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

Health Economics

Final Exam

December 22, 2015

(3-hour closed book exam)

Suggested answers

Please note that the language used in your exam paper must correspond to the language of the title for which you registered during exam registration. I.e. if you registered for the English title of the course, you must write your exam paper in English. Likewise, if you registered for the Danish title of the course or if you registered for the English title which was followed by "eksamen på dansk" in brackets, you must write your exam paper in Danish.

SOLUTION SKETCH:
Part I: Health and Productivity

Introduction: Iron deficiency reduces productive capacity in adults and impairs cognitive development in children below the age of 5. In 1943, the United States government required nationwide fortification of bread with iron to reduce iron deficiency in the US working age population. A number of surveys prior to 1943 revealed that the prevalence of low iron consumption varied markedly across geographic areas in the US.

Question 1.1: From a health-theoretical perspective, explain why simple correlations of health (e.g., iron consumption) and economic outcomes (e.g., earnings) are unlikely to measure the causal effect of iron consumption on earnings.

Answer: *The main purpose here is to explain why, from a theoretical viewpoint, that health is endogenous; i.e., health status is (in theory) a function of economic outcomes, such as earnings, which makes it relatively hard to empirically quantify the effect of health on economic outcomes. During the first part of the course, we have been discussing the so-called Grossman model, which suggests that health is in fact a function of earnings. A comprehensive solution (briefly) elaborates on the very basic elements of the Grossman model and notes that an increase in the wage rate (i.e.,* w *in the Grossman model) has an ambiguous effect on health status, as it raises the price on healthy activities.*

In order to quantify the contemporaneous productive effects of the national fortification program, the following estimation equation is proposed:

$$Y_{its} = \beta \left(Iron_s \times Post_t \right) + \delta_t + \delta_s + X_{its}\Gamma + \varepsilon_{its}, \tag{1}$$

where i indexes individual, s indexes state, and t indexes time periods, which are 1930, 1940, 1950, and 1960. The outcome variable, Y_{its}, is the average annual wage income of individual i

living in state s at time period t, $Iron_s$ denotes the pre-intervention average iron consumption in state s, $Post_t$ is an indicator equal to one if $t > 1943$, the δ_t are time-period dummies, the δ_s are state fixed effects, X_{its} is some vector of individual-level controls, and ε_{its} is the error term.

Question 1.2: (i) Explain the principal idea behind the proposed estimation equation. (ii) If iron deficiency indeed impairs productivity, should the estimate of β then be positive or negative? Explain.

Answer:

(i) This is difference-in-difference design with treatment measured continuously by average pre-intervention iron consumption in a given area (i.e., state). The basic idea is to compare economic outcomes before/after the intervention (i.e., the national fortification program) between individuals in states with lower levels of iron consumption ($\sim$"treatment") and individuals in states with higher levels of iron consumption ($\sim$"control"). Thus, we expect that areas with low pre-intervention levels of iron consumption benefited more from the national fortification program. Since we don't get to observe whether people actually consume more of the fortified bread, this is also an intention-to-treat design (ITT). The logic of this particular empirical strategy follows closely the designs in studies such as Bleakley (2007), Acemoglu and Johnson (2007), Feyrer et al. (2012), and Bhalotra and Venk. (2015).

*(ii) If Iron deficiency indeed reduces productive capacity in adults, we should find that $\hat{\beta} < 0$, as this would imply that areas with **lower** levels of iron consumption prior to the program experienced greater increases in earnings afterwards.*

Question 1.3: Outline different robustness tests which can be used to check the credibility of the proposed identification strategy, while discussing potential threats to identification related to, for example, other health improvements of the 1940s.

Answer: *The most important check is an indirect test of the identifying assumption (i.e., the considered areas would have experienced similar earnings changes in the absence of the* *fortification program) of common pre-trends in earnings. One way of checking this is to estimate the following model:*

$$Y_{its} = \sum_{k=1930}^{1970} \beta_k \left(Iron_s \times year_t^k \right) + \delta_s + \delta_s + X_{its}\Gamma + \varepsilon_{its},$$

where the indicator $Post_t$ has been replaced with a full set of year fixed effects, $\sum_{k=1930}^{1970} year_t^k$, and the omitted year of comparison is, e.g., 1940. This means that we should compare the $\hat{\beta}_k^{'}s$ to 1940. If we find $\hat{\beta}_{1930} \approx 0$ and $\hat{\beta}_{1950}, .., \hat{\beta}_{1970} < 0$ that would support the common pre-trend assumption as well as showing that areas with lower levels of iron consumption prior to the program experienced greater increases in earnings afterwards. As alternative checks, with the purpose of investigating potential mean reversion, we could 1) control for the initial level of the outcome (i.e., earnings in 1940) interacted with $Post_t$; 2) control for state specific linear time trends, $\delta_s t$.

In addition, we might be worried that the estimate of β in eq. (1) is capturing other health improvements of this time period. As also argued in Acemoglu and Johnson (2007), Bhalotra and Venk. (2015), and the lecture slides, this is exactly the period when modern medicine starts to diffuse (sulfa drugs, antibiotics, etc.). Thus, $\hat{\beta}$ might contaminated by secular declines in, e.g., pneumonia and TB which also has the potential to increase productivity and, therefore, earnings. One way of taking this problem into account would be to control for state-specific pneumonia (and TB) mortality in, e.g., 1940 interacted with $Post_t$.

Question 1.4: Exploiting the national fortification program of 1943, write down an estimation equation that quantifies the impact of iron deficiency during early childhood on productivity in adulthood using 1970 US census microdata, which, crucially, contains information on age, birth state, and annual wage income.

Answer: *There are different ways to capture this, but following, e.g., Bleakley (2007), the following cohort model is proposed:*

$$Y_{isk} = \beta \ \left(\text{EXP}_{ik} \ \times Iron_s \right) + \delta_t + \delta_k + X_{isk}\Gamma + \varepsilon_{its},$$

where Y_{isk} is earnings for an indicidual i born in state s belonging to birth cohort k, δ_s are state-of-birth fixed effects, δ_k are birth-cohort fixed effects, and X_{isk} are some individual level controls. Now the variation in health gains comes across states of birth based on the average iron consumption in state s in 1936, $Iron_s$, and the cross-cohort variation comes from the number of childhood years exposed to the iron fortification campaign, EXP_{ik}. As Iron deficiency impairs cognitive development in children below the age of 5 (and the program started in 1943) cohorts born in 1937 and before received no exposure to the program, while cohorts born in 1939 (at the least) received one year of program-exposure before their five-year birthday. If we assume that health benefits are increasing linearly in years of exposure below the age of five and that we include cohorts born from 1935 to 1951 in this study, EXP_{ik} is zero for the cohorts born 1935–1937, increases linearly in years of exposure for cohorts born 1938–1943 (i.e., in the interval 1 to 5), and for the birth cohorts 1944–1951 it takes on the value 5.

Question 1.5: Say that estimating the coefficient of interest in the estimation equation from Questions 1.4 reveals that iron deficiency in early childhood has a severe negative effect on adult productivity. Discuss this finding in relation to the theoretical predictions of the Grossman model.

Answer: *This discussion is related to the argument in Almond and Currie (2011a) on p. 158-159 that the basic predictions of the Grossman model is seemingly inconsistent with the Fetal origin (early childhood) literature. In particular, the Grossman model suggests that shocks in early childhood is, as such, not measurable in adulthood, since the shock "fades/depreciates" away while ageing. Almond and Currie (2011a) reconciles this gap by augmenting the Grossman model with dynamic complementarities.*

Part II Information economics

Question 2.1
Analyze potential failures in health insurance markets characterized by asymmetric information between the insurer and the individual demanding insurance, and where individuals have differential risks of falling ill, while those who have the lowest risks are in fact more willing to pay for insurance. Explain your analysis in a graphical illustration.

Answer:
Under a few more assumptions the answer could rely on Einav and Finkelstein, 2011 (Selection in insurance markets: Theory and Empirics in Pictures, JEP, vol 25, Number 1 , Winter 2011, Pages 115-138).
We furthermore assume that a risk neutral insurance company supplies only one contract, which the consumers can choose to buy or not.

*The market described is characterized by **advantageous selection** and is sketched in figure a and explained below. Advantageous selection leads to over insurance, i.e. in equilibrium the number of people insured is larger than the efficient number of people.*

Figure a

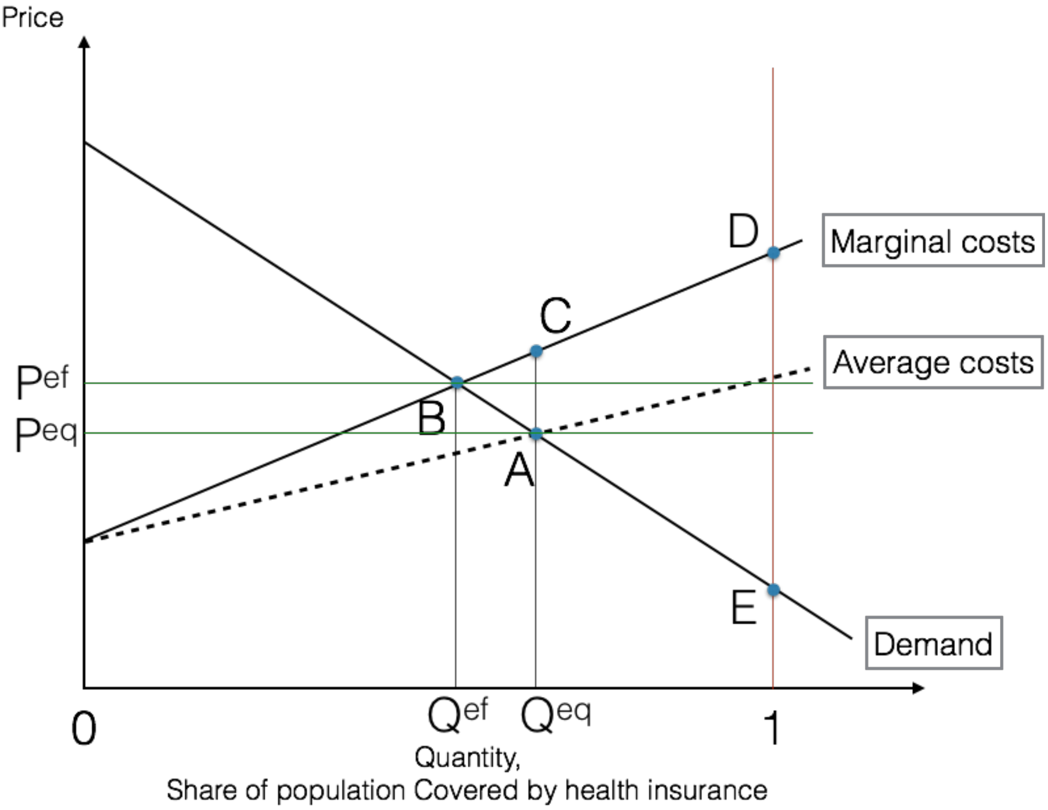


Figure a plots a "supply and demand diagram" in the market for health insurance. The x-axis orders all individual's in their economy by their willingness to pay for insurance. While the person most willing to pay is in the left most part of the diagram, the one with the lowest willingness to pay is in the right most end of the picture. Consequently, the demand curve is downward sloping. Importantly, the cost curves

are directly related to the demand: because the individual who has the highest willingness to pay for insurance is the one with the lowest risk of falling ill, (s)he will also be the one expected to impose the lowest cost on the insurance company. A consequence of these heterogeneous risk preferences makes the marginal cost curve upward sloping.
The vertical distance between the demand and marginal cost curve captures the risk premium, or put differently the welfare enhancing effect of being covered by insurance for the given individual. The efficient share of the population covered, Q^{EF} is at the intersect of the demand and marginal cost curve, marked B in the diagram.
Asymmetric information means that health information is private, and consequently the insurance company cannot tell robust and frail individuals apart. The insurance contract is to priced at the intersect of the demand and average cost curve, marked A. This is a zero profit condition. Offering a lower price would lead to negative profits and given competition higher prices would not attract any buyers.
The result is that the market fails to provide the efficient price and too many individuals, Q^{EQ}, are actually covered by insurance.

Question 2.2
What are the welfare implications of mandating full insurance in this framework? Explain your result in a graphical illustration.

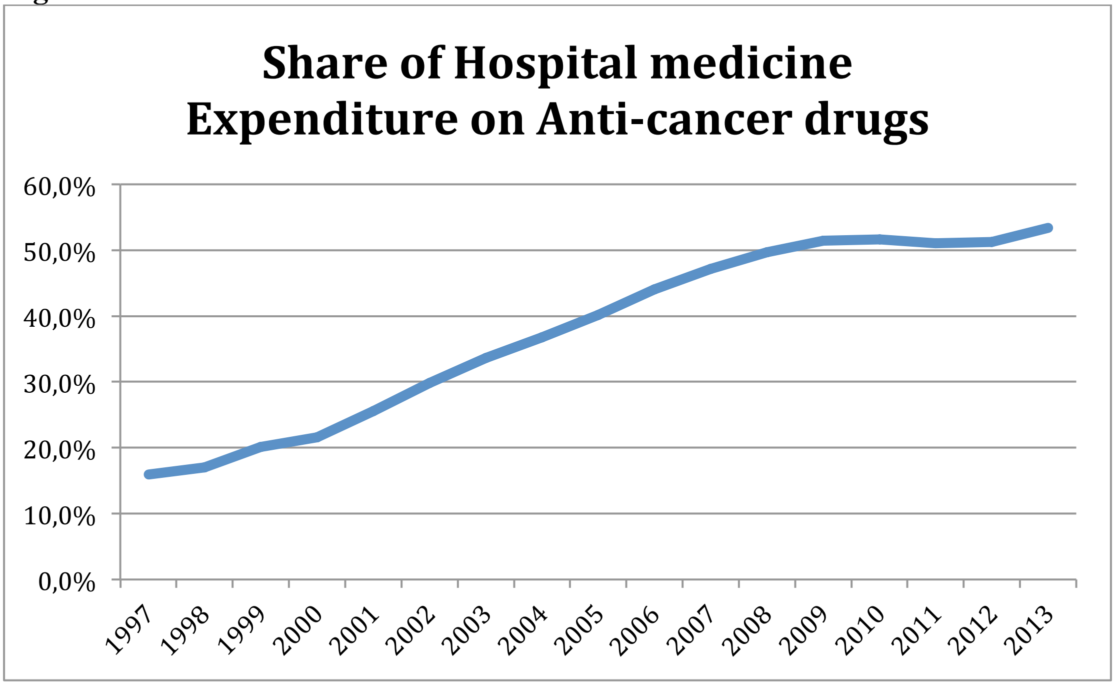
Answer:
In figure a the welfare loss in the described health insurance market is captured by the triangle spanned by the points ABC. Mandating insurance so that everybody are covered exacerbates the welfare loss. In that case the welfare loss is spanned by the triangle BDE.

Question 2.3
Given micro data containing information of individual degree of insurance coverage and claims, how can we empirically test whether the situation outlined in question 2.1 is present in the health insurance market? Explain potential biases of such a test.

Answer:
The basic idea of such a test is to investigate the costs for people with differential insurance coverage. The "standard test" is a positive correlation test: A positive correlation would suggest adverse selection. However, the setup in Q 2.1 suggests advantageous selection, which would be reflected in negative correlation between insurance coverage and claims.
Such a test may, however, be bias by moral hazard. That is, those who have more coverage have fewer incentives to avoid costs. Hence, moral hazard biases estimates upwards. Therefore, even with a zero or a positive correlation between coverage and claims (costs) advantageous selection may be present, but is completely off-set buy moral hazard.

Part III Economics of Health Innovations:

Figure 1



The picture shows the evolvement in the percentage of drug expenditure in Danish hospitals spend on anti-cancer drugs.

Question 3.1
Explain how different underlying factors affecting prices and quantities consumed in the market for anti-cancer drugs may drive the pattern in figure 1.

The answers to questions 3.1 and 3.2 may rely on chapters 12, 13 and 14 in the textbook, and Howard et al. 2015 ("Pricing in the Market for Anticancer drugs", JEP, vol 29, Number 1, Winter 2015, Pages 139-162.).

Answer:
The picture shows that the share of hospital medicine expenditure spend on anticancer medication more than tripled from 1997 to 2013. This pattern not is driven by a decrease in the numerator, e.i., expenditure on other drugs have not been decreasing, but rather steadily increasing in the data window. Anti cancer medication is in Denmark taking up an increasingly share of total health care expenditure.

In general expenditure increase could be driven either by increasing prices, quatities or a combination of the two, because:

Expenditure = prices x quantities.

Factors related to quantities:

Ageing populations. Populations are ageing, and people are more likely to get a cancer diagnoses at older ages. Hence, the expenditure are increasing.

New types of medicines. More and more types of cancer medicine are being approved, and hence, more types of cancer can be treated at more progressive stages. This raises the quantities demanded.

Increased policital focus on cancer treatment: Three cancer initiatives in the data window prioritizing better quality and faster treatment of cancer. Cancer plan I, II, III in 2000, 2005, 2011. Politicians may be more willing to pay for expensive drugs.

Factors related to prices:

Pricing on the launch of new drugs: Some evidence that launch prices of cancer drugs are increasing by 10% per year (adjusted for inflation).

This pattern could be due to increased quality, but some evidence of "reference pricing" exists. In countries without prioritizing institutes, oncologist are determining whether to use a given drug and whether the price of drug is fair or not.

Discount agreements in the US may affect the initial pricing of a drug. This price may be used as an anchor in price negotiations with non-US governments.

Question 3.2

Discuss pros and cons of policies to reduce government expenditures on hospital medication.

Answer:

Some countries with Beveridge health care systems, e.g., UK and Norway, have introduced health technology assessment institutes, which systematically use cost-effectiveness and Cost-benefit analyses to determine whether expensive medication should be offered.

Pros:

- *The quantities demanded of some expensive drugs fall, because they are simply not offered. Hence, expenditure is dragged down.*
- *In price negotiations with drug companies, the buyer/government have the option to reject some medicines, which may lower the price anchors from the supplier side and affect the final prices.*

Cons:

- *Obviously, not everybody will receive treatment although technologies exist.*
- *The assessors (politicians) are implicitly putting a value on life, e.g., the threshold for offering new drugs in NICE in the UK is at an ICER of £20,000 (the student may elaborate on what an ICER is). This is politically sensitive. Note that even though the UK has NICE, the Cameron government broke its principles by adding additional funding to the treatment of some cancer types, which may have undermined the bargaining position of NICE.*
- *Decreasing prices for medication undermines the effects of giving pharmaceutical companies patents, which should give them a chance to recoup fixed investments costs in the R&D process, hence, an incentive to innovate better medicine.*

- *Small countries may not have much bargaining power in negotiations with pharmaceutical companies, who may anchor their prices to larger markets such as the UK or US. In that case, one may speculate whether savings in medication purchases recoup the cost of a prioritizing body.*