# Macro II, Spring 2016

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**Instructions.** The exam consists of two parts, part one covering John's part of the course and part two covering Karl's.

**Exam score.** Part one contains three exam questions with a total maximum of 100 points. Part two contains three exam questions with a total maximum of 100 points. The exam score is the sum of the scores on part one and two divided by two.

**Course score** The course score is a weighted average of the exam score and the score on the problem sets. Weights are 4/5 on the exam and 1/5 on the problem sets. The threshold for pass is 50 and for pass with distinction 75.

The core of your answers should be based on what you have learned during the course. Make sure you specify your definitions and assumptions clearly.

## Part I

1. **Labor supply in the long and short run (40 points)** Consider the planning problem

$$\max_{\{C_t, K_{t+1}, L_t\}_{t\geq 0}} E\sum_{t=0} \beta^t U(C_t, L_t)$$
$$\text{s.t. } C_t + K_{t+1} = Z_t F(K_t, 1-L_t) + (1-\delta) K_t \forall t \geq 0$$
$$K_0 \text{ given}$$

and where $Z_t$ is productivity, $C_t$ consumption, $L_t$ leisure and $K_t$ capital. $\delta$ denotes depreciation and $U$ and $F$ satisfy standard concavity conditions.

(a) (10) Derive the optimality conditions for the planner by using the first order conditions for $C_t, K_{t+1}$ and $L_t$. Express your results as:

1. an Euler condition expressing the intertemporal optimality condition involving a trade-off between $C_t$ and $C_{t+1}$ and
2. an intratemporal optimality condition involving a trade-off between labor and leisure. Show the steps in your derivations!

(b) (10) Suppose that $U(C_t, L_t) = \frac{\sigma\left(C_t L_t^{1-\nu}\right)^{\frac{\sigma-1}{\sigma}} - 1}{\sigma-1}$. Show that this formulation implies that labor supply is constant along a growth path where labor productivity (and thus the wage) and consumption grows at a constant and common rate.

(c) (10) Discuss verbally how leisure (labor) responds to a permanent versus a shortlived increase in the wage. Provide an intuitive explanation for your result.

(d) (10) Now consider quasi-linear preferences $U(C_t, L_t) = \frac{\left(C_t + L_t^{1-\nu}\right)^{1-\sigma} - 1}{1-\sigma}$.

1. Analyze whether these preferences are consistent with balanced growth and constant labor supply.
2. Compare the effects on leisure (labor) of a permanent vs. a temporary increase in the wage.

2. **Monopolistic competition (40 points)**. In class we discussed a model with a large number of different consumption goods, produced under monopolistic competition. Now instead assume that there

is only one final good $Y$. This good is produced using $N$ different intermediate goods $Y_i$, $i \in \{1, ..., N\}$ according to the production function

$$Y = \left( \sum_{i=1}^{N} Y_i^q \right)^{\frac{1}{q}}, q \in (0,1)$$

Suppose there is a large number of final good producers acting on a competitive market but that each intermediate good is produced by a monopolist. Let $P$ be the price of the final good and let $P_i$ be the price of intermediate good $i$.

(a) (10) Write down the profit function of a representative final good producing firm and take the first-order condition for the purchase of good $i$. Use this to derive the demand function for good $i$. (Hint: Use the first order condition for $Y_i$ and note that $\left( \sum_{i=1}^{N} Y_i^q \right)^{\frac{1}{q}-1} = Y^{1-q}$).

(b) (10) Suppose that the production function of a representative intermediate goods producing firm $i$ is $Y_i = \phi L_i$where $\phi$ is a parameter determining marginal labor productivity and $L_i$ is labor input.

1. Write the cost function of the intermediate firm, i.e., nominal costs as a function of its output and the nominal wage $W$.
2. Write the nominal profit function of the firm using the cost function you just derived and the demand function from (a.) to substitute for $Y_i$.

(c) (10) Show that the price that maximizes the intermediate good producing firm's profits is a markup on its marginal costs.

(d) (10) Now consider a dynamic setting where the firm might be unable to reset its price the next period (after that it can reset for sure). The probability that the firm cannot reset the price is denoted by $p$. Write down the first order condition for the firm and note specifically which variables would imply that the current optimal price would more reflect next period's marginal costs.

3. **New Keynesian Models (20 points)**. Describe briefly the main similarities and differences between the RBC and the New Keynesian modelling approaches. Focus on key features of prototype models. Also briefly discuss their respective advantages and shortcomings. Be brief, 100 words is likely to be enough.

# Part II

4. **Short questions**. **(25 points)** Please answer briefly.

(a) (6 points) What's the relationship between earnings and wealth inequality (say, e.g., in terms of cross-sectional standard deviation)? Does the Aiyagari (1994) model generate too much or too little wealth inequality for a standard earnings calibration? Mention a mechanism or changed assumption that could reduce this discrepancy between model and data.

(b) (5 points) For the US in the last 100 years, what is the key time series pattern for income inequality that Piketty reports? Is the change since 1970 mainly driven by capital income or labor income? How is Europe different in this respect?

(c) (7 points) Precautionary savings: Assume that marginal utility is convex, i.e. $U''' > 0$, and that $\beta(1 + r_t) = 1$. The budget constraint is $c_t + a_{t+1} = (1 + r_t) a_t + y_t$ where $c_t$ denote consumption, $a_t$ denote savings, $y_t$ denote earnings and $r_t$ is the net interest rate. Derive the partial equilibrium result that savings are higher in a world with idiosyncratic earnings uncertainty compared to a world without such uncertainty.

(d) (7 points) What is the research question in Krusell *et al.*, "Gross worker flows over the business cycle"? In their model the decision to participate in the labor market depends on two idiosyncratic variables. Characterize the participation decision in terms of these two variables - draw a diagram if you like.

5. **The Aiyagari model (29 points)**

 (a) (6 points) Define the stationary equilibrium in the Aiyagari model.

 (b) (11 points) For this model, please draw the demand and supply of capital curves (capital $K$ on the x-axis, interest rate $r$ on the y-axis) as well as the borrowing limit. Mark the equilibrium interest rate and capital stock. Finally, mark the interest rate that would obtain if markets where complete.

 (c) (7 points) Quantify the precautionary savings using the figure from b). What are the two reasons for precautionary savings in this model?

 (d) (5 points) Name and explain three different changes of parameter values in this model that would yield a higher equilibrium interest rate.

6. **The Diamond-Mortensen-Pissarides model (46 points)**
 Consider a setup similar to the standard DMP model discussed in class. In particular, we have: risk-neutrality, homogenous workers, homogenous firms, a worker-firm match produces output $y_t$. Wages, $w_t$, are determined by Nash bargaining, the cost of creating a vacancy is $c$, free entry of firms, unemployment benefits, $b$, exogenous break-up rate, $\delta$, constant labor force participation normalized to unity, no intensive margin (choice of hours/worker). The discount factor is $\beta$. Denote the job finding rate with $f_t$ and the vacancy filling rate with $q_t$.
 Please define clearly any notation that you add.

 (a) (7 points) Please write down and explain the value, $W$, to a worker of being employed, compared to being unemployed. Assume that a worker that loses his job doesn't have the ability to look for a new job until the next period.

 (b) (5 points) Assume a matching function $M_t = \gamma_t V_t^{1-\lambda} U_t^{\lambda}$ where $V$ denotes vacancies and $U$ unemployment. Derive expressions for the job finding rate and the vacancy filling rate in terms of market tightness, $\theta_t \equiv V_t/U_t$.

 (c) (7 points) State the job creation condition implied by free entry, assuming that a vacancy that is filled today becomes a productive match the next period.

 (d) (7 points) Describe, using the relevant equations, how a temporary, unexpected one-period increase in $\gamma_t$ affects the equilibrium quantities: vacancies, matches, unemployment etc. Mention which variables are affected and for how long.

 (e) (7 points) What is the Shimer (2005) puzzle? Name two suggestions in the literature on how to solve or reduce this puzzle.

 (f) (7 points) Using equations for flows into and out of unemployment in steady state, derive a steady state expression for the job finding rate $f$ as a function of the job separation rate and unemployment.

 (g) (6 points) Explain the appropriation externality and the congestion externality that affect the vacancy posting level in the DMP model, including in what direction (increasing or decreasing vacancies) each of them go.