Written Reexam for the M.Sc. in Economics winter 2015-16

**Health Economics**

Final Reexam

February 15, 2016

(3-hour closed book exam)

# Suggested Solution

# Part I: Public Health and the Mortality Decline

**Question 1.1:** Briefly explain the most prominent theories of why mortality started to decline in Western countries in the late 19th century.

**Answer (**from slides distributed in class)**:**

1. *Improved Nutrition:* The argument in a nutshell:

- – mortality started to decline before the advent of medicine
  - – for example, TB started to fall in the US before antibiotics were invented (McKeow, 1976)
  - – economic growth (and thus nutrition growth) starts in the 18th century
  - – income↑⇒ nutrition↑⇒ health↑

2. *Public health:* One can argue that the Germ Theory ultimately paved the way for major public-health investments

- – The Bacterial Revolution of the 1870's, involved the discovery that sub-microscopic organisms were the main cause for disease (Louis Pasteur, Robert Koch, ...) ⇒ germ theory of disease
  - – In the 1850s, John Snow already demonstrated that cholera was water-borne and that its spread could be halted by uncontaminated water supplies
  - – first DD analysis: compared cholera fatalities between households supplied by two different water companies, one of which was recycling human waste, and one of which was not
  - – Major public-health starts in the US in the late 19th century; clean water etc.
  - – The first clean-water hist. of DK: Odense in 1853 and CPH 1859 (after a severe cholera outbreak in 1853)
  - – Therefore, it's very likely that public health played a role in the initial mortality decline

3. *Modern Medicine:* While the method of vaccination was discovered in 1796, the modern medicine era is typically dated to the 1940s. So, this seems to be unlikely explaination of why mortality started to decline in the late 19th century.

**Question 1.2:** What is the principal idea behind the proposed estimation equation?

**Answer:** The idea is to compare the development TB mortality before and after the opening of a dispensary in a given city, which is basically differences-in-differences estimation, in a similar way as in the paper by Cutler and Miller (2005), who study the health implication of introducing clean water into American cities. If the dispensaries indeed lowered TB mortality we should find that $\hat{\beta} < 0$.

**Question 1.3:** Explain how and why estimates of $\beta$ are likely be biased, along with possible solutions in the form of robustness tests.

**Answer:** The main issue is that the adoption (i.e., an opening) of a dispensary might be endogenous (remember, the cities do not adopt them at the same date). For example, a city might choose to open a dispensary because of an unusual high level of TB mortality. This would bias $\beta$ towards zero. On the other hand, it might be that the estimate of $\beta$ is contaminated by a secular decline in TB, which means that $\hat{\beta}$ overestimates the effect of a dispensary on TB mortality.

One way of testing for pretrends would be - as in Cutler and Miller (2005) - to include leads of the intervention (i.e., $Dispensary_{ct+1}$, $Dispensary_{ct+2}$, ...). If we are not capturing any pretrends, the estimates on the leads should come out statistically insignificant and close to zero.

**Question 1.4:** Assume that data on other causes of death has been collected as well. These are: cancer, influenza, pneumonia, and accidents. How could one exploit these data to test the validity of the proposed research design? Explain/discuss.

**Answer:** If the principal idea of the TB dispensaries was to reduce the spread of TB (and, therefore, TB mortality), as suggested in the introduction, we should find much smaller (or no) effects on cancer, influenza, pneumonia, and accidents. Thus, one could:

1) Exploit these cause-of-deaths as placebo tests in equation (1) by regressing them on $Dispensary_{ct}$ along with the fixed effects.

2) Setup a triple-differences model:

$$M_{ctd} = \beta \; Dispensary_{ct} \times Prevent_d + \phi_{ct} + \lambda_{dt} + \mu_{dc} + \varepsilon_{ctd},$$

where the disease data have been stacked, so that $M_{ctd}$ is the mortality rate of disease $d$ in city $c$ at year $t$, $Dispensary_{c,t}$ is the same indicator as above but is now interacted with $Prevent_d$, indicating whether cause-of-death $d$ was prevented (i.e., treated) by the dispensary, which, we should assume, was only the case of TB. The $\phi_{ct}$'s are city-by-year fixed effects, the $\lambda_{dt}$'s are disease-by-year fixed effects, $\mu_{dc}$ are disease-by-city fixed effects, and $\varepsilon_{ctd}$ is the error term.

(*notice, in order to obtain the maximum points for this question, mentioning and explaining 1) - the placebo test - is sufficient; that is, we do not expect that the students are able to explain the triple-differences setup)*

**Question 1.5:** Assume that the TB dispensaries in fact had a significant negative impact on TB mortality in Denmark (i.e., $\hat{\beta} < 0$). In relation to the literature on health, productivity, and economic growth, discuss how this might have influenced the economic development of Denmark—as measured by human capital and income—both in the short and long run.

**Answer:** In class, we have been reading different papers on how health improvements influence income and economic development. For example, in the cross-country study by Acemoglu and Johnson (2007), it is shown that the eradication of a number diseases (including TB) - due to modern medicine - caused an increase in population size, but actually had a negative effect on income per capita. This evidence could suggest that the TB dispensaries had a negative impact on income in Denmark.

On the other hand, it's also questionable that Acemoglu and Johnson's results are useful in a Danish context, as their evidence primarily relies on developing countries in the 1940s onwards. Moreover, other within-country studies, such as Bleakley (2007), has show positive effects of the eradication of hookworm on education and income.

## Part II Economics of Health Innovation

For many years two pharmaceutical companies were the only producers of medication that could treat a fatal disease. If treated, the life expectancy would increase, but at a low quality level of the remaining life. With no treatment people would die within a month, with no quality of the remaining life. For the price of 150000 UK pounds the first company could provide a treatment gaining five quality adjusted life years (QALYs). The second firm supplied medication that gained 3 QALYs at the price 50000 UK pounds. After a number of years new medical products entered the market, and today the products in table 1 (including prices that are the same across the world and the QALY characteristics) are available:

**Table 1 The current market**

| Treatment | Price (UK £) | QALY |
|---|---|---|
| A | 0 | 0 |
| B | 25000 | 2 |
| C | 15000 | 2,5 |
| D | 100000 | 5 |
| E | 125000 | 6 |
| F | 50000 | 3 |
| G | 50000 | 5 |
| H | 150000 | 5 |

**Question 2.1**

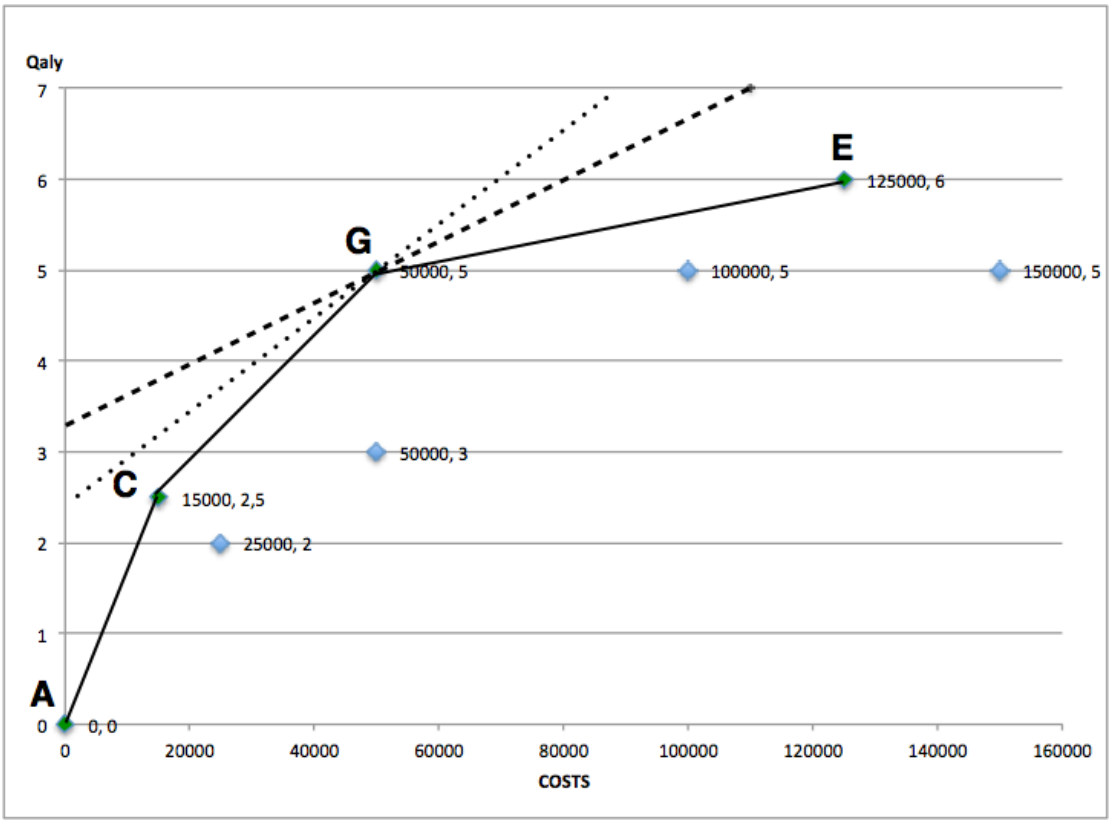
In the current market situation, which products are potentially cost-effective? Which product is offered within National Health Services (NHS) in UK and MediCare (health insurance for people aged 65+) in US respectively? Explain your results.

***Answer:***

*Products A, C, G and E are the potential cost effective products. They all lie on the cost effective frontier (CEF) sketched with the solid black line in figure 1. All other products are dominated by at least one of the products on the CEF. The slopes on the CEF reflects the incremental cost effectiveness ratio (ICER) between the products on the CEF.*

*In UK patients will be offered treatment G. In the UK NHS is using health tehchnology assessments (carried out by NICE) to choose which products to offer sick patients. NICE is generally considering a product cost effective if the ICER is below £20000, and there should be strong reasons to endorse more expensive treatments with ICERs greater than £30000. These threshold values can be interpreted as indifference curves in figure 1. The £20000 is illustrated by the dotted line. The £30000 is illustrated by the dashed line. NHS will choose to offer the treatment at which the indifference curve is tangent to the CEF. That is the case for product G, regardless of which threshold value that is taken into account.*

*Within MediCare in the US it is forbidden to reject products on the basis of HTAs. Hence, elderly Americans with the given disease could expect to be offered product E, because it has the highest QALY (even the ICER of E compared to G is £75,000).*




**Question 2.2**

The pharmaceutical company that produces product H gets a research breakthrough. The price of the product is reduced by £25000, while the QALY increases to impressively 11. To meet this competition the producer of product E reduces it price per treatment by £45000. Simultaneously, the producer of treatment D realizes that doubling the amount of the active drug in their pills also doubles its effect on QALYs. They launch this new drug, and to make it competitive, they even lower its price by £10000 compared to their old product.

Which drugs are now offered within NHS in UK and MediCare in US respectively? Explain your results.

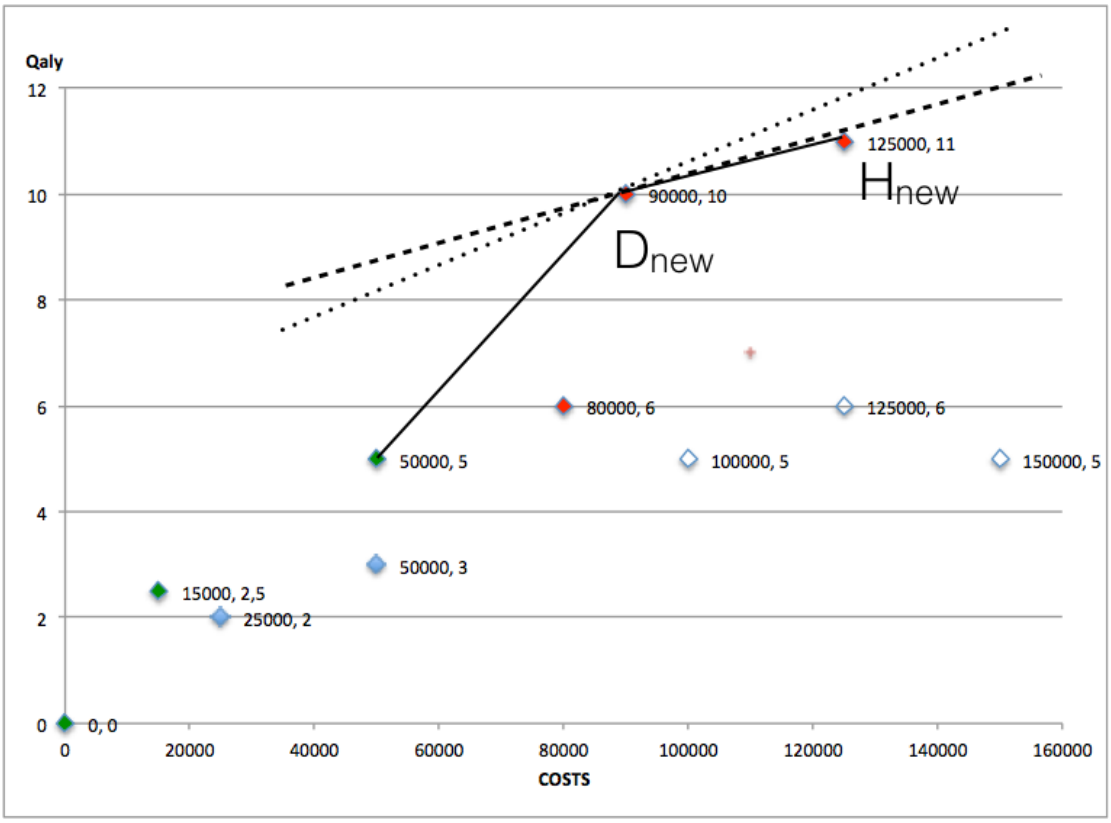
***Answer:***

*The UK chooses the new product E. Medicare chooses product H.*

*The new products have the following characteristics.*

| Treatment | Price | QALY |
|---|---|---|
| H new | 125000 | 11 |
| D new | 90000 | 10 |
| E new | 80000 | 6 |

*All products are plotted figure 2. The indifference curves of NICE in this new market is tangent to the CEF in product "D new", and hence, chooses that product. Medicare goes for the more expensive product "H new", because it yields more QALYs.*




**Question 2.3**
How are QALYs typically measured and how could such measurements affect the analysis of question 2.1?

***Answer:***
*QALYs are usually measured using one of three of the following survey methods:*

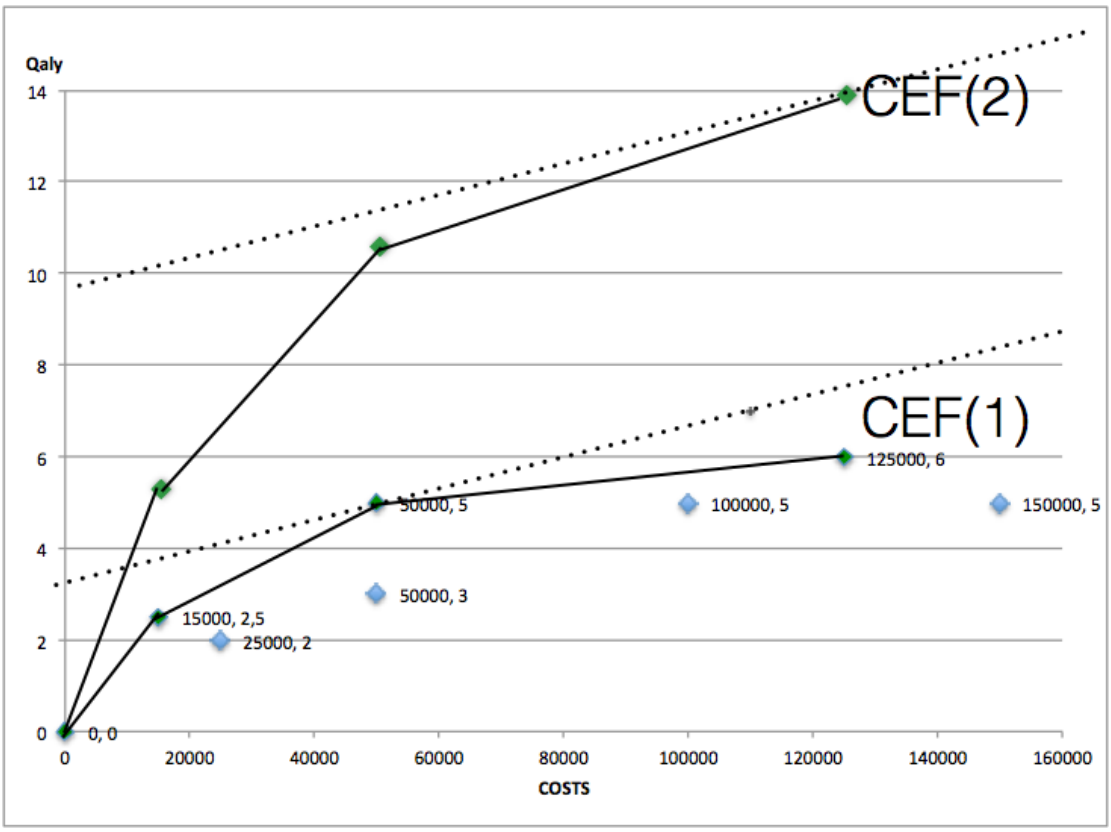
*Visual Analogue scale (VAS):*
*Respondents are asked to rate health outcomes on a scale between 0 and 100.*

*Standard Gamble (SG):*
*For any health condition H, questionnaire respondents choose between having H with certainty or the probability p of having full health and (1-p) of death. The p at which people are indifferent captures the QALY.*

*Time Trade-offs (TTO):*
*For any health condition H, questionnaire respondents choose between having x years of condition H before dying or fewer years of full health before dying.*

*While VAS is easy for respondents to comprehend, it is criticized for not inferring a trade-offs for the respondents. However, while SG and TTO in that regard seems more compelling, the assessments may be biased by risk preferences and time discounting (patience) parameters.*
*Furthermore, it is not trivial to decide on who are the relevant respondents: e.g., diseased individuals, relatives or random people in the population.*

*In standard gambles the same diseases are typically assessed worse than, say, visual analogue scales. For instance, depression and blindness is rated twice as bad. Hence, the assessments of the benefits of drugs are subject to how they are measured. Given that institutions like NICE uses a more or less fixed threshold for assessing whether to offer the product or not, the measurement of the QALY becomes crucial for whether a specific drug is offered.*
*Such situation is plotted in the figure below. CEF(1) plots the CEF of assignment 2.1, while CEF(2) has used another measure of the QALY that has used an alternative QALY that assesses the pain and annoyances of a given health outcome less. Given that the threshold value for whether an institutions such as NICE accepts a drug, the measurement method of the QALY becomes pivotal for which drug that is chosen.*



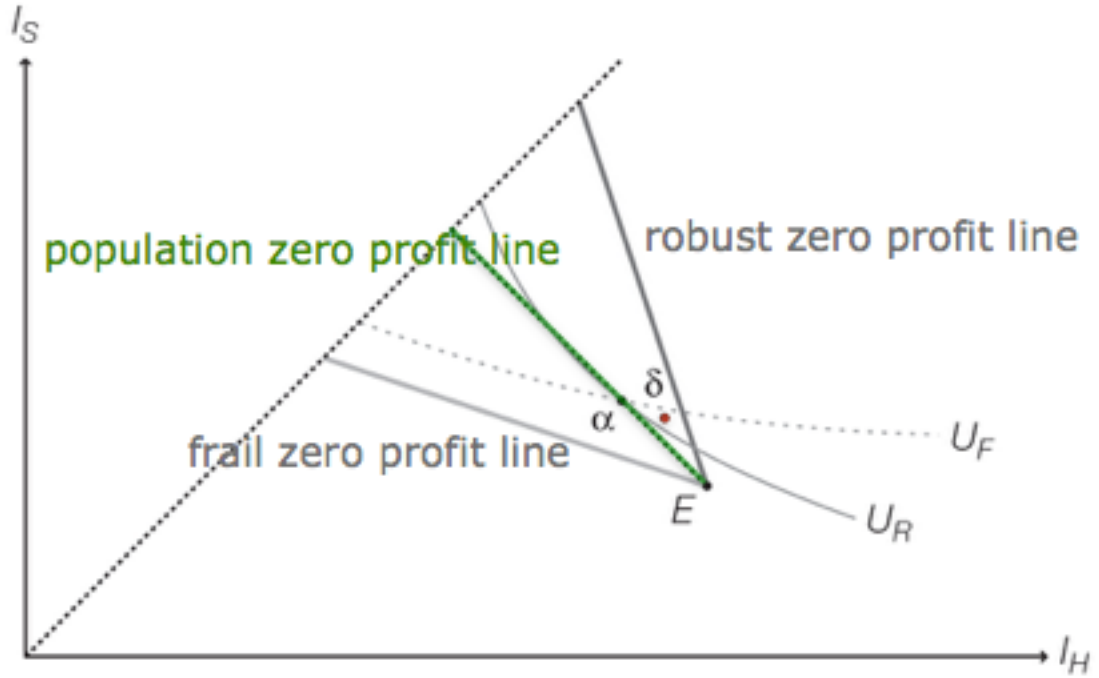

## Part III Information Economics:

**Question 3.1**
What is the "adverse selection death spiral"? Explain the theoretical foundations for why it may appear and illustrate it graphically.

*Answer:*
*The adverse selection death spiral arises when frail and robust individuals are pooled together. Adverse selection arises due to asymmetric information (health information is private). The premium is the average costs of people in the pool. Frail individuals are hence indirectly subsidized by the robust. The healthier individuals are consequently exiting the pool. This cycle repeats: the premium is readjusted and the*

*healthier types again leave the pool. When the cycle have repeated itself enough times, the market unravels.*

*The adverse selection death spiral can graphically be visualized in the $I_s$-$I_h$ space, within the Rothschild Stiglitz framework of adverse selection. The figure plots the zero profit lines for the robust and frail individuals as well as the population (the student may explain why the robust individuals' zero profit line is steeper than the frail ). Given average costs determines the premium (due to asymmetric information), the contract must lie on (green) population zero profit line.*
*A contract, alpha, is offered. However, another firm could offer contract delta, which would attract robust individuals leaving the frail in alpha, which breaches the equilibrium for a pooled contract (the student may explain why the indifference curves for the robust are steeper than the frail individuals' indiff. curves.). This pattern repeats: a contract closer to the endowment point E is offered. But again, a contract like, delta, could be offered. This is the adverse selection death spiral, because the market eventually unravels (the classic result that no pooling equilibrium can exist).*




**Question 3.2**
Discuss empirical evidence of an adverse selection death spiral in real markets and the reasons why it may not occur.

*Answer: Cutler and Zeckhauser, 1998, tested the adverse selection death spiral in a health insurance plan for Harvard University staff in the mid-1990's. The insurance plan consisted of two elements: a zero premium Health Maintaince Organization (HMO) plan with low costs and quality and an optional higher costs and quality Prefered Provider Organization (PPO) plan with additional premiums to enroll. The University faced heavy budget cuts. Cutting subsidies for the PPO option financed the budget cuts and the authors investigate characteristics of the PPO stayers and leavers. As the cuts took effect, the premiums increased and the enrollment fell. The stayers were more likely to be old and more costly. Premiums*

*rose annually, and every year more and more robust individuals left the PPO option. This is evidence for the existence of an Adverse Selection Death Spiral in a real market.*

*There are, however, a number of reasons for why a death spiral may not occur, or completely unravels the market: costumers may misperceive their own risks or do not act on their private information. Insurers can accurately observe costumers risks (hence, no asymmetric information). Finally, Advantageous selection may be present in the market, ie., those wither lower risks are in fact also more risk averse. Advantageous selection comes to the reverse result than adverse selection.*