Written Exam for the B.Sc. in Economics, Winter 2011/2012

Makro A and Macro A

Second year

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(3-hours closed book exam)

All questions, 1.1-1.3 and 2.1-2.8, are to be answered, and all are weighted equally.

In Problem 1 the focus is on the verbal, intuitive explanations. Formal analysis can, however, be used in the explanations if wanted.

In Problem 2 formal and computational elements are more important, but verbal, intuitive explanations are still important.

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.

If you are in doubt about which title you registered for, please see the print of your exam registration from the students' self-service system.

Problem 1: Ideas, R&D, and endogenous growth

1.1 Explain how and why the non-rival character of ideas implies that imperfect competition (which could possibly be monopoly) is required in the markets for ideas or idea based products to ensure a private, profit motivated production of ideas.

1.2 Discuss the degree of excludability of ideas and the implication this degree has for private R&D. Include in your discussion legal arrangements meant to ensure a degree of monopoly power and of excludability needed for private R&D.

1.3 Consider Figure 1 and the explanation of it on page 5. Discuss this figure in connection with the R&D based endogenous growth model (Chapter 9 of the text book).

Problem 2: Temporary and permanent shocks under efficiency wages

We consider a representative firm i with a revenue function $zR(a_iL_i)$, where a_i and L_i are labour productivity and employment in firm i, respectively, and $z > 0$ is a demand/supply shock. The function R is assumed to fulfill: $R(0) = 0$, $R' > 0$, $R'' < 0$, $R'(x) \to \infty$ as $x \to 0$, and $R'(x) \to 0$ as $x \to \infty$.

The shock z is composed of a permanent, systematic shock $z^p > 0$, and a temporary, unsystematic one $z^t > 0$, such that $z = z^t \cdot z^p$. For instance, z^p could be growing steadily over time. For z^t, on the other hand, we assume that it takes random values around a mean value of one. The representative firm is assumed to know the full realization of $z = z^t z^s$ when it makes its decisions.

Productivity a_i is assumed to depend on the real wage rate w_i of the workers in firm i through the "efficiency function" $a_i = a(w_i)$, where $a' > 0$.

The representative firm chooses w_i and L_i to maximize profits, $zR\left(a\left(w_i\right)L_i\right) - w_iL_i$.

The firm is representative in the sense that it is the only firm in the economy, but should be thought of as small relative to the entire economy. The representative firm framework makes it possible to take general equilibrium effects into account. The first three questions, however, are concerned with a partial equilibrium analysis of the individual firm. Since the firm observes the shock z, the decomposition into z^t and z^p is not of importance for this analysis.

2.1 Show that the first order conditions for the firm's profit maximization are:

$$zR'\left(a(w_i)L_i\right)a'\left(w_i\right)L_i = L_i, \tag{1}$$

$$zR'\left(a(w_i)L_i\right)a\left(w_i\right) = w_i, \tag{2}$$

and show that from these follows the "Solow condition":

$$\frac{a'(w_i)w_i}{a(w_i)} = 1. \tag{3}$$

Explain (1), (2), and (3) intuitively.

From now it is assumed that the efficiency function takes the specific form:

$$a(w_i) = (\frac{w_i - v}{v})^{\eta}, \tag{4}$$

where $v > 0$, the outside option of the workers in firm i, is taken as given by the firm, and $0 < \eta < 1$.

2.2 Show that the optimal wage rate and productivity in firm i are then:

$$w_i = \frac{v}{1-\eta}, \text{ and} \tag{5}$$

$$a_i = a^* \equiv (\frac{\eta}{1-\eta})^{\eta}, \tag{6}$$

respectively. Explain the content of (5) intuitively.

2.3 Show that the optimal level of employment in firm i must be given by the equation:

$$zR'\left(a^* L_i\right) a^* = w_i, \tag{7}$$

where w_i is given by (5) and a^* by (6). Describe how the shock z $(= z^t z^p)$ affects the firm's real wage rate and employment in the *partial* equilibrium (where v is exogenous) given by (5) and (7). Relate to the empirical (stylized) facts of growth and business cycles, respectively.

From now general equilibrium effects are brought into the picture. First assume that:

$$v = (1-u)\, w + ub, \tag{8}$$

where u and w are the economy's rate of unemployment and general (average) wage level, respectively, and b is the rate of unemployment benefits. Second we exploit that from the representative firm framework:

$$w_i = w, \tag{9}$$

$$L_i = L = (1-u)\, N, \tag{10}$$

where total employment in the economy has been denoted by L, and an exogenous, inelastic total labour supply of N has been assumed.

Finally assume that b is given by an exogenous replacement ratio c times the "normal" general wage level $\bar{w}$:

$$b = c\bar{w}, \tag{11}$$

where $0 < c < 1$, and $\bar{w}$ is defined as the general wage level of the economy given that the temporary shock, z^t, takes its mean value of one, $z^t = 1$. The idea is that temporary, unsystematic shocks do not build themselves into the level of unemployment benefits whereas permanent, systematic shocks do.

Because of the definition of $\bar{w}$, it is of interest to analyze the model under the restriction $z^t = 1$. This is done in questions 2.4 and 2.5. When $z^t = 1$ (and only then), there is no distinction between $\bar{w}$ and w, so $\bar{w} = w$.

2.4 Assume $z^t = 1$. Using (5), (8), (9) and (11) above, show that the equilibrium rate of unemployment is then:

$$\bar{u} = \frac{\eta}{1 - c}. \tag{12}$$

2.5 Still assuming $z^t = 1$ (and hence $z = z^p$), show that the equilibrium general wage level is:

$$\bar{w} = Kz^p, \text{ where } K \equiv R'\left(a^*\left(1 - \bar{u}\right)N\right)a^*. \tag{13}$$

Describe how the permanent shock z^p affects the real wage rate and the employment level of the *general* equilibrium in the case $z^t = 1$.

From now we do not impose $z^t = 1$.

2.6 Show that in this general case an equilibrium rate of unemployment and wage rate, u^* and w^*, respectively, must be solutions in u and w to the following two equations:

$$w = \frac{u}{u - \eta} cKz^p, \tag{14}$$

$$w = z^t z^p R'\left(a^*\left(1 - u\right)N\right)a^*. \tag{15}$$

Explain intuitively the negative relationship between u and w of the "wage curve", (14), and the positive one of (15).

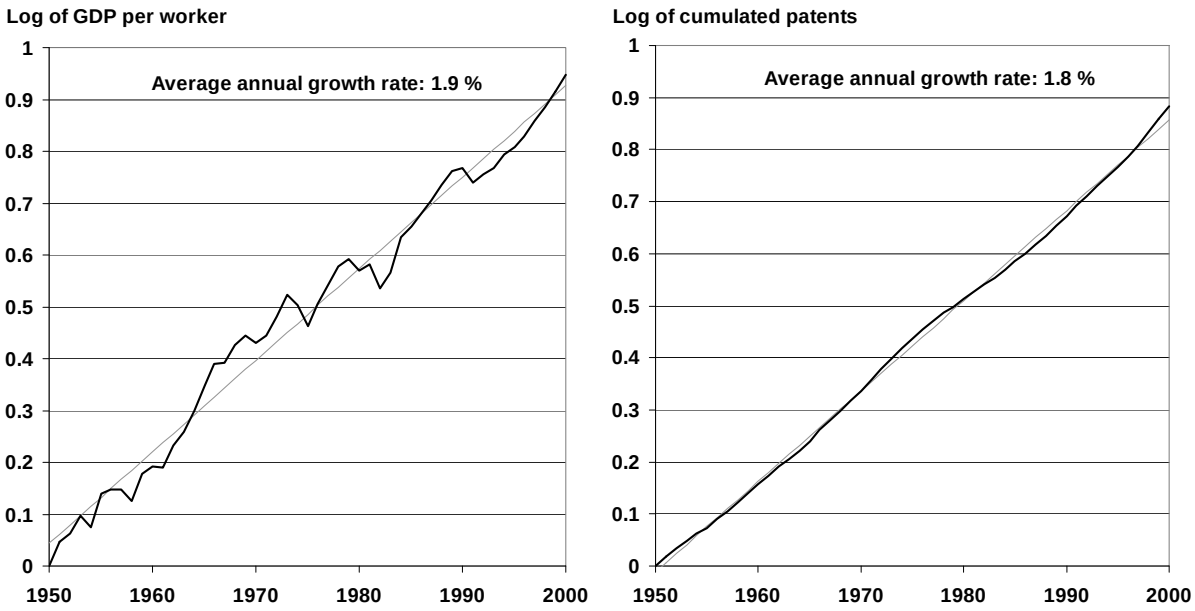
2.7 Illustrate the two equations (14) and (15) as curves in a diagram with u along the horizontal axis and w along the vertical axis, considering only $u > 0$ and $w > 0$. Show that given z^t and z^p, the system (14) and (15) has a solution u^*, w^* with $\eta < u^* < 1$, and $w^* > 0$. Explain how shifts in z^t and z^p, respectively, affect the two curves.

2.8 Describe how the general equilibrium values u^* and w^* are affected by temporary and permanent shocks, respectively, in the general case. Relate again to the empirical (stylized) facts of growth and business cycles.

Figure 1.

Left panel: Log of GDP per worker, 1950-2000, USA.

Right panel: Log of the total (cumulated) number of patens granted by the US patent authorities from 1790 up to the year in question, 1950-2000, USA



Note: The black curves show actual numbers and the grey lines are linear trends

Sources: Penn World Table 6.1. Technology Assessment and Forecast (TAF) Branch, U.S. Patent and Trademark Office (USPTO)