Written Exam at the Department of Economics Summer 2020

AØKA08209U Economics of Education

Final Exam

June 16, 2020

(3-hour open book exam)

Answers only in English.

This exam question consists of 6 pages in total

The paper must be uploaded as <u>one PDF document</u>. The PDF document must be named with exam number only (e.g. '127.pdf') and uploaded to Digital Exam.

This exam has been changed from a written Peter Bangsvej exam to a take-home exam with helping aids. Notice that any communication with fellow students or others about the exam questions during the exam is considered to be cheating and will be reported. It is also considering cheating to let other students use your product.

Be careful not to cheat at exams!

You cheat at an exam, if during the exam, you:

- Make use of exam aids that are not allowed
- Communicate with or otherwise receive help from other people
- Copy other people's texts without making use of quotation marks and source referencing, so that it may appear to be your own text
- Use the ideas or thoughts of others without making use of source referencing, so it may appear to be your own idea or your thoughts
- Or if you otherwise violate the rules that apply to the exam

This document provides a sketch of solutions to the exam. The provided solutions are intended as a guide to answering the questions, and are not meant as exhaustive. The written solutions would have to be worked out more completely.

This is the final exam for Economics of Education, Spring 2020. You have three hours to answer the following 5 questions. The exam assignment is given in English and must be answered in English. According to the decision of the Board of Study due to the Corona-crisis, the exam is an online take-home exam. The exam is still individual and you may not communicate with others about the exam assignment or solutions in any circumstances.
Draft your responses with an eye to clarity of exposition and structure as well as to showing your understanding of the concepts learned in class. Link the problem at hand to economic theory. You are free to make any reasonable assumptions that help you in answering, as long as you are specific and explicit.

Make sure to *pace yourself*. Also, you may choose to work on the questions in a *different order*: All questions can be answered independently.

FIRST PART

Gifted education program in Italy

Programs for gifted students find their rationale in the public interest to promote individual self-fulfillment and in the positive returns in terms of economic and societal development ([Renzulli(2012)]). Since the late '80s, several special education programs targeting gifted students have been introduced in the US. These programs involve around 7% of the overall student population ([Card and Giuliano(2014)]). In Europe, many countries have introduced laws to match gifted students' needs for special intervention starting in 2000.

The share of Italian top performers (students who attained levels 5 or 6 in PISA tests) is only 9.5% compared to 11.4% in the entire OECD. In this context, gifted programs may be useful to improve performance at the top of the Italian distribution. Only recently, in 2019, the Ministry of Education acknowledged gifted students' needs for special attention (Law 562/2019) and decided to **invest in a gifted mathematics program for high school students.** The camp takes place once a year and lasts three days. It targets students of high ability from high schools, grades one to four (ages 14 to 18).

Questions

1. (1) Outline the classical Ben Porath human capital model (describing the variables involved) and use it to analyze the implications of the investment in the gifted mathematics program.
   (2) Where would the program enter in this model? (Which variable would you use?)
   (3) What are the effects of this program in terms of educational attainement?
   (4) How would the program impact inequality? Reflect on the target and the timing of the investment (secondary education).
   (5) Would the effect be homogenous (i.e., equal for all students)?
   (6) How would the impact of the program differ if the target of the gifted program were college students?

Solution:

(1) The optimal share of time in schooling in period t by individual i is S_{it}^*:

$$S_{it}^* = \left[\frac{\beta_{t+1}}{\beta_t} \frac{\alpha}{1+\rho} \frac{1}{H_{it} + \gamma_t/\beta_t} \left(A_i H_{it} E_{it}\right)^{\alpha} \right]^{1/(1-\alpha)},$$

where

- β are the wage-returns to human capital,
- H_{it} is i's human capital in period t,
- A_i is personal initial learning ability,
- E_{it} are public expenditures on schooling,
- α is the parameter of the human capital production function, ρ is the discount rate, γ is the direct cost of schooling.

(2) The gifted mathematics program would enter as a higher E_{it}, greater public expenditures into the schooling process.

(3) The effects of this program, in a first step, is to increase optimal schooling S^*_{it} for everyone who is involved in the program, because E_{it} enters positively. More specifically,

$$\frac{\partial S^*_{it}}{\partial E} = \underbrace{\frac{\alpha}{1-\alpha}}_{+} \underbrace{\left[\frac{\beta_{t+1}}{\beta_t}\frac{\alpha}{1+\rho}\frac{1}{H_{it}+\gamma_t/\beta_t}\left(A_i H_{it}\right)^{\alpha}\right]^{\frac{1}{1-\alpha}}}_{+} \underbrace{E_{it}^{\frac{2\alpha-1}{1-\alpha}}}_{+},$$

which is positive because A, H, and E are positive.

Following the greater schooling investments, adult human capital is higher for those who experienced the greater public investment through the involvement in the gifted program, and their earnings will be increased. Outcomes later in life improve thanks to the higher investment in schooling.

(4) To the extent that this is a targeted increase in public expenditures for high skills students - in the current model, this would appear as being targeted at high-A_i - it would be a policy that increases inequality. Note that we studied in class that even an equal increase in E_{it} (i.e. targeted to all students) would *increase* inequality: this is exacerbated in this case, where we consider a program that targets a subgroup of the population in the top part of the skills distribution.

(5) The effect of this particular E_{it} increase is not homogenous and contributes to increase inequality in two ways: first, it causes an increase in optimal schooling for students involved in the program (See answer (3)); second, the increase in optimal schooling is enlarged due to the fact that higher public expenditures increase the influence of ability on optimal schooling:

$$\frac{\partial^2 S^*_{it}}{\partial E \partial A} = \underbrace{\left(\frac{\alpha}{1-\alpha}\right)^2}_{+} \underbrace{\left[\frac{\beta_{t+1}}{\beta_t}\frac{\alpha}{1+\rho}\frac{1}{H_{it}+\gamma_t/\beta_t}H_{it}^{\alpha}\right]^{\frac{1}{1-\alpha}}}_{+} \underbrace{\left(A_i E_{it}\right)^{\frac{2\alpha-1}{1-\alpha}}}_{+}$$

This mechanism plays a role also in determining the not homogenous effect among the subgroups of students who experience the camp: if we assume that abilities of students who are selected to attend the camp are not homogeneous, students who have lower ability A_i or low initial human capital H_{it-1} benefit less from the investment. Targeting a specific group (high skills students) still does not preclude heterogeneous effects by initial ability and human capital.

(6) Subsidizing higher education has a non neutral effect on income distribution. While investing in primary education advances the economy toward enhancing efficiency and reducing inequality, investing in higher education is in general regressive. In particular subsiding initiatives at the college level adds to the value of the HK of those who attend college relative to those who do not go to college. Moreover, it provides schooling predominately for students from middle and upper income families and a part of the cost id paid for by taxes on poor families. In the end, substantial amounts of valuable assets would be transferred to a particular intellectually elite set of individuals. Therefore we can reasonably expect a worsening in inequality if we enhance the level at which we devote public investment in academic programs.

2. The establishment of gifted programs can be considered a policy put in place by governments and schools to improve students' performance.
   (1) What other policies that have this goal do you know from the literature? List and describe the impact of policies/interventions (at least those we saw in the lectures) that aim to improve students' academic performance. We expect that you are able to present a detailed overview of the existing literature on the topic.
   (2) This policy has a specific target (i.e. high skills students): it is however possible that the Minister of Education expects an overall improvement in students' performance (i.e. an imporvement also in the academic performance of those not involved in the camp). How can this be possible? Explain and discuss other empirical evidence on the role of the average perfomance on the individual one.

Solution:

(1) Students' academic performance has been a key issue in education. Therefore, many different interventions from governements and schools to improve it have been implemented in the last decades. Interventions are generally based on valid information about current performance, whereby realistic implementation and ongoing student progress monitoring are essential. For any intervention to be effective, the programmes designed should be based on clearly defined objectives, and the program should be monitored and evaluated. The empirical literature available analyzes many interventions among which the most important are the following:

- **Increase spending/put in more resources** (reduce the **class size**, increase **instructional time**, increase teachers' salaries, investing in gifted programs, etc.)
  - very little evidence for a direct link between increasing financial resources and improved student outcomes
  - Instructional time has been shown to be a significant driver for educational outcomes - but we noted the embedded character of human capital that makes an un-limited increase in instruction time unlikely to work.

  - [Lavy(2015)] shows that especially girls, immigrants, and low-SES students benefit more from increased instruction time, using PISA test scores. While the age range of PISA is too old for our question, the heterogeneous effects of instruction time could indicate that students in the *special zones* could benefit more than advantaged students. In this sense, this policy could be very effective at reducing inequality.

- Select **teachers** according to their performance (tacher value-added literature). "Teacher value-added" has been shown to improve students' test scores significantly, and also has long-term effects on students' labor market outcomes.
- Select and sort **students** into classes (homogeneous or mixed class composition, role of peer effect, etc.) There may be an argument that gifted students could benefit from initiatives in which the purpose is to make them cooperate and interact with other high skills students and perhaps learn better from this selected and homogeneous environment. [Carrell et al.(2013)Carrell, Sacerdote, and West] experiment of extreme stratification ideed shows that students in stratified classes tend to autosegregate and interact in subgroups of students with similar abilities, thus suggesting that it may be useful to promote initiatives which reproduce this kind of setting.
- Government interventions to finance alternative schemes (i.e. Voucher plan)
- Implement **systems of values/"high expectations'** which emphasise the important of behave properly and achieve educational goals (i.e. charter schools vs public schools). Charter schools that implement strong values that students (and their parents) have to subscribe to have been shown to significantly improve their students' learning achievements. Some of these have been evaluated in randomized experiments, others not.
  - [Angrist et al.(2010)Angrist, Dynarski, Kane, Pathak, and Walters] evaluate KIPP, which is one example of the "high expectations" type of schools. Students' test scores of those who won an admission lottery were much higher than those who lost the lottery.
  - [Dobbie and Fryer Jr(2013)] evaluate charter schools and show that while traditional input measures (including class size) are not significant drivers of student outcomes, other policies are important: frequent feedback, data use, high-dosage tutoring, increased instructional time, and high expectations. All these features are likely to characterize gifted education programs and therefore could contribute to enhance students' performance in the case presented above.

(2) An investment in a gifted education program as the one analysed has as its main consequence an increase in optimal schooling for students benefiting from the program (in this case high skills students). However, an

improvement in the performance of these selected students can also translate into an improvement in the other students (in particular the low skills ones) belonging to the same class. This is because of the phenomenon known as the **peer effect**. [Kirabo Jackson(2010)], for example, showed that in high schools being with higher-ability peers improves later performance. Also [Carrell et al.(2009)Carrell, Fullerton, and West] showed that low-achieving students benefit in terms of learning gains from being in a classroom (squadron, actually) with high-achieving students.

SECOND PART

3. The Economist has published an online article on April 30th 2020 titled "Closing schools for Covid-19 does lifelong harm and widens inequality". The article describes that, at the time of its publication, roughly 1.5 billion schoolchildren across the world are not visiting school and points to likely consequences for social mobility. It contains the following paragraph:

> "(...) You can make up for lost maths with summer school. But you can't easily do that with the stuff kids learn very young," says Matthias Doepke of Northwestern University. Social and emotional skills such as critical thinking, perseverance and self-control are predictors of many things, from academic success and employment to good health and the likelihood of going to jail.

Regarding home schooling, the article makes the following observations:

> Less well-off children everywhere are less likely to have well-educated parents who coax them to attend remote lessons and help them with their work. In Britain more than half of pupils in private schools are taking part in daily online classes, compared with just one in five of their peers in state schools, according to the Sutton Trust, a charity (private schools are more likely to offer such lessons). In the first weeks of the lockdown some American schools reported that over a third of their students had not even logged in to the school system, let alone attended classes. Meanwhile, elite schools report nearly full attendance and the rich have hired teachers as full-time tutors.

(1) Please interpret the article's message in light of economic theory: Why and how will the current closure of schools influence social mobility?

(2) Please explain the potential role of sensitive/critical periods in skill acquisition as well as the role of dynamic complementarities in exacerbating the effect of school lockdowns on social mobility.

(3) Describe how the potential of later remediation of lost schooling time depends on the degree of dynamic complementarity between skills. (Feel free to use examples to explain the more general points you are making).

(4) What kind of production function could you use to model an extremely high degree of dynamic complementarity? (a very short answer is totally fine)

Solution:

(1) Social mobility is low at baseline. According to the article, it will likely become even lower due to the current lockdown. Why: Because low SES families cannot provide high quality home schooling (lack of hardware and internet access, lack of quiet working space, lack of time, lack of skills of parents). Therefore disadvantaged kids will lose even more compared to higher SES kids.

(2) In case there are sensitive periods: Some important skills may not be acquired at the time when it would be highly efficient. Much more costly and difficult to catch up later. ⇒ Exacerbated negative effect on social mobility. In case of critical periods: Impossible to catch up later ⇒ Exacerbated negative effect on social mobility, regardless of later compensatory investments. Dynamic complementarities: Investments are missed now due to the lockdown. Important skills not acquired. Example given by M. Doepke above: critical thinking. Lower investment today will lead to later complementary investments having a lower return, too. For example: A later exposure at school to scientific knowledge will lead to a lower accumulation of additional knowledge for students because they lack critical thinking. ⇒ Again exacerbated negative effect of lockdown on social mobility which even grows over time.

(3) Degree to which later compensatory investments are possible depends negatively on the degree of dynamic complementarity of skills. If substitutability high (complementarity low) it is possible to catch up later. If it is low (complementarity is high) it will be very difficult.

(4) Leontieff

4. Consider the Lochner (2004) model and specifically consider the simple case of "unskilled crime", i.e. the return from crime does not depend on the agent's human capital.
Assume now there is a policy change and the prison sentence in case the agent is caught committing a crime increases (permanently) from J years to $J + x$ years. This question is about how the policy change affects the agent's trajectory in comparison to the counterfactual scenario where the prison sentence is still J years. Your answers do not have to be long, but it should be precise.

   (1) What would be the immediate (short-run) effect on a young agent's time allocation?

   (2) How would the short-run effects translate into the agent's longer-run career trajectory?

   (3) How does the policy change affect the probability that the agent eventually ends up in prison?

   Here are some instructions for how to answer this question: You may refer to the simplified sketch of the model we have discussed in lecture 10 or the full-fledged model in Lochner (2004) Please make clear in your answer which one you are referring to, in case this makes a difference for your argument. You may make (reasonable) assumptions, if necessary. A perfect answer to this question requires that you describe the mechanisms of the Lochner (2004) model. This means that you refer to elements of specific equations, describe how these elements change in response to the policy change and how this change affects the agent's time allocation. Ideally, you would combine intuitive statements/sentences with references to the model. When referring to equations, you may either write down the equation, describe the equation ("the FOC for crime") or refer to the corresponding slide number ("slide 20"). In case you

have difficulties with the equations, just providing the intuition of the model will also earn you points!

Solution:

(1)
- Slide 20: FOC for crime. Opportunity costs of crime ($V_{t+1}(H_{t+1})$–$\Omega_{t+1}(H_{t+1})$) now higher because $\Omega_{t+1}(H_{t+1})$ lower due to higher sentence. ⇒ To bring RHS of the equation up again, lower k (this also lowers the equilibrium probability to be in prison) ⇒ Lower crime k in short run.
- Budget constraint: More time left to work and study. How to allocate time between the two ⇒ FOC for studying on slide 18. Work, in the short run, has a linear return $w_t H_t$, which is unchanged. What will be changed is $P(k_t)$, i.e. it is lower at lower k_t. More weight on derivative of V_{t+1} wrt H_{t+1} which is larger than derivative of Ω_{t+1} wrt H_{t+1}. Assume that derivatives are independent of levels of Ω_{t+1} and V_{t+1}. Then term in [] on RHS goes up. To bring it down again, increase I_t. This would imply that I increases relative to working and not just in absolute terms. However, it is enough if student argues through budget constraint and comes to the conclusion that I_t increases in absolute terms.

(2) Longer run, higher human capital. FOC for crime on slide 20 ⇒ MC to crime higher because going to prison more painful ⇒ lower crime in the long run.

(3) Lower prob. because lower crime k_t

5. IV vs. Mincer
In the literature on the "returns to education", college proximity is one commonly used instrumental variable for educational attainment.

(1) Can you think of any problem/weakness of the "college proximity" instrument?

(2) Some papers have used the school proximity instrument and found estimates of the returns to schooling that are 25-60% higher than conventional OLS estimates. What reasons can you think of? Please elaborate on each of them.

Solution:

(1) It could be that college proximity is not random, i.e. families who care about education may move close to a college for the sake of their children. If such families, for instance, provide other resources to their children, which ultimately increase their children's wages, the exclusion restriction is violated.

(2) Reason 1: Measurement error in educational attainment. Downward bias in OLS. Reason 2: Compliant subpopulation has a higher return to education than the average person in the population. One reason could be credit constraints, another reason could be that among the compliant subpopulation individuals have a higher required "rate of return" for education.

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