Written Exam at the Department of Economics winter 2018-19

Course name

Final Exam – **SUGGESTED ANSWERS**

January 9th 2019

(3-hour closed book exam)

Answers only in English.

This exam question consists of 5 pages in total

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Inequalities in waiting times for health care

Question 1. Describe briefly the main traits of Beveridge health care.

Beveridge health care is organized under the principle that access to health should depend on needs and not ability to pay. It is thus characterized by its universal coverage funded by a single payer, such as the NHS in the UK (but is often organized in smaller the government units such as regions and counties in Denmark). It is funded via taxes and has no insurance premiums and no (or only limited) out-of-pocket costs. Hospitals are publically owned and staffs are public employed.

In such a system moral hazard (in principal adverse selection is lees of concern because everyone are covered) is the main challenge, as expenditures are covered by the government, and hence, not necessarily internalized by the patient (demander). It is often times rationed by limited provider choices, health technology assessments or waiting lists.

Beveridge countries includes UK and the common wealth countries as well as the Scandinavian countries.

In recent decades Beveridge countries have experimented with Bismarckian elements, such as increased choices, copayments etc.

Question 2. How can waiting lists (compared to pricing) motivate optimal allocation of health care?

Waiting lists are in Beveridge countries used to ration access to (non-urgent) health care (out-patients). A waiting list could in principal consist of patients who will benefit differentially from treatment, and by financial constraints. This could be visualized in the following way:

The surgeon represents the provider. "U-circles" represents patients for whom surgery will be beneficiary. "W-circles" represents patients for whom surgery will benefits less so (waste-full treatments driven by moral hazard). Sub-scripts "p" represent poor patients.
With price rationing the patients would internalize the expenditure, leading "w-patients" to leave the queue. Price would lead those more willing to pay to receive treatment first. However, poor patients would not be able to afford health care and leave the queue, too, which would breach Beveridge systems aims of providing access to the needy regardless abilities to pay.
So, in order to motivate an optimal allocation health care, waiting lists must be paired with some mechanism, such as monitoring (gate-keepeing), that could lead W-patients to leave the queue while keeping poor patients, and let waiting times to be independent of abilities to pay.

A recent paper, Moscelli et al. (2018), study patient-level UK hospital-episode data to test whether hospital and procedure choices affect socio-economic inequalities in waiting times for non-acute heart procedures.

Particularly, for high versus low-income patients, the authors study differential waiting times for two particular revasculization procedures: (1) bypass operations (coronary artery bypass grafting, CABG, surgery) and (2) angioplasty (percutaneous coronary intervention, PCI).

To some extent CABG (that requires open-chest surgery), and PCI (less invasive) are substitutable. Still, the risk of short-run complication is particularly higher for CABG, however, the post-procedure health improvements are also potentially larger.

For each of the procedures, the main objective is to estimate the following regression:

$$w_{ij} = h_j + \beta'_1 y_{ij} + \beta'_2 s_{ij} + \beta'_3 x_{ij} + \varepsilon_{ij} \qquad \text{Equation (1)}$$

Where $w_{ij} = \ln(W_{ij})$ and W_{ij} is the waiting time (days) of patient i in hospital j, $W_{ij} > 0$. y_{ij} is a vector of dummy variables measuring socio-economic status. To construct this measure, the authors do not have access to individual income records. Instead, socio-economic status is approximated by the income deprivation of the area where the individual resides (specifically, the authors assign to each patient i, the proportion of people aged 18-59 living in low-income households in their residential area). Particularly, the authors split the income deprivation distribution into five quintiles with the highest indicating the least deprived areas (the reference category). s_{ij} is a vector consisting of severity related controls (age, gender, secondary diagnoses, previous emergency room admissions and co-morbidities). x_{ij} is a vector of non-severity controls, such as month of admission. h_j is a vector of hospital fixed effects. It controls for waiting times differences across hospitals, which arise from unobserved differences in supply and demand side factors. ε_{ij} is an idiosyncratic error.

Question 3. What is the interpretation of the sign of β_1?

A positive sign would reflect that poor patients wait longer times than rich patients. One may note however, that y_{ij} is measured with error because it captures a geographical unit of income, rather than individual level income (which could lead to an attenuation bias. We don't know neither whether the richest within a neighbourhood receive care faster than the poor in the same neighborhood. If that is the case the estimates would provide lower bound estimates of inequality in waiting times.

Ordinary least squares estimates of $\beta_1$are provided in Table 1.

Question 4. Given Table 1, how did inequality in waiting times for revasculization procedures evolve over time?

Provided that the OLS estimates are unbiased, Table 1 shows differences in waiting times depending on economic resources. The table shows that the poorest quintile in 2002 waited 29% longer for CAGB and 42% longer for PCI than the richest quintile. This gradient becomes smaller when comparing more equally wealthy patients (eg. fourth quintile "only" waits 2% and 11% longer than the fifth income quintile for CAGB and PCI respectively). Over time these differences become smaller.

One may notice and comment on that average waiting generally fell during the observation period (app. 150 days in 2002 for CAGB to 50 days in 2010, and more than halved from app. 90 to 40 days for PCI treatments). One may also notice that capacities for PCIs increased tremendously for PCI treatments in the observation window, the number of patients increses from app. 16K – 24K and the number of hospitals offering the procedure more than doubles. CAGB remained at same levels, while waiting times declined.

Table 1. Parameter estimates of β_1

	CAGB						PCI				
Year	2002	2004	2006	2008	2010		2002	2004	2006	2008	2010
$\boldsymbol{\beta_1}$											
1st inc. quintile	0.29	.17	.16	.07	0.09		.42	.23	.17	.11	.14
2nd inc. quintile	0.21	.10	.15	.07	0.09		.34	.20	.16	.10	.12
3rd inc. quintile	0.15	.13	.08	.05	.07		.24	.11	.12	.10	.10
4th inc. quintile	0.02	.05	.03	.03	.03		.11	.05	.07	.05	.05
5th inc. quintile (richest)	Ref. cat.	Ref. cat.	Ref. cat.	Ref. cat.	Ref. cat.		Ref. cat.	Ref. cat.	Ref. cat.	Ref. cat.	Ref. cat.
Number patients	14654	14074	11536	11829	8888		16095	24355	26772	25399	23759
Number of hospitals offering treatment	32	34	32	34	32		37	44	60	73	83
Average waiting times (days)	153.5	98.3	65.9	57.8	50.4		89.8	83.7	52.5	37.4	39.2

Notes: Estimates of Equation 1 for each of the years 2002, 2004, 2006, 2008 and 2010. Each regression controls for hospital fixed effects, measures of severity and non-severity. The 5th income quintile (the richest) is the reference category. All estimates are statistically significant. The table also shows the number of patients that were treated each year, the number of hospitals that offered the specific treatments and the average waiting times.

Question 5. Given the papers from the health economics course, discuss whether outcomes of local populations are empirically suitable for assessing dimensions of local hospital quality (hint: you may highlight the overall findings from these papers).

The main objection of using "local" patients to assess quality-traits of hospitals is "patient selction". The outcomes (such as waiting times or health outcomes) reflect an equilibrium of patients' demand and the providers' suppliers that may be targeted the particular pool of patients with specific practice styles. At least four papers from the curriculum seeks to tackle this concern, by keeping either supply or demand fixed.

Doyle (2011) studies heart attacks patients in Florida and investigates whether variation in costs across hospitals manifest in better health outcomes, specifically, mortality rates. The study is unable to find strong evidence of an association costs and patient outcomes among local Floridian's. To circumvent the problem of patient selection the paper studies visitors to Florida that experience heart attacks during their stay. Under the identifying assumption that it is as good as random which hospital the visitors are admitted to the paper finds that higher expenditure are associated with better health outcomes.

Doyle et al. (2015) gets to similar overall result (better outcomes for high spending suppliers) for admission of patients with non-deferral diagnoses. The identification strategy relies on a rotational scheme in which ambulance companies are assigned to pick up patients in different geographical zones in New York at different times. It turns out that different companies varies in their tendency to *drive patients to specific hospitals different characteristics in terms costs profiles. Given the timing of the shock of the patient is orthogonal which ambulance company that is on duty the estimates are unbiased. In another identification strategy, they exploit how patients living close to, but on each side of hospital referral-zones, has different outcomes. Again the paper finds a positive causal effect of hospital spending on patient outcomes, supporting the evidence that more costs are also associated with better outcomes.*

Finkelstein et al. (2016) studies sources of geographical variation in health expenditure, by looking at the MediCare populations (age 65+) that move across hospital referral zones in the US, and investigate how much of the cost profile of the place of origin determines spending in the place of destination. In that, way they are able to break down how much of the variation that stems from supplier versus demand side effects. While this paper doesn't inform about patient outcomes, it reveals some of the underlying reasons behind differential costs. Particularly, the study finds that 50-60% of the variation in costs are driven by supplier characteristics.

Laird and Nielsen (2016) studies how patients that move residence and consequently are distached from their usual family doctors are affected by their prescription tendency for different types of drugs. For instance, they find that 40% of variation in anti-depressant medication take-up is driven by supplier side prescription rates and the remaining 60% is driven by patient demand.

The answer may elaborate on the comparison and discussion on these papers.

Box 1.
Patient choice of hospital may modify the results in Table 1.
Equation 2 is a (probit) model to predict whether the patient chooses surgery at the geographically nearest hospital

$$n_{ij} = I\left(z_{ij}\gamma'_0 + \gamma'_1 y_{ij} + \gamma'_2 s_{ij} + \gamma'_3 x_{ij} + v_{ij} > 0\right),\ n_{ij} = \{0,1\} \qquad \text{Equation (2)}$$

n_{ij} is an indicator that equals 1 if the patient chooses surgery at the closest hospital and 0 if the patient bypasses the nearest hospital. z_{ij} measures the km-distance between the two closest hospitals faced by individual i, who received treatment at hospital j.
To adjust for patient for patient choice of hospital in Equation (1), predictions from Equation (2) can be included as regressor.

Question 6. Under which identifying assumption would an estimation of Equation (1), that includes the predicted choice of hospital as describe in Box 1, provide consistent estimates of β_1?

The identifying assumption is that the distance between the two nearest hospitals is uncorrelated with the error term of equation (1), and hence, circumvents issues of patient selection. Particularly, expansions of access may not be correlated with demand.
This is not necessarily the case if capacity increments is targeted in areas that face particularly large demand for the specific types of procedures.

Table 2 presents the predicted gradient (inequality) in waiting times from an “unadjusted model” without controlling for whether the patient chose the closest hospital and an “adjusted model” that takes into account, whether the patient chose the closest hospital.

Table 2. Differences in the estimates of overall waiting time inequalities (in days) with and without adjusting for selection into hospitals.

Year	Procedure	%Bypassing local hospital	Predicted days waiting - Unadjusted model		Predicted days waiting - Adjusted Model		Difference in estimates between unadjusted and adjusted waiting time gradient	
		A	B	C	D	E	F	G
			1st income quintile	5th income quintile	1st income quintile	5th income quintile	Absolute	Relative
2002	CABG	35.9%	188.9	140.7	165.2	122.4	-5.37	-11.0%
2003	CABG	40.4%	127.5	101.0	108.5	85.2	-3.17	-12.0%
2004	CABG	39.0%	109.2	92.3	92.1	77.3	-2.07	-12.1%
2005	CABG	34.9%	70.6	61.7	67.1	58.4	-0.25	-2.7%
2006	CABG	35.3%	73.7	62.6	71.2	60.4	-0.30	-2.7%
2007	CABG	36.0%	68.7	60.6	62.8	55.2	-0.51	-6.8%
2008	CABG	34.8%	60.7	56.6	56.2	51.9	0.29	5.6%
2009	CABG	33.0%	52.5	48.6	48.6	44.9	-0.20	-7.0%
2010	CABG	31.3%	53.9	49.1	52.7	48.1	-0.23	-3.8%
2002	PCI	35.4%	114.2	74.8	114.5	122.4	0.17	0.3%
2003	PCI	36.7%	111.8	81.5	106.1	85.2	-2.13	-7.1%
2004	PCI	34.3%	96.0	76.2	92.1	77.3	-1.15	-5.4%
2005	PCI	40.4%	61.5	52.2	59.5	58.4	-0.31	-3.1%
2006	PCI	44.0%	56.9	48.1	56.0	60.4	-0.26	-3.9%
2007	PCI	41.7%	48.7	41.2	46.6	55.2	-0.27	-3.5%
2008	PCI	40.6%	39.1	35.0	37.8	51.9	-0.09	-1.8%
2009	PCI	35.6%	41.6	36.8	38.7	44.9	-0.34	-6.0%
2010	PCI	36.3%	42.1	36.6	40.2	48.1	-0.26	-3.7%

Notes: F=(D-E)-(B-C), G=((D-E)-(B-C))/(B-C)

Question 7. Explain briefly the results in Columns B-F of Table 2. To what extent did patient hospital-choice affect the inequalities in waiting times (Column G)?

Columns B and C are providing the estimated days of waiting in the unadjusted model (in principal the same results as in Table 1, only including more years). Columns D and F show the similar estimates now controlling for patient choice. For CAGB these estimates are lower everywhere, but for PCI the results are more mixed.
However, turning to column G the answer may discuss bounds for patient selection issures and notice, that the importance accounts for up to 12% for CAGB and 7% for PCI procedures, and that these differences are largest in the earlier period.

Question 8. Which theoretical mechanisms could explain the results from Question 7? Relate your answer to predictions from the Grossman model.

The qualitative results of Table 2 would be consistent with theoretical predictions from the Grossman model that richer individuals have larger opportunity costs of worse health and are hence more willing to impose the costs (in this case travel costs) to increment their individual health.
They will be willing to spend more time to improve their health, which will expand their production possibility frontier, making them reach larger consumptions of both health and home goods. However, given that treatment is independent of income, there should be no direct income effects. The patterns that the rich gets treatment quicker could reflect that they somehow are better in manoeuvring through the health care system (an "elbowing effect") that effectively make them more efficient producers of health. In the Grossman model, this would be reflected in an outward shift in the MEC curve, leading them to higher levels of health.
More elaborated answers would make a visualization of the argument.

Question 9. Outline policies implemented in the past decades to tackle excessive waiting (hint: you may distinguish between policies targeted at the demand and supply side of health care respectively), and given the information in Table 1 and 2, discuss whether you think any of these policies have been particularly successful.

A number policies have the recent decades been implemented to tackle excessive waiting times. Siciliani and Hurst (2005) are paying particular attention to the procedures under consideration in this current set of exam questions (CAGB and PCI). Moreover, they compare outcomes for the UK and Denmark. These countries both introduced supplier side policies aimed at increasing capacities, but in different pace. England expanded CAGB and PCI capacities in the late 1990's, and as Table 1 shows particularly increases in PCI treatments in the 2000's. Denmark expanded its capacities much earlier and to a larger extend with the heart-plan of 1992, leading to both more procedures and shorter waiting times for the particular procedures.
In the same data window both countries introduced more options for choosing between providers. In UK 2006 for instance NHS required that general practitioners offered multiple hospitals for the same procedures. Interestingly, however, Table 2 shows that the declines in the patient choice are taking off prior to this reform.
In all it seems that the capacity increases in PCIs have led to declines in waiting for both types of procedures, and that both the rich and the poor have benefitted.
It is not clear form the current analysis of whether demand side policies have been introduced too. That could for instance be stricter clinical thresholds for eligibility, increased gate-keeping or a

differential prioritization of patients on the waiting list (rather than first come – first serve principals).

While questions 1-9 study socio-economic inequalities in waiting times and the role of choice of hospitals, the questions do not consider unequal health outcomes as such. One such outcome could be mortality.

> **Question 10.** Given the papers from the health economics course, discuss briefly the determinants of inequality in mortality/life-expectancy?

Culter, Deaton and Lleras-Muney (2006) studies the determinants of mortality and conclude that disparities arise with the enlightenment period and the diffusion of health technologies have been unequally distributed with the highly educated benefitting from new treatments faster than the poor, which is reflected with differential morality rates. Moreover, they state that knowledge, education and technology are keys to coherent explanations for determinants of unequal mortality. With an increased pace of technological progress they predict that gradients will continue to increase.

Using schooling and child labor in the US in the first half of the twentieth century Lleras-Muney (2005). She shows a causal relation that additional years of mandatory schooling decreases mortality rates in later ages.

Finally, Chetty et al. (2016) shows large disparities in life expectancies across the US. They find that these differences are associated with differential health behaviours such smoking and drinking.