and the generalized Lorenz coordinates are obtained as the cumulative means of the three HALE distributions in Table 2 of that worksheet.

*Hint: Calculate population shares to facilitate the calculation of the cumulative means.*

1. Graph the GL curves (cumulative mean on Y axis and fractional rank on X axis).
2. To see whether curves cross, plot the difference between the GL curve of a simulated policy and that in the baseline.
3. The generalized Lorenz curves of HALE 2 and HALE 3 cross, indicating that the principle of health transfers (& transitivity) does not suffice to order these distributions in terms of welfare.

*Hint: note that, due to the principle of health transfers, the crossing of the curves occurs at a higher fractional rank than occurred with the cumulative distributions (compare with Figure 3 in worksheet <FOSD>).*

1. See Table 2 for a summary of this information.

*Optional extra exercise on second order generalized Lorenz dominance*

Select the <SOGLD> worksheet.

While the principle of health transfers is sufficient to order the three policies in terms of the relative inequality generated, it was insufficient to establish a welfare ordering of HALE 2 and HALE 3. We now examine whether imposing downside positional transfer sensitivity (DPTS) suffices to achieve this by checking for second order generalized Lorenz dominance.

1. In Table 1, derive the SOGL coordinates, which are the cumulative means of the GL coordinates in Table 1 of worksheet <GLD>.
2. Graph the SOGL curves and check for SOGLD.
3. To see whether curves cross, look at Figure 2 which plots the difference between the second-order GL curve and that of the baseline distribution.
4. HALE 3 second-order generalized Lorenz dominates HALE 2.
5. See Table 2 for a summary of this information.

If SOGLD were not established, one could proceed to check generalized Lorenz dominance at higher orders.

**Part Two: Web-based exercise on social welfare functions**

Open the web-based tool at this website: [**https://shiny.york.ac.uk/dcea/**](https://shiny.york.ac.uk/dcea/)

Click on “Evaluate using social welfare functions”.

**Atkinson social welfare function**

Look at the graph entitled “Equity weighted NHB compared with No NRT”. This “Atkinson EDE plot” compares social welfare under the three policies using the Atkinson social welfare function with different levels of concern for reducing health inequality (“inequity aversion”). Social welfare is measured in units of “Equitably Distributed Equivalent Health” (EDEH) that are comparable with population total HALYs.

1. At what level of inequity aversion do the two lines cross, such that Proportional Universal NRT has higher EDEH than Universal NRT? What does this mean?
2. Try changing the baseline decision to “Universal NRT”. (Select this in the left hand panel). How and why do the lines change?

Now click on “Equity impact plane”.

1. Try setting the inequity aversion parameter to zero, by moving the slider. What do the results mean? (*Hint: This corresponds to a standard CEA, which focuses only on efficiency in improving total health without concern for reducing health inequality).*
2. Now try gradually increasing the inequity aversion parameter by moving the slider. What happens to the points? Why?
3. Try changing the baseline decision to “Universal NRT”. At what level of inequity aversion does the “Proportional Universal” become clearly better than “Universal NRT”?

**Extended Gini social welfare function**

Now do the same thing using the Extended Gini welfare function – i.e. look at the “Gini EDE plot” and then return to the “Equity impact plane” and select the Extended Gini function.

**Optional extra exercise involving 3 fictional individuals**

Load up a new set of fictional policy options into the website. First go back to this website and download the CSV file entitled “Three individuals.csv”.

[**https://www.york.ac.uk/che/research/equity/economic\_evaluation/**](https://www.york.ac.uk/che/research/equity/economic_evaluation/)

Then in the left-hand panel of the web-based tool, under “Choose CSV file”, upload this CSV file. To understand the data, first look at the “raw input data” tab. You will see six hypothetical distributions of lifetime HALY outcomes for three individuals, under six different policy options A to F. Now repeat the analysis above for this fictional example, starting with the Atkinson EDE plot. Notice, for example, that option C Pareto dominates option A, even though it is more unequal and lies in the North-West “win-lose” quadrant of the equity impact plane.