Suggested answers for written Exam for the B.Sc. in Economics winter 2015
Macro B

Final Exam

January 13 2015
(3 hours closed-book exam)

Academic Aim: The aim of the course is to describe and explain the macroeconomic fluctuations in the short run, i.e. the business cycles around the long run growth trend, as well as various issues related to this, and to teach the methodology used in formulating and solving formal models explaining these phenomena. Students are to learn the most important stylized facts about business cycles and to acquire knowledge about theoretical dynamic models aimed at explaining these facts. In connection with this, the aim is to make students familiar with the distinction between deterministic and stochastic models. Furthermore, students are to gain an understanding of the distinction between the impulses initiating a business cycle and the propagation mechanisms that give business cycles a systematic character. Finally students are to learn how to use the models for analyzing the effects of macroeconomic stabilization policy under various assumptions regarding the exchange rate regime. To obtain a top mark in the course students should at the end of the course be able to demonstrate full capability of using the techniques of analysis taught in the course as well as a thorough understanding of the mechanisms in the business cycle models for open and closed economies, including the ability to use relevant variants and extensions of the models in order to explain the effects of various shocks and the effects of macroeconomic stabilization policies under alternative monetary and exchange rate regimes.

Problem A

1. Equation (A.1) is the money market equilibrium condition which states that real money supply, M/P, has to equal real money demand, L. M is the nominal money supply and P is the general price level. Money demand, $L(Y, i)$, depends positively on income since a higher income leads to more transactions which requires more liquidity. At the same time money demand varies negatively with the nominal interest rate because the opportunity cost of holding money is higher when the interest rate goes up; the cost of holding liquidity instead of interest bearing assets is increased. In equation (A.2) the strength of the transaction motive for holding money is reflected in the parameter η whereas the speculation motive is reflected in β.

   The income elasticity of money demand is

   $$\frac{dL}{dY}\frac{Y}{L} = \eta k Y^{\eta-1} e^{-\beta i} \frac{Y}{kY^{\eta} e^{-\beta i}} = \eta,$$

   so that money demand is increased by η percent when income, Y, is increased by 1 percent.

   The semi-elasticity of money demand wrt. the interest rate is

   $$\frac{dL}{di}\frac{1}{L} = -\beta k Y^{\eta} e^{-\beta i} \frac{1}{kY^{\eta} e^{-\beta i}} = \beta,$$

   meaning that money demand is increased by β percent when the interest rate, i, is increased by 1 percent point.

2. Based on a study of almost 100 years of monetary policy in the USA Milton Friedman and Anna Schwartz concluded that monetary policy affected the real economy with long and variable lags. Therefore, Friedman was convinced that policy makers who are trying to stabilize the economy in fact often end up destabilizing the economy. Also, Friedman believed that money demand was stable and that money demand had a low interest elasticity. Under these circumstances a constant growth rate in nominal money supply will ensure stable growth in nominal money income. Furthermore, in Friedman's view the self-regulating market forces are so strong that activity and employment fairly quickly are pulled towards their natural levels. Therefore, the CMG

based monetary policy will also ensure a high degree of stability in the growth of real income. This may also be seen formally by applying the money market equilibrium condition (A.1) and (A.2). It follows that if β is close to zero and η is close to 1 then

$$\frac{M}{P} = kY^{\eta}e^{-\beta i} = kY$$

so that a stable development in nominal income is achieved if the development in money supply is stable. Though the student is not expected to give above mentioned historical "tour de force" in its entirety it is expected that the observation of long and variable lags is mentioned. Also, the formal description is expected.

3. When money supply is following the constant growth rule the money supply is the policy instrument - the exogenous variable - chosen by the central bank. In this situation the central bank wants a certain nominal money supply and the nominal interest rate ('the price of money') becomes an endogenous variable that eqilibrates the money market by bringing (real) money supply and demand in line with each other.

   An increase in y will increase the interest rate. A higher value of y will increase real money demand due to a higher transaction demand. Since real money supply is growing at an unchanged rate this increase in money demand has to be eliminated so that demand equals supply. Hence a higher interest rate is needed. This increases the opportunity cost of holding money which in turn reduces money demand.

   It is seen that for a given increase in y the increase in i needed in order to secure money market equilibrium is larger, the stronger the transaction motive in money demand (η) and the weaker the speculation motive (the lower β, yet positive). The reason is that the increase in money demand is larger when η is larger. Thus, the cancelling effect on money demand through the speculation motive has to be strenghtened. Hence i has to be increased. The needed increase in i is larger if β is lower because money demand becomes more insensitive to changes in the interest rate. Therefore it takes an even larger increase in the interest rate to obtain a given effect on money demand.

An increase in inflation, π, will increase the nominal interest rate (since $\partial i/\partial \pi = 1 + (1-\beta)/\beta = 1/\beta > 0$). Other tings equal an incrase in inflation will reduce the growth in real money balances. Hence growth in money demand has to be reduced. This requires an increase in i. It is noted that if $0 < \beta < 1$ then the increase in the nonimal interest rate is larger than the increase in inflation. This is the Taylor principle which is the driving force behind stability in the AD-AS model backed out in the text book.

We may interpret μ as the central bank's inflation target. Though not expected the student may comment on the effects on i from a change in μ.We cannot tell whether the interest rate will be increased or decreased by an increase in μ, since $\partial i/\partial \mu = -(1-\beta)/\beta \lesseqgtr 0$ if $\beta \gtreqless 1$. The reason is that an increase in μ will have two opposite effects on real money supply: it will increase the growth rate of the nominal money supply thereby increasing the growth rate of the real money supply. At the same time it will increase long run inflation which is a drag on real money growth. For the money market to be in equilibrium, the change in the growth rate of real money supply will have to equal the change in the growth rate of real money demand. Depending on whether the change in μ induces a change in the growth rate of real money supply which is smaller, greater or equal to the induced change in real money demand, the interest rate will have to either increase, decrease or to be unchanged in order to equal real money supply and demand.

$\overline{r}$ is the equilibrium real interest rate. It is the real interest rate when output is at the 'natural level', $y - \overline{y}$ and inflation is at the target level, $\pi = \mu$.

If β is close to zero, it follows from (A.3) that fluctuations in the output gap and the rate of inflation leads to large fluctuations in the nominal and real interest rate to maintain a constant growth rate of the nominal money stock. This may be problematic, since sharp fluctuations in the real interest rate will tend to cause a significant redistribution of income between borrowers and lenders. (A.3). Furthermore, if the demand for money is unstable (the pameters k, η and β change in a unpredictable way), the constant money growth rule is hard to implement and will not succeed in ensuring a stable growth of nominal income. In these circumstances it may be better to follow a Taylor rule where the responses of the central bank interest rate to changes

in output and inflation are not determined by the (estimated) parameters of the money demand function, but are chosen directly by the central bank with the purpose of stabilizing output and inflation.

4. When the central bank has ideal condition for conducting monetary policy all shocks are perfectly observable. As a consequence the central bank can immediately and perfectly observe and respond to the various types of shocks hitting the economy. There are no inside lags related to neither the recognition of shocks nor the decision and implementation of the policy response. Furthermore, the central bank has full credibility so that inflation expectations are firmly anchored by its inflation target and no outside lags exists. Economic agents reacts swiftly to changes in policy. Interest rates are adjusted instantaneously throughout the economy to changes in the monetary policy rate and by assumption there are no delay before a change in the policy rate attains its (full) impact on aggregate demand and no additional time before a change in the output gap leads to a change in inflation. Hence, the economy responds immediately to changes in the policy rate.

   These assumptions are very heroic, but as a benchmark it is useful to know what stabilization policy can be expected to achieve under the most favorable circumstances imaginable. In reality, the central bank cannot identify precisely the shocks hitting the economy. Many shocks cannot be directly observed imediately when they hit the economy. In reality it has also proven difficult to distinguish between demand and supply shocks. Furthermore, it is hardly the case that the central bank knows the true structure of the economy. Thus, the central bank also has imperfect information in relation to how policy changes affect the term structure and private demand. Lags may be long and variable. As a result in practice the conduct of monetary policy is surrounded by various problems on timing and dosing etc. of policy.

5. When information is perfect the central bank is able to respond directly to the specific shock that has occurred. Each shock has its own term in optimal policy function. Hence, it is optimal to respond to the specific shock instead of the resulting output and inflation gap as prescribed in the Taylor rule. This may be one of several reasons why the ECB is not following a simple

Taylor rule.

An expansion in government demand so that $(g - \overline{g})$ is equal to 1 percent calls for an increase in the policy rate of α_1/a_2-percentage point. According to equation (A.5) an increase in the policy rate of α_1/a_2 percentage point reduces private sector demand by $a_2 \cdot \alpha_1/a_2 = a_1$ percent. Thereby monetary policy eliminates the effect on total demand from the expansion in government consumption and thereby any effect on inflation is eliminated also.

Demand shocks may be stabilized perfectly since they do not raise a dilemma between stabilizing output and stabilizing inflation. It is seen that the parameters in the social loss function do not enter the in the expression governing the optimal policy response to demand shocks. This is a sufficient explanation. (The student may add that since the AS-curve is linear any output and inflation gaps induced by shifts in the AD-curve are perfectly correlated). Supply shocks on the other hand raises a dilemma for the central bank. A negative supply shock for example reduces output while at the same time increase inflation. In that case a lowering of the monetary policy rate in order to stimulate demand will lead to even higher inflation bringing inflation further away from the target value. This is reflected in equation (A.5) where it is seen that the optimal response depends on the weights in the social loss function attached to fluctuations in employment and inflation, a_l, a_π respectively.

Though not asked for, it could be noted that mark-up shocks and productivity shocks - both are supply shocks - calls for different monetary policy reactions. This is easily seen as the coefficients in the optimal monetary policy function (A.2) are different. For instance when an adverse mark-up shock hits the economy the AS curve shifts upwards. Then the central bank will accept a lower level of output. If it were to increase output, it would push inflation further above target. (Also, in the text book it is assumed that the cost of increasing inflation rises with the square of the inflation gap). In case a negative productivity shock is shifting the AS curve upwards the central bank accepts an even lower level of output compared to a mark-up shock with the same direct cost effect. The reason beeing that a higher out-

put can only be sustained by requiring workers to put in more hours when productivity is low. This is not optimal because an even higher labor input is required when the output produced from a given effort is unusually low. To stimulate labour supply a higher wage rate is needed which in turn drives marginal costs and hence inflation even higher.

6. Equation (A.6) is a financial arbitrage condition that establish a connection between short-term and the long-term interest rates (effective yield) – the yield curve.

   The right-hand side of (A.6) is the total amount of money a firm is expected to pay back at time $t + n$ if financing an n-year running investment project using the short-term interest rate which is "rolled over" each period at the initially expected short-term interest rates for each of the future n years. The left-hand side is the total amount the firm should pay had it chosen to finances the project through a fixed long-term interest rate. If the right-hand side is lower than the left-hand side, no firms will finance investment projects through the long-term interest rate et vice versa. Therefore, in a financial market equilibrium the left-hand side is expected to equal the right-hand side.

   This simplistic argument requires the lender and borrower to be risk neutral. Although not asked for the student could elaborate on this by noting that that, neither lender nor borrower knows how interest rates change in the future and therefore a risk premium could be added to the tight hand side of the equation. The lender is likely to prefer to be able to re-negotiate the terms of the load each period rather than commit to a interest rate. Likewise, the borrower would like to eliminate the risk of rising interest rates and prefers to borrow at fixed rate. Hence, in equilibrium with risk averse investors a risk premium, ε_t, is plausible. The risk premium is the price the borrower is willing to pay to eliminate risks of swings in the interest rate as it is the compensation required by the lender for eliminating the borrowers' risk.

Using the approximation $\ln(1+x) \approx x$ if $x \approx 0$ (A.6) may be rewritten as

$$n \ln\left(1+i_t^l\right) = \ln(1+i_t) + \ln\left(1+i_{t+1}^e\right) + \ln\left(1+i_{t+2}^e\right) + \\ ... + \ln\left(1+i_{t+n-1}^e\right)$$

$$\Downarrow$$

$$n i_t^l \approx i_t + i_{t+1}^e + i_{t+2}^e + ... + i_{t+n-1}^e$$

$$\Downarrow$$

$$i_t^l \approx \frac{1}{n}\left(i_t + i_{t+1}^e + i_{t+2}^e + ... + i_{t+n-1}^e\right). \tag{A.7}$$

This is called the expectations hypothesis which states that the long-term interest rate is a simple average over the expected short-term interest rate over the corresponding period.

As shown in the above the central bank can affect the short term interest rates (through the policy rate). The long-term interest may be influenced by movements in short term interest rate, and by affecting the expected future sort-term interest rates. This is *i.a.* affected by the central banks willingness to secure stability of output and inflation and through the central banks communication.

Central bank credibility plays a crucial role for the central banks ability to affect total demand in the economy. If the central bank is unable to provide the market with information regarding the expected development in future short-term interest rates, it cannot affect the long-term interest rates much and it is ultimately unable to control the longer-term interes rates.

In the extreme case where the central bank has no credibility it can not affect future short term interest rates at all through communication. In this situation the only (and negible) effect on long term interest rates comes from the observed reduction in the current policy rates.

7. In scenario a) the short term interest rate is lowered in exactly one period. In scenario b) the short term interst rates are expected to be lowered by one percentage point in five years. In scenario c) the short term interest rates are expected to be lowered by 1 percentage point for more than one year but less than five years. It follows directly from equation (A.7) (A.2)

that if a period is one year then the effect of a temporary 1 percentage point reduction in the short tem interest rate lasting for one year will have an effect on the long term interest rate of $1/n$. Hence, the one-year reduction in the interest will affect the current 10-year interest by one-tenth of a percentage point. Correspondingly, the 30-year interest rate will be affected by 1/30 of a percentage point. The effect in scenario b is five times af large. The current 10-year interest is lowered by five-tenth of a percentage point and the 30-year interest rate will be affected by 5/30 of a percentage point. The effect in scenario c) is somewhere between this.

Central bank credibility plays a crucial role for the central banks ability to affect total demand in the economy. In the extreme case where the central bank has no credibility the only (and negible) effect on long term interest rates comes from the observed reduction in the current policy rates. (It could be argued that the observed reduction in the policy rate may be expected to last for less than one year so that the effect from the reduction in i^p is negigible).

Problem B

1. Under both fixed and flexible exchange rates, a higher inflation rate results in a lower output gap because of an appreciation of the real exchange rate which is defined as

$$\varepsilon = \frac{eP^f}{P}$$

where e is the nominal exchange rate (the number of domestic currency units needed to aquire one unit of foreign currency), P^f is the foreign price for the foreign good in terms of foreign currency units and P is the price of the domestic goods in terms of domestic currency units.

Under fixed nominal exchange rates, the real exchange rate appreciation is solely caused by higher domestic inflation. A higher rate of inflation leads to an appreciation of the real exchange rate and hence a loss in external competitiveness. Declining exports and rising imports result in a lower real GDP and hence a smaller output gap. The negative correlation between inflation and the output gap is reflected in the negative slope of the short-run aggregate demand curve.

This effect is also present under flexible nominal exchange rates. However, under flexible exchange rates, a higher rate of inflation also induces higher nominal interest rates via the Taylor rule. Therefore, two additional effects are present. Both curbs demand for domestic goods so that the AD-curve becomes flatter. The first effect is known from the closed economy. The policy rate is increased so much that the real interest rate is increased (the Taylor principle). As a result total domestic demand (private consumption and investments) is reduced. The second effect results from the uncovered interest parity. With the foreign rate of return unchanged, higher domestic interest rates leads to a capital inflow and a rising demand for domestic currency. As consequence, the nominal exchange rate appreciates and so does the real exchange rate. Due to the loss in external competitiveness, output declines and the output gap declines, too.

2. The expectations augmented Phillips curve states that in the short run there is a trade-off between unemployment and inflation. For a given level of inflation expectations any combination of unemployment and inflation associated

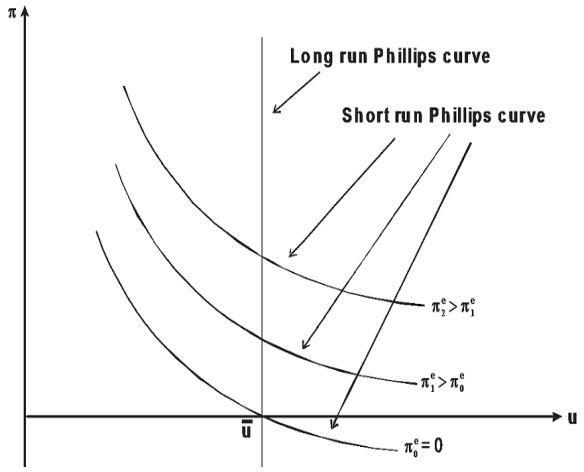
with this specific Phillips curve (which position is determined by π^e) may be obtained. The expectations-augmented Phillips curve allows for shifts in the trade-off between inflation and unemployment as the inflation expectations changes.

In the short run lower interest rates or expansionary fiscal policy such as increasing public consumption or lowering taxes may foster lower unemployment. However, according to the Phillips curve it comes at a cost; namely higher inflation. In the textbook this increase in inflation is driven by higher growth rates in marginal cost in production which are translated into higher inflation.

Though not irrelevant,the student is not expected to discuss Ricardian Equivalence, foreign trade effects or a counteracting monetary policy. The student could note, that an active monetary policy is not a feasible option forthe Danish Central Bank. It has no means of stimulating short-run employment since the purpose of Danish monetary policy to maintain the peg towards the euro.

An economic policy that is systematically focused on obtaining $u < \overline{u}$ will lead to an ever increasing inflation level. It is possible to have an unemployment rate below the natural rate of unemployment if our actual rate of inflation is above the expected rate of inflation. However, such a low rate of unemployment cannot be sustainable because the actual inflation exceed the expected inflation assuming that expectations includes a backward-looking component (in the textbook static or adaptive inflation expectations are assumed). As a result inflation expectations will be rising. That means the Phillips curve trade-off would shift upwards and the lower rate of unemployment would require a rate of inflation even higher than before. Inflation expectations follows this acceleration of inflation rates. An illustration could look like the following.

The mechanism outlined in the text book: Wage setters realise, that inflation is higher than expected. Hence, real wages lower and unemployment lower than targeted *i.e.* $\overline{u}$. As a consequence inflation expectations are revised upwards. This will shift the Phillips curve upwards. When economic authorities stimulate activity in order to obtain an unemployment level below



the structural level $u < \overline{u}$ actual inflation will once again outpace expectations. This process continues until a shift in economic policy takes place.

3. When explaining why it is socially desirable to stabilize inflation it is sufficient that the student notes that stabilizing around a constant target value makes it easier for wage setters, consumers and firms to forecast inflation. A fluctuating inflation rate typically leads to unanticipated inflation, causing the ex post real interest rate and the ex post real wage to deviate from their ex ante expected levels. Due to this unanticipated inflation and the resulting explication errors makes economic agents will make suboptimal decisions and hence experience lower welfare relative to a situation where actual inflation equals anticipations. When economic agents makes expatiation errors on inflation an arbitrary redistribution of real income between lenders and borrowers takes place and real wages deviate from target resulting in deviations in employment relative to target/structural employment.

   When choosing the inflation target, there is a trade-off between on the one hand the cost of inflation and on the other hand the risk of ending up in a liquidity trap and/or a limited scope for reducing real wages through (unexpected) high inflation. Even a stable positive inflation rate is socially costly due to so-called 'shoeleather costs', 'menu costs', relative price distortions due to staggered price setting. Also the tax system may fail to distinguish between nominal and real income from capital. When inflation is kept low these cost are likely to be small. The target rate should however be above

zero as policy makers should take into account that a very low inflation rate and hence a low level of nominal interest rates reduces the scope lower real interest rates when the economy is hit by a negative shock, since the nominal interest rate cannot fall below zero. A very low inflation rate may also reduce the scope for a downward adjustment of real wages if nominal wages are downward sticky.