

Written Exam, Department of Economics, summer 2019

Economic Growth

(3-hour closed book exam)

August 21, 2019

Answers in English only.

This exam consists of 6 pages in total

Falling ill during the exam:

If you fall ill during an examination at Peter Bangs Vej, you must:

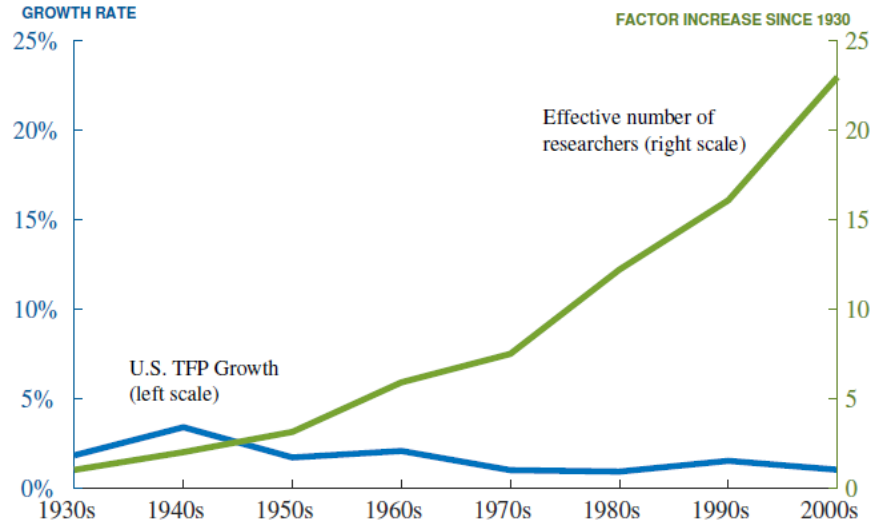
- contact an invigilator who will show you how to register and submit a blank exam paper
- leave the examination
- contact your GP and submit a medical report to the Faculty of Social Sciences no later than five (5) days from the date of the exam

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

Figure 1: Aggregate Data on Growth and Research Effort



Question 1: Essay questions

1. What is a hedonic price index, and how might it help us to capture quality changes of products in the national accounts? Discuss the advantages and disadvantages of hedonic price indices compared to other methods for adjusting for quality changes.
2. Automation may hurt workers' income and employment prospects due to a displacement effect. Through what mechanisms might the displacement effect be mitigated?
3. Figure 1 in Bloom et al (2019), reproduced here, shows TFP growth and the number of (effective) researchers in the US. Explain why the trends in this figure are consistent with, but do not prove that research productivity is declining.
4. Statement: "*Faster growth inevitably leads to higher welfare*". Do you agree or disagree? Please explain why/why not.
5. Please, explain how espionage during the cold war can help us understand the convergence process.
6. It is conventional wisdom that older firms tend to be less innovative; especially if they hold market power. What could explain a lack of innovative activity on the part of an incumbent? (Please, explain.)

Question 2: The skill premium in the canonical model

Suppose that the labor force consists of skilled and unskilled workers. Each worker inelastically supplies one unit of labor. Aggregate output, produced by a representative firm acting as a price-taker, is given by:

$$Y = \left[(A_L L)^{\frac{\sigma-1}{\sigma}} + (A_H H)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

L and H are the number of unskilled and skilled workers, respectively, and A_L and A_H are the associated productivity levels.

1. Show that skill premium, defined as the wage of skilled workers relative to the wage of unskilled workers, is given by:

$$\omega = \frac{w_H}{w_L} = \left(\frac{A_H}{A_L} \right)^{\frac{\sigma-1}{\sigma}} \left(\frac{H}{L} \right)^{-\frac{1}{\sigma}}$$

Figure 2 below shows the evolution of the relative wage rate of college graduates in the US.

How might this picture be explained, according to the expression you have just derived?

2. How would you use the expression for the skill premium to test the model empirically? What will the regression look like, and what variables would you use? What are the strengths and weaknesses of this approach to analyzing the evolution of the skill premium?
3. We also observe increased wage dispersion within educational groups, meaning that wage differences among, e.g., college graduates, are increasing. Acemoglu and Autor (2011) argue that the canonical model is consistent with this pattern if true skill levels are unobserved, but correlated with education levels. To be specific, they assume that a fraction ϕ_c of college graduates are skilled, and a smaller fraction ϕ_n of those without college are skilled. Firms observe whether a worker is skilled or not, and pay them accordingly, but in the statistics we only see the worker's education level. Use these assumptions to write down the observed college wage premium as a function of ϕ_c , ϕ_n and the true, unobserved skill premium. Show that skill biased technical change increases the observed college wage premium.
4. Suppose now that ϕ_c and ϕ_n are endogenous variables. How might these have changed

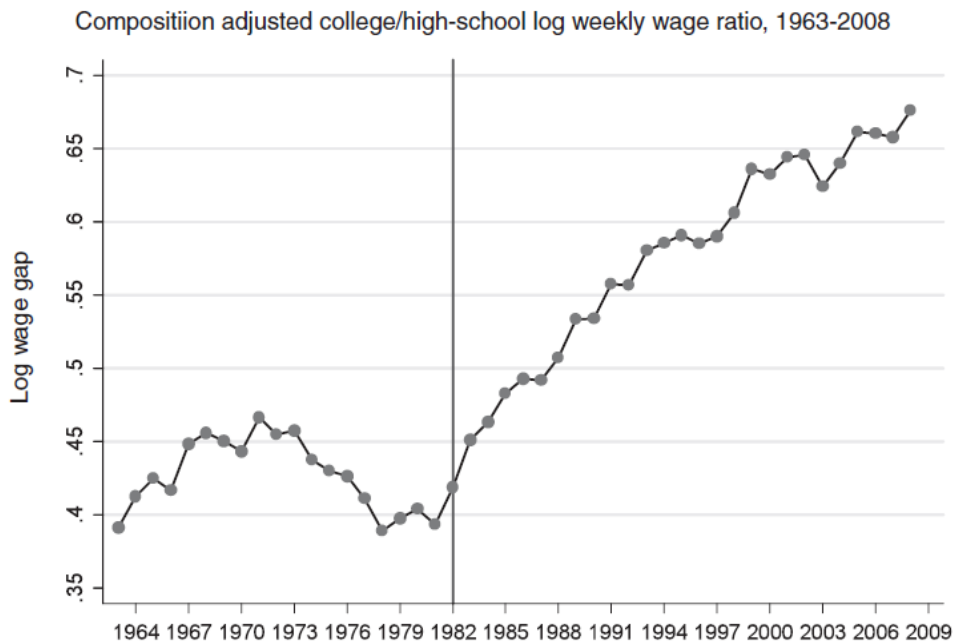


Figure 2: The evolution of the skill premium in the US

over the past decades? Can such changes can help us to understand the trend observed in Figure 2?

Question 3: The Romer model

Consider a Romer-model of growth through research and development (R&D). Time is continuous and suppressed in the notation that follows. The economy is closed. Final goods are produced using the technology:

$$Y = L_Y^{1-\alpha} \sum_{i=1}^A x_i^\alpha,$$

where L_Y is labor input in the final goods sector, x_i is an specialized intermediate input and A is the number of such inputs, as well as an index signifying the level of technology in the economy. The final goods sector is competitive, and the price of output is normalized to one. The real wage is denoted w and the price of the i th specialized input is p_i .

1. Solve the profit maximization problem of the final goods firm and derive the demand for labor and intermediate goods, $i = 1, \dots, A$.
2. x_i is produced in an intermediate good sector, which comprises A firms. Each firm is a

monopolist, and thus selects the price p_i and quantity, x_i . A unit of intermediate good is produced using one unit of physical capital. The cost of a unit of capital is the real rate of interest r . Solve the problem of the intermediate goods producer, and show that her profits are

$$\pi_i = (1 - \alpha) \alpha L_Y^{1-\alpha} \bar{x}^\alpha, \text{ for all } i = 1, \dots, A.$$

where \bar{x} is the optimal quantity supplied by the monopolist, which is the same for all $i = 1, \dots, A$.

3. Ideas are produced using the technology $\dot{A} = \delta L_A A$. There is free entry into the research sector, for which reason perfect competition rules. Accordingly, the R&D firm owner takes the value of an idea, p_A , as given along with the value price of labor, w . Show that profit maximization implies

$$p_A \delta A = w.$$

4. Along a balanced growth path – which is what we are considering from now on – the value of a new idea, p_A , equals the discounted value of profits from production of the type of intermediate good that is produced using the idea. The monopolist has a patent of infinite duration. Accordingly, along a balanced growth path $p_A = \pi/r$. Furthermore, labor markets clear so that $L_A + L_Y = L$ where L is total (and time constant) labor supply. Show that the growth rate of ideas fulfills

$$\frac{\dot{A}}{A} \equiv \gamma = \delta L - \frac{r}{\alpha}. \quad (1)$$

5. Households maximize utility from consumption over an infinite horizon. Per period utility is logarithmic, $u(c) = \ln(c)$. As a result, they follow the standard consumption Euler equation

$$\frac{\dot{C}}{C} = r - \rho = \gamma.$$

where the last equality follows as we are considering a balanced growth path where all endogenous variables grow at the same rate. Derive the long-run growth rate of the economy, as well as the long-run real rate of interest.

6. Over the last 30 years the real rate of interest has been declining empirically. According

to the model: what could generate a reduction in the real rate of interest? What would be the implications for the growth rate of the economy?