Macroeconomics III: Task list 1

To be handed in by

All answers should be SHORT AND PRECISE! Good luck!

NOTICE: All the impulse responses are reactions to a one-percent shock. They are in percentage deviations from steady state. Only the interest rate is in *percentage point* deviations.

1) **RBC Model with adjustment costs**

The model is an RBC model with adjustment costs, such that

$$K_t = (1-\delta)K_{t-1} + \phi(I_t)K_{t-1} \tag{1}$$

The price of installed capital is given by

$$Q_t = 1/\phi_I(I_t) \tag{2}$$

a) There are two Euler equations:

$$U_c(C_t, L_t)Q_t = \beta U_c(C_{t+1}, L_{t+1})(Rk_{t+1} + Q_{t+1}(1-\delta)) \tag{3}$$

$$U_c(C_t, L_t) = \beta(1 + r_t)U_c(C_{t+1}, L_{t+1}) \tag{4}$$

Why are there two now? Explain both of them.
Solution: We assume two assets: installed capital, and an asset with a riskless real return r_t.

(3) is the Euler equation for installed capital, which has price Q. For one unit of installed capital, we give up $U_c(t)Q_t$ in period t. In the next period, we earn on it the rental rate Rk_{t+1}, plus the value of the installed capital net of depreciation. The return is valued at next period's marginal utility, discounted by β.

(4) is the standard equation for a riskless real return. Notice that the return r_t is known in t (this is what "riskless" means).

b) Use this to explain why Rk goes up on impact and r goes down (cf. Figure (1)).
Solution: Higher productivity and labor input increase the marginal productivity of installed capital, therefore the rental rate Rk goes up on impact.

The increase in Q on impact is a windfall gain to capital owners, but the future reductions in Q mean a lower future return on capital. Since the return on all assets has to be the same in a linearized solution, the return on the riskless asset also decreases.

c) Explain why investment increases much less on impact than in the simple RBC model.
Solution: Simple: convex adjustment costs make fast adjustment of the capital stock very costly; so investment reacts less.

d) Why is labor input below steady state from period 20 onwards?
Solution: Productivity is almost back to normal, and so the wealth effect (more leisure) dominates.

2) **Mortensen/Pissarides Model**

Consider Figure (2), which shows the impulse response to a technoloyg shock in the MP model.

a) Explain why pW goes up and pF goes down
Solution: Increase in productivity increases the surplus from a match (difference value match to value unemployed); the increased surplus is split between firm and worker, this means that the firm is willing to post a vacancy even if pF is lower (lower probability compensated by higher profit); from the mechanics of the matching function, lower pF (higher tightness) implies higher pW.

b) Notice that the reduction in unemployment is very strong. This has to do with the parameter choice $b = 0.96$. Explain why the reduction would be much smaller with a parameter of $b = 0.4$, for example.
Solution: The percentage change in pF comes from the percentage (proportional) change in surplus. If $b - 0.4$, the average surplus is already high, so an increase in productivity causes a smaller percentage change in the surplus than with $b = 0.96$, where the average surplus is small.

c) Explain why M goes back to normal much faster than pW.
Solution: M are created by vacancies and searchers. Although pW stays high, after some time there are fewer unemployed, and therefore fewer new matches.

3) **NK Model (Gali chapter 3)**

a) Consider Figure (4), which shows the impulse response to a technology shock in the NK model. We see that labor input decreases on impact. Explain why this happens (what is the essential difference of the NK model compared to the RBC model that is responsible for this?).
Solution: Put simply: because of price rigidity, demand determines production (this holds as long as price is bigger than marginal cost, cf. below). Demand here is consumption demand. There are two effects on consumption:

i. The wealth effect from higher productivity; notice that it is not only the wage that determines household wealth; the total increase in productivity goes to the household, partly in terms of profit income. Lower wage (compared to productivity) means higher profits.

ii. The substitution effect, coming from changes in the real interest rate. This depends on monetary policy. The increased productivity lowers marginal cost (wage increases less than productivity, as can be seen in the graphs); those firms that can change their price lower it (at least compared to steady state inflation rate), which decreases inflation. The nominal interest rate then decreases even more, lowering the expected real rate.

Both effects increase consumption on impact, but not by enough to compensate for the increase in productivity, therefore less labor is needed to satisfy consumption demand.

The central difference to the RBC model is price rigidity; this generates endogenous fluctuations in markups. With flexible prices, each firm would set at any moment

$$P_t = MC_t \frac{\epsilon}{\epsilon - 1} = \frac{w_t}{MPL_t} \frac{\epsilon}{\epsilon - 1} \tag{5}$$

which implies that

$$\frac{w_t}{P_t} = MPL_t \frac{\epsilon - 1}{\epsilon} \tag{6}$$

such that the real wage is a constant markup over marginal costs. For firms that cannot adjust their price in this period, a changing wage will change the markup. Therefore, price rigidity makes the markup endogenous.

Notice that households are on their labor supply schedule; the wage will adjust so that this is the case; the wage does not affect firms' labor demand, as long as $P_t > MC_t$. We assume that fluctuations are small enough such that $P_t > MC_t$ is always satisfied.

b) Why does inflation go down? Why does the nominal interest rate go down?
Solution: Real marginal costs are real wage divided by the MPL. Higher productivity increases the MPL, and the real wage goes up by less than MPL, there real marginal costs go down. This means that the firms who can change prices adjust then donward, compared to the situation without the technology shock. This decreases the inflation rate.

The nominal rate then goes down mechanically, because of the Taylor rule.

c) Explain how the change in the real interest rate is compatible with the path of consumption.
Solution: Nominal rate down(compared to steady state), inflation also down but less

(compare R_t to π_{t+1}), means the real interest rate is lower than in steady state, this implies a decreasing consumption path after the period of the shock. After the first shock, there is no other shock, and the change in C exactly mirrors the level of the real rate. The increase of C on impact is due both to a positive wealth effect because of higher productivity, and the reduced real rate.

d) Now consider Figure (5), which shows the impulse response to an interest rate shock in the NK model.

Explain why the interest rate goes up by 0.5 percent (and not 1 percent).

Solution: The shock is the difference between R and the Taylor rule. The Taylor rule incorporates the instantaneous reaction to the current changes, in particular the reduction in inflation. The reduction in inflation is about 1/3 percentage point, multiplied by the coefficient 1.5 this give a 1/2 percentage point reduction in the interest rate, so that the total rate increase is $1 - 0.5 = 0.5$ percent.

e) Explain the time path of consumption.

Solution: Similar to above: nominal rate up(compared to steady state), inflation down means the real interest rate is higher than in steady state, for a number of periods. This increase in the real rate, in the absence of a significant income effect (no change in productivity) implies a reduction of consumption demand on impact. Since demand determines production, this then causes the reduction in outpout.

After the impact, consumption has to grow, because the rate of interest is higher then in steady state.

Figure 1: IR to technology shock, RBC model

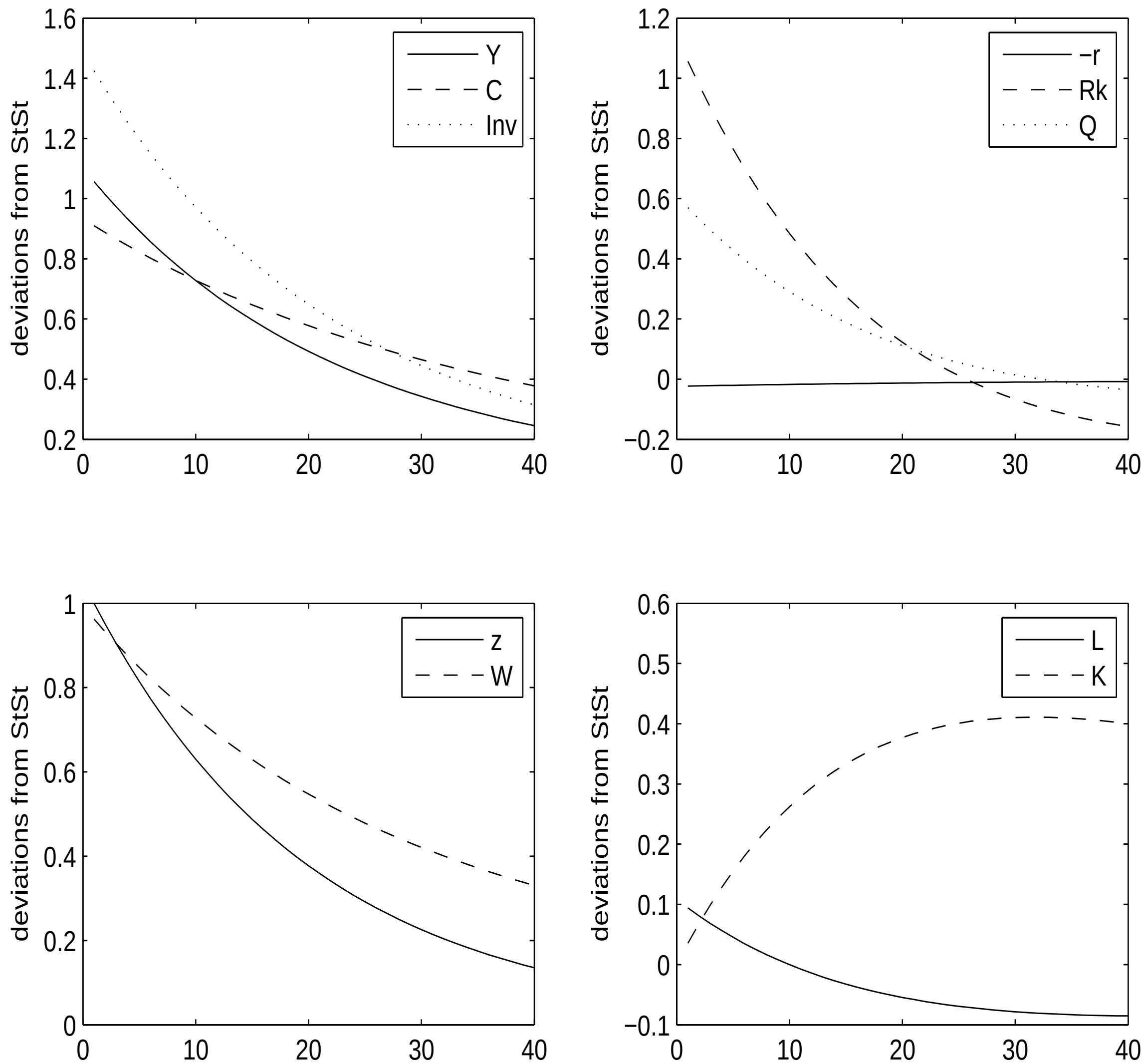

Figure 2: IR to technology shock, Mortensen/Pissarides model

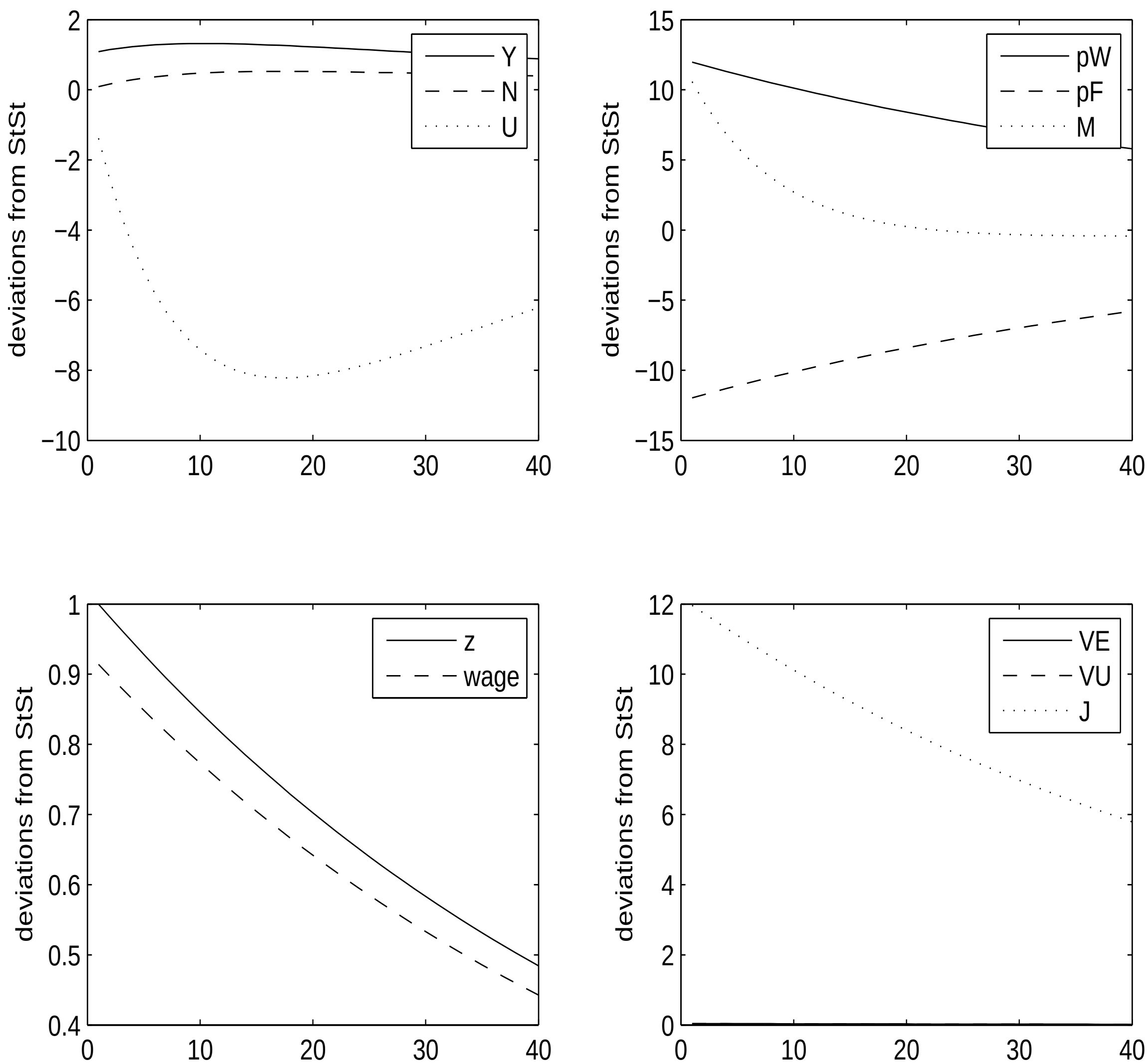

Figure 3: IR to technology shock, BGG model

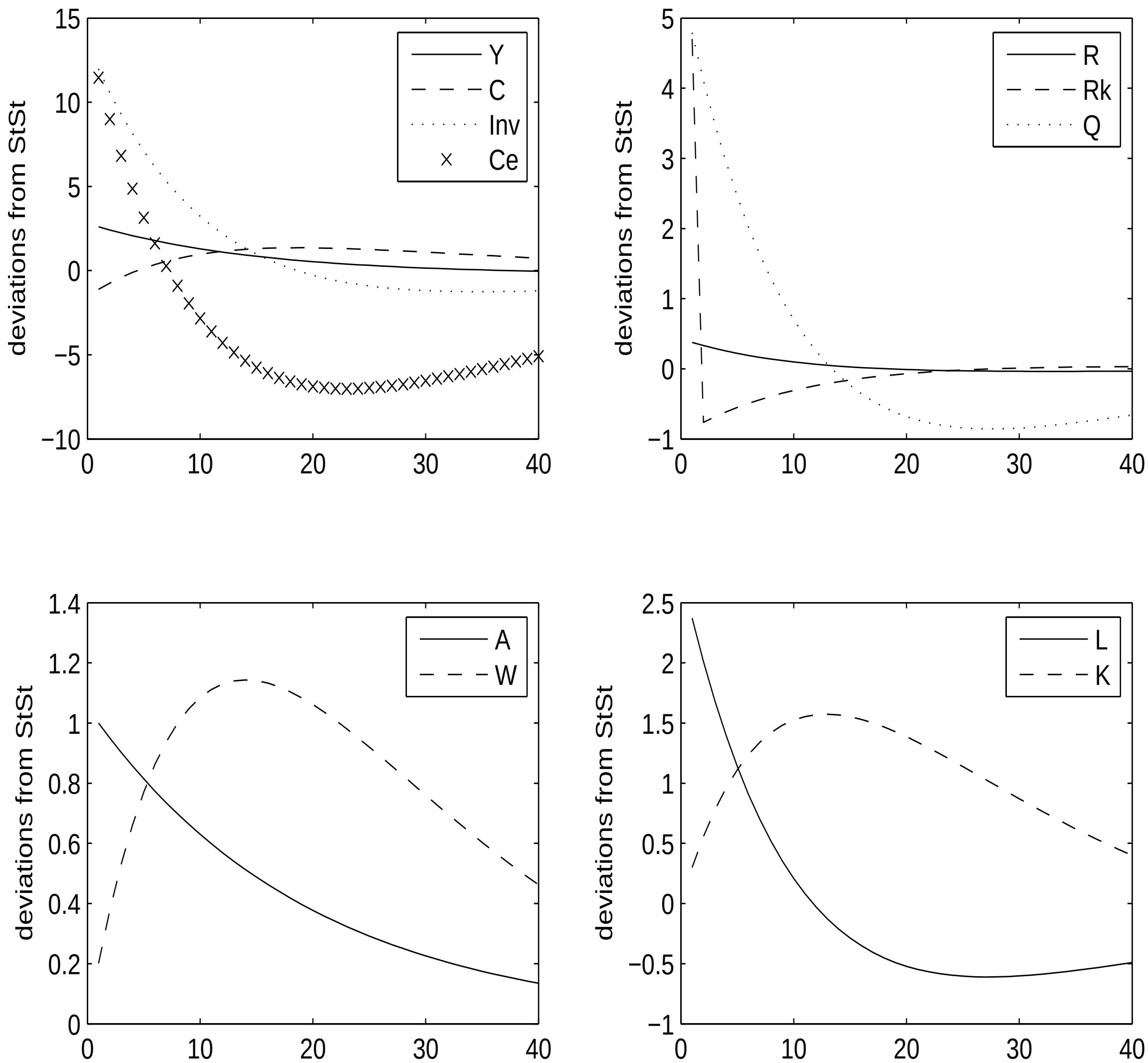

Figure 4: IR to technology shock, Gali model

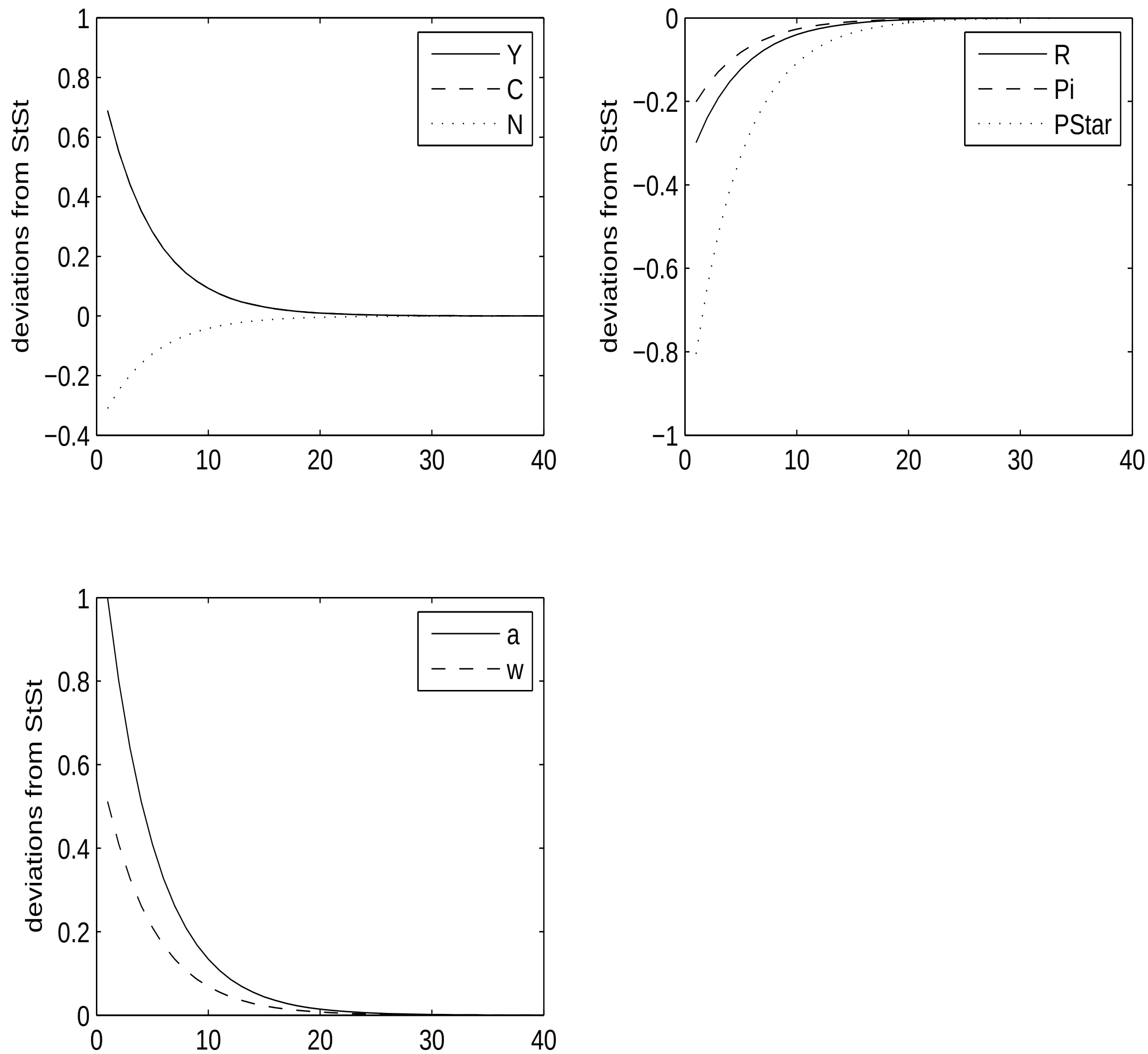

Figure 5: IR to interest rate shock, Gali model