

UNIVERSITY COLLEGE LONDON

EXAMINATION FOR INTERNAL STUDENTS

MODULE CODE : ECON7011

**ASSESSMENT : ECON7011B
PATTERN**

MODULE NAME : Economics of Science

DATE : 10 May 2016

TIME : 2:30 pm

TIME ALLOWED : 2 hours

This paper is suitable for candidates who attended classes for this module in the following academic year(s):

2015/16

Summer Term 2016

ECON7011 Economics of Science

Final Exam

Time Allowance: 2 hours.

The final written exam counts for 70% of the final mark of the ECON7011 module, the exam is marked out of 100. Section A and B each carry 50 marks. Answer 4 questions from Part A, both questions from part B.

The use of calculators is **not allowed**. In cases where a student answers more questions than requested by the examination rubric, the policy of the Economics Department is that the student's first set of answers up to the required number will be the ones that count (not the best answers). All remaining answers will be ignored.

Part A

Answer 4 questions from this section, all sub-questions carry 6 marks, 2 marks are awarded for overall performance on section A. Always explain your answers!

A1] *Researchers & Money*

- a: Give three distinct ways in which researchers can monetize the fruit of their research work.
- b: What are 'patent trolls'? Explain how they affect the proper functioning of the patenting-system.

A2] *Knowledge*

- a: Explain in which way knowledge can be seen as a public good and give an example of 'tacit knowledge' from the readings.
- b: Describe how the existence of 'tacit knowledge' affects the 'public good view' of knowledge.

A3] *Caring Agents*

Consider a network of N non-selfish agents where we have a vector of allocations $\vec{x} = \{x_1, \dots, x_N\}$, of a single good to each of the N agents. Now it is given that agent k 's behaviour is described by the utility function that reads

$$u_k[\vec{x}] = m_k x_k - \frac{1}{2} m_k R_k x_k^2 + \sum_{j \neq k} C_{kj} x_k x_j \text{ where } |C_{kj}| \ll 1.$$

- a: Give a complete interpretation of the matrix-elements C_{jk} .
- b: Assume that this matrix has all eigenvalues between -1 and 1. Explain why it makes sense to define the 'most central agent' as the node which has the largest component in the eigenvector pertaining to the largest eigenvalue of C .

A4] *Random Productive Networks*

- a: Explain how we can use 'random networks' to study, in models, the consequences for the productivity of a network of having certain broad characteristics that we might find in large classes of real-world networks.
- b: Give three examples of such 'broad characteristics' that you might find in a 'citation network' of a research discipline that are linked to the behaviour of authors or standards set by publishers.

A5] *Refined Technologies*

- a: In which way can we view a Leontief production function as representing a fully refined production technology? Sketch in a diagram an isoquant of a production-function that is the optimal combination of two fully developed technologies.
- b: Consider a Solow model economy, with depreciation-rate γ and investment-rate s , in which two, fully refined, technologies are available. Sketch the usual diagram that indicates where the equilibrium state is. Show in the drawing that if γ drops below a certain value further reduction of γ will (at constant labour supply) increase the equilibrium capital stock but not output.

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TURN OVER

A6] *Productivity and impact of researchers*

- a: Explain what the h -index of a researcher is and how it measures the researchers productivity and her impact.
 b: Give three examples of 'issues' regarding the use of the h -index as a measurement for the comparison of different researchers, possibly across different fields of research.

Part B

Answer both questions from this section, all sub-questions carry 6 marks, 2 marks are awarded for overall performance on section A. Always explain your answers!

B1] *Researchers sharing resources*

In this problem we are considering a network of researchers, described by an adjacency matrix A , where the presence of a link between two researchers $i \rightarrow j$ indicates that researcher i takes an active interest in researcher j 's work because it is thematically and methodologically closely associated to i 's. Assume that all researchers need resources to do their research work in addition to the fact that if they have access to each other's tacit knowledge they will also use that as input into their own productivity. We denote the level of resources allocated to researcher k as x_k and the level of tacit knowledge possessed by researcher k as τ_k .

- a: Discuss for both the resources x_j as well as the tacit knowledge τ_j whether you consider them (1) excludable and (2) rival goods. Explain your answers!

Now we model the resources that agent j gets as

$$x_j = \bar{x}_j + \delta x_j$$

where \bar{x}_j is fixed and performance-independent and δx_j is a performance dependent addition or subtraction relative to the fixed allocation.

- b: Give *two* arguments in favor of such a form of allocations, give *two* arguments why a utility-function for of the form

$$u_k[\tilde{x}] = m_k \delta x_k - \frac{1}{2} m_k R_k \delta x_k^2 + \zeta_k \sum_{j \neq k} A_{kj} \delta x_k \delta x_j \quad \text{where } |A_{kj}| < 1 ,$$

can be considered an appropriate and approximate description of these agents' preferences regarding the resource x_j and give an interpretation of the parameter ζ_k .

Suppose the funding institutions distribute a total budget of B to these agents

$$B = \sum_{j=1}^N \delta x_j .$$

- c: Write down the Lagrangian for the optimisation problem of researcher k , derive the first-order conditions and find the solution to these equations.

The funding bodies decide to award funding according to a winner-takes-it-all rule that awards δx_+ to the winner and δx_- to the agents that do not win. Let π_j denote the probability that agent j wins the contest.

- d: Write down the utility for agent j if agent j is the 'winner'. Explain why there is uncertainty about agent j 's utility if j is not a winner. Discuss the nature of this uncertainty and possible implications for a policy recommendation to the funding bodies.

B2] Citation & Author Networks

Consider a network of N authors and m publications that spans the publication record of some discipline over T time-periods. We denote the knowledge-production of author J in period t as $\text{Log}[Y_{J,t}]$ and the knowledge production in paper j in period t' as $\text{Log}[\bar{Y}_{j,t'}]$. We collect all these into a vector

$$\overline{\text{Log}[Y]} = \{\text{Log}[Y_{1,1}], \dots, \text{Log}[Y_{J,t}], \dots, \text{Log}[Y_{N,T}], \text{Log}[\bar{Y}_{1,1}], \dots, \text{Log}[\bar{Y}_{m,T}]\}.$$

The weighted adjacency matrix \tilde{A} describes the links between all these different nodes, where an author-paper link like $J, t \rightarrow k, t'$ means that author J in period t was (co-)authoring paper k that was published in period t' . The paper-to-paper links describe citations and the author-to-author links describe 'learning' of one author from the other.

a: Explain why we expect that in such a model the vector $\overline{\text{Log}[Y]}$ represents a possible 'history' of productivity and that it satisfies

$$\overline{\text{Log}[Y]} \propto \overline{\text{Log}[Y]} \cdot \tilde{A}.$$

b: Why should we expect that, in general, we need to distinguish left- and right-eigenvectors when studying such networks, what is the meaning of the components calculated through

$$\overline{\text{Log}[Y]} \cdot \hat{\rho}^a = y^a \quad \text{and} \quad \overline{\text{Log}[Y]} = \sum_{a=1}^N y^a \hat{v}_a, \quad \text{where}$$

$$A \cdot \hat{\rho}^a = \pi_a \hat{\rho}^a, \quad \hat{v}_a \cdot A = \pi_a \hat{v}_a, \quad \hat{\rho}^a \cdot \hat{v}_b = \begin{pmatrix} 1 & \dots & 0 \\ \vdots & \ddots & 0 \\ 0 & 0 & 1 \end{pmatrix},$$

and in which sense would the left-eigenvector with the highest eigenvalue represent a kind of optimal valuation of all nodes?

c: Now we can decompose the adjacency matrix into 'blocks' as

$$\tilde{A} = \begin{pmatrix} A_{AA} & A_{AP} \\ A_{PA} & A_{PP} \end{pmatrix}$$

where A_{PP} for example is the adjacency matrix of the network of the paper-paper connections, i.e. the classical 'citation network', of the discipline. A_{PP} is a $m \times m$ matrix, give the 'dimensions' of A_{AA} and argue why we do expect to have that $A_{PA} \neq (A_{AP})^T$.

d: Use the form above to give an expression of the following two matrix-products

$$B = \tilde{A} \cdot \tilde{A} \quad \text{and} \quad C = \tilde{A} \cdot (\tilde{A})^T$$

in block-form and interpret the 4 blocks in terms of the type of 'knowledge productivity' they describe.