Suggested answers for written Exam for the B.Sc. in Economics 2013

Macro B

Final Exam

June 24 2013
(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.

A.

1. Equation (A.1) states the goods market equilibrium value of real output. (Although not correct it, is acceptable if students refers to (A.1) as the goods market *equilibrium condition*). The model is log-linearized around the long run equilibrium in which output is given by natural output, $\bar{y}$. In equilibrium real output is equal to demand. Government consumption, g_t, is one part of total demand of goods. $\bar{g}$ represents normal or trend demand from the government sector. This explains the positive effect from $(g_t - \bar{g})$ on the output gap $(y_t - \bar{y})$. The other part of total demand of goods is private demand which depends on the real interest rate, r_t. A higher real interest rate affects real demand due to the negative effect on demand through private investment and possibly also through private consumption. The effect on private consumption from a higher real interest rate can not be determined theoretically. This is due to the income effect stemming from a higher real interest rate. The income effect works in the opposite direction of the substitution effect and the income effect may dominate the substitution effect. Private investments on the other hand, are declining in the real interest rate. This is due to a tougher discounting of future expected dividend payments. Thereby, the stock market valuation of firms is lower. This in turn reduces the value of existing capital relative to the replacement cost (Tobins q) making investments in real capital less attractive for shareholders. In the textbook total private demand is assumed to decline when the real interest rate goes up. This assumption is backed by the empirical evidence presented in the textbook.

   (A.2) defines the (ex ante) real interest rate,with ρ_t representing shocks to market risk premium.

   Equation (A.3) is the monetary policy rule. Monetary policy is assumed to follow a Taylor rule where policy aims at stabilizing both inflation and activity around the central banks target values π^* and $\bar{y}$ respectively. The monetary policy rate is an increasing function of the inflation gap and the output gap, where the inflation gap is defined as the difference between actual inflation, π_t, and the target level for inflation, π^*.

Combining (A.3) and (A.2) it is seen that an increase in inflation makes the central bank raise the policy rate so much that the real interest rate is increased. This is the so-called Taylor principle which ensures that the model is stable. The economic intuition behind this is as follows: an increase in inflation also increase the real interest rate which will in turn decrease goods market demand and hence real output. As will be seen below, this will affect inflation negatively through the supply side of the economy.
(A.4) is the short run aggregate supply curve, SRAS, which states that inflation is an increasing function of real output and expected inflation. The SRAS curve is upward sloping. Given nominal wages a higher real output increases employment which in turn decrease the marginal product of labour. Thereby the marginal production costs of firms is increased and they respond by increasing prices. Also, a so-called right-to-manage model is underlying the wage setting in the model. As higher employment improves the unions outside option wage claims are increased. This in turn increase wage costs and hence marginal costs in production which leads to higher inflation. The SRAS curve will shift upwards if expected inflation goes up because the labour union sets nominal wages based on the expected inflation in order to obtain a certain real wage. Hence, higher expected inflation increases wage claims. Thereby marginal costs of firms are higher for any given output. Thus the SRAS curve shifts up.

Equation (A.5) is the assumption of static inflation expectations. The expected inflation is given as the actual inflation level in the previous period.

2. The AD curve (A.6) can be found by inserting (A.2) and (A.3) into (A.1). The calculations may look as follows:

$$\begin{aligned}
y_t - \bar{y} &= \alpha_1 (g_t - \bar{g}) - \alpha_2 (r_t - \bar{r}) + v_t, \quad \alpha_1 > 0, \quad \alpha_2 > 0 && \text{(A.1)} \\
&= \alpha_1 (g_t - \bar{g}) - \alpha_2 \left(i_t^p + \rho_t - \pi_{t+1}^e - (\bar{r}^* + \bar{\rho})\right) + v_t && \text{(insert A.2)} \\
&= \alpha_1 (g_t - \bar{g}) && \text{(insert A.3)} \\
&\quad -\alpha_2 \left(\bar{r}^* + \pi_{t+1}^e + h(\pi_t - \pi^*) + b(y_t - \bar{y}) - \pi_{t+1}^e - \bar{r}^* + (\rho_t + \bar{\rho})\right) + v_t \\
&= \alpha_1 (g_t - \bar{g}) - \alpha_2 (h(\pi_t - \pi^*) + b(y_t - \bar{y}) + \alpha_2 (\rho_t + \bar{\rho})) + v_t
\end{aligned}$$

from which it follows that

$$(1+\alpha_2 b)(y_t-\bar{y}) = \alpha_1(g_t-\bar{g}) - \alpha_2 h(\pi_t-\pi^*) - \alpha_2(\rho_t+\bar{\rho}) + v_t$$

$$\Downarrow$$

$$y_t-\bar{y} = -\frac{\alpha_2 h}{1+\alpha_2 b}(\pi_t-\pi^*) + \frac{\alpha_1(g_t-\bar{g}) - \alpha_2(\rho_t+\bar{\rho}) + v_t}{1+\alpha_2 b}.$$

(A.6) follows directly.

The SRAS curve (A.7) follows directly by inserting (A.5) into (A.4).

The AD curve has a negative slope because higher inflation induces the central bank to raise the policy interest rate, causing an increase in the real interest rate. This in turn induces a decline in total private demand as consumers and firms meet a higher real interest rate. See also above. The SRAS is upward sloping for the above mentioned reasons.

3. Figure A.1 illustrates the convergence process in the economy described above. In the long run actual inflation has to equal expected inflation, $\pi_t = \pi_t^e$. Accordingly, in the long run (where shocks are absent, *i.e.* $s_t = z_t = 0$) it then follows from the SRAS curve given by equation (A.7) that $y_t = \bar{y}$. From the AD curve in equation (A.6) it then follows that $\pi_t = \pi^*$. Thus, in Figure A.1 the long run equilibrium is given by the intersection between the vertical LRAS curve and the AD curve where $y_t = \bar{y}$ and $\pi_t = \pi^*$.

   In Figure A.1 the economy is initially in a recession at point E_0 which is the intersection between the AD and $SRAS_0$ curve. At E_0 inflation is π_0 and real output is $y_0 < \bar{y}$. Due to the assumption of static expectations it follows that in period 1 $\pi_1^e = \pi_0$. Assuming that the economy is not hit by any shocks the SRAS will shift down in period 1 to $SRAS_1$. Given static expectations the SRAS will shift down by the full vertical distance $\pi_0 - \pi_0^e$ so that $SRAS_1$ goes through the point $(\bar{y}, \pi_0)$. This can be seen by using (A.7) from which it follows that $y = \bar{y} \Rightarrow \pi_t = \pi_t^e$. The new short run equilibrium will then be given by point E_1 where inflation has decreased and real output increased compared to period 0.
   The economic explanation is the following: Between period 0 and period 1 there is a decrease in expected inflation (from π_0^e to $\pi_1^e = \pi_0$). This will cause the labour union to reduce the growth rate of nominal wages which

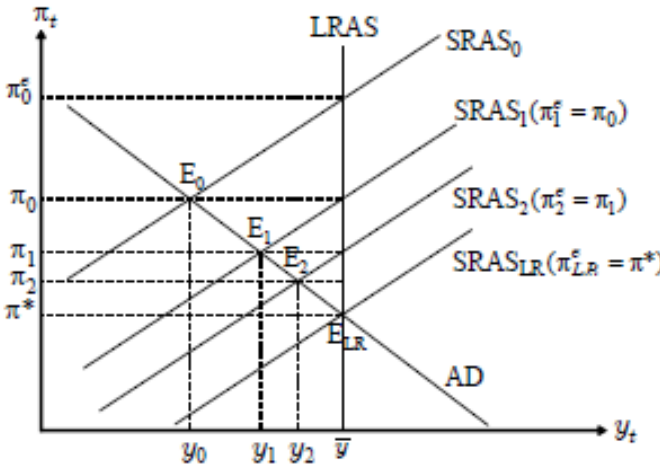

Figure A.1: Convergence in the closed economy

will in turn makes the marginal costs of the firm increase at a slower pace. Consequently, firms will increase their prices at a slower pace, *i.e.* the rate of inflation will be reduced. According to the monetary policy rule the reduction in inflation will lead monetary authorities to lower the nominal interest rate so much that a lower real interest rate results. This in turn increases goods market demand which finally leads to increased real output.
In period 2 we then have that $\pi_2^e = \pi_1 < \pi_1^e$ and consequently this process of downward-shifting SRAS curves will continue with gradually lower inflation and higher activity and gradually smaller changes in inflation and activity from one period to the next until the economy reach the long run equilibrium. Hence the economy is stable but deviations from long-run equilibrium shows persistency.

4. We assume that the economy is in a long run equilibrium at E_0 in period 0. Then in period 1 a negative supply shock occur. The effect of the supply shock is shown in Figure A.2 where the SRAS shifts up by the vertical distance s_t in period 1 to $SRAS_1$. This moves the economy from the long run equilibrium at point E_0 to point E_1 causing inflation to rise and real output to decrease.

   The economic explanation is the following: A negative supply shock directly

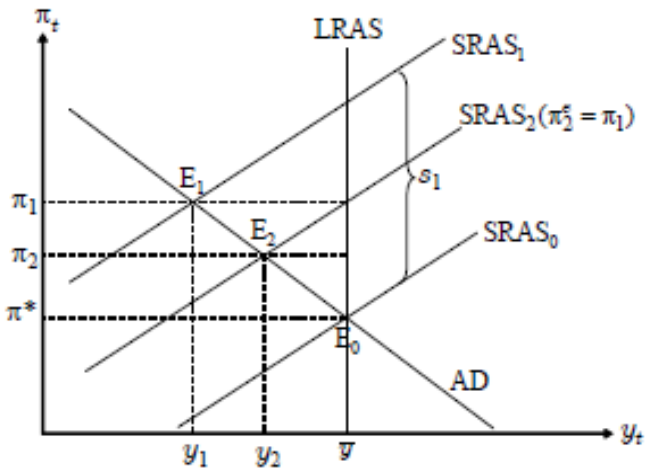

Figure A.2: A temporary supply shock

leads to higher inflation through, e.g. lower productivity, higher prices of raw materials etc. which causes firms' costs to increase thereby leading them to increase prices. The central bank responds to this by increasing the policy rate. The response is determined by the monetary policy rule according to which the nominal rate is increased so much that the real interest rate is higher. As a result private demand is curbed. Hence the economy moves along the AD curve.

In period 2 the negative supply shock has disappeared. However compared to the initial situation inflation expectations have increased. This is due to the higher inflation of period 1 compared to period 0. Therefore in period 2, the SRAS only shifts down to SRAS_2 which goes through $(\bar{y}, \pi_2^e = \pi_1)$. This moves the economy from E_1 to E_2 whereby inflation decreases and real output increases. Monetary policy responds to the decrease in inflation (the mechanism already described) by lowering the nominal interest rate by so much that the real interest rate is reduced. Accordingly private demand is spurred. From E_2 the economy then moves back to long run equilibrium as described in question 2.

From (A.6) it follows that the AD curve may be written as

$$\pi_t = \pi^* - \frac{1}{\alpha}\left(y_t - \bar{y} - z_t\right)$$

Hence the slope of the AD curve is given by

$$-\frac{1}{\alpha} = -\frac{1}{\frac{\alpha_2 h}{1+\alpha_2 b}} = -\frac{1+\alpha_2 b}{\alpha_2 h}$$

We can thus conclude, that a higher value of b (relative to h) makes the AD curve steeper while a higher value of h (relative to b) makes the AD curve flatter. The AD curve is flatter the more weight the central bank attaches to stable inflation compared to output stability *et vice versa.* Figure A.3 shows the effect of a negative supply shock when the AD curve is either flat or steep. It is seen that the more monetary policy is focused on stabilizing activity around the trend output the steeper is AD curve (b high relative to h) and the smaller is the effect on real output and the larger is the effect on inflation.

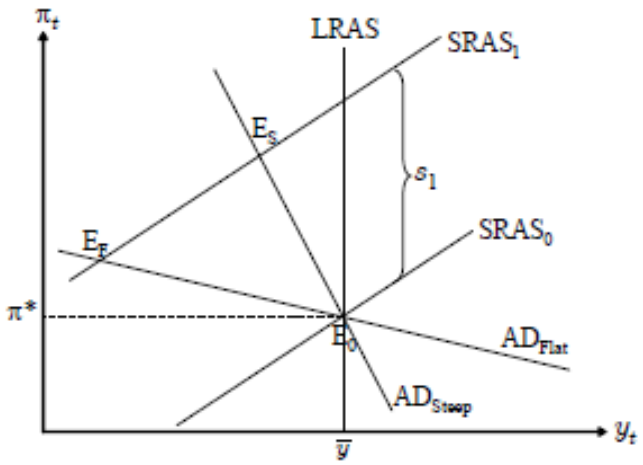

Figure A.3: The importance of monetary policy parameters in case of a negative supply shock

According to the SRAS curve in equation (A.7) a negative supply shock will have to *either* affect inflation positively, affect real output negatively or a combination of both. Hence, the conclusion is that in case of a supply shock policy makers have to choose between stabilizing real output *or* inflation. This is not the case when shocks occur on the demand side of the economy. A graphical analysis is somewhat complicated because both the slope and

the vertical shift given $z_t \neq 0$ will be affected by h and b. (This can be seen directly from the above rewriting of the AD curve). However, the economic intuition is the following: A demand shock will directly affect goods market demand and thereby equilibrium real output. Real output in turn affects inflation through the supply side of the economy. Consequently, by stabilizing real output around its long run level, inflation will also be stabilized (and by stabilizing inflation, real output will be stabilized through monetary policy).

A temporary demand shock give rise to business cycle movements in the economy. Figure A.4 illustrate this in case of a temporary negative demand shock in period 1. Due to the shock both inflation and output is below the long-run equilibrium values. In the next period the shock disappear. Consequently the AD curve shifts back to the original position. However, the short-run AS curve shifts down as inflation expectations and hence wage setting in period 2 is affected by the low inflation in period 1. This is due to the assumption of static inflation expectations.

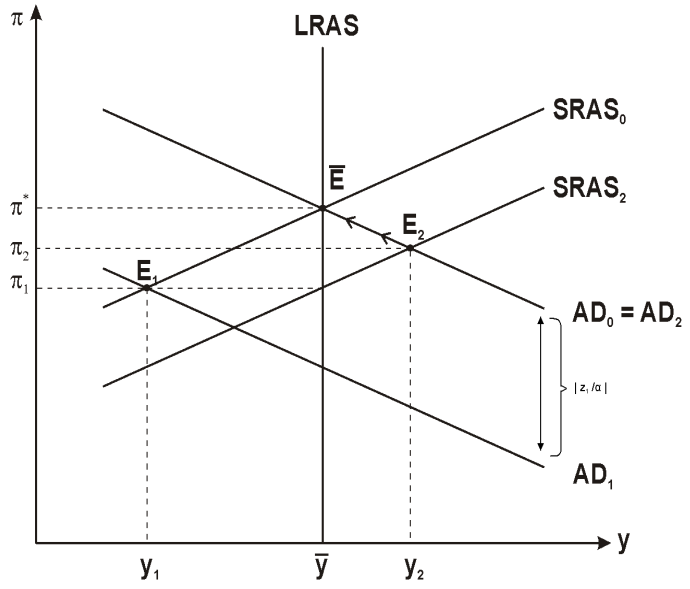

Figure A.4: A negative demand shock

5. The new long-run equilibrium level of output can be found from (A.9) by

inserting $\pi_t = \pi_{t-1,}$ $y_t = \bar{y}$ and $s_t = s$.

$$\pi_t = \pi_{t-1} + \gamma\left(y_t - \bar{y}_0\right) + s_t \tag{A.9}$$

$$\Downarrow$$

$$\gamma\left(\bar{y} - \bar{y}_0\right) = -s$$

$$\Downarrow$$

$$\bar{y} = \bar{y}_0 - \frac{s}{\gamma} \tag{A.10}$$

The new equilibrium real interest rate is the interest rate ensuring that the goods market clears when supply is given by (A.10). From (A.8) it follows that

$$\begin{aligned} \bar{r} &= \bar{r}_0 + \frac{\bar{y}_0 - \bar{y}}{\alpha_2} \\ &= \bar{r}_0 + \frac{s}{\gamma\alpha_2} \end{aligned} \tag{A.11}$$

when $v_t = 0$.

In order to obtain the target inflation rate and avoid large output gaps the central bank has to change the policy rate so that it takes into account permanent supply (and demand) shocks. A permanent negative supply shock ($s > 0$) reduces the natural output. To maintain a long-run equilibrium at the goods market a fall in aggregate demand is required. The central bank can curb total demand by increasing the real interest rate through a higher policy rate. The central bank will do that by revising its estimate of the risk free equilibrium real interest rate $\bar{r}^* = \bar{r} + \bar{\rho}$ which is part of the monetary policy rule. In order to obtain a demand that is consistent with the targets for monetary policy the central bank set the policy rate on the back of the revised risk free equilibrium real interest rate where the required revision is given by equation (A.11).

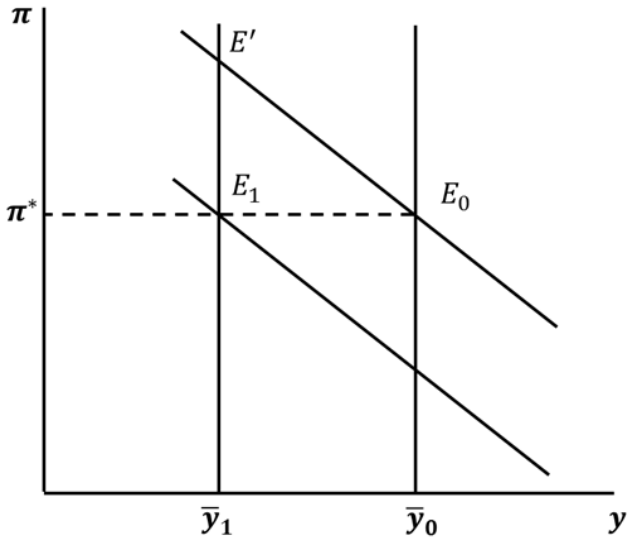

Figure A.5: The long-run effects of a permanent negative supply shock

This is illustrated in Figure A.5. Initially the economy is in the long run equilibrium E_0. Then supply shifts down on a permanent basis and the LRAS shifts from LRAS_0 to LRAS_1. If the central bank does not take this shift into account when setting the policy rate the economy will end up in the long-run equilibrium $E^{'}$ where inflation permanently exceeds target. Hence, the central bank is not be able to achieve its goals. To prevent this the central bank has to revise its estimate of $\bar{r}$ upwards in accordance with (A.11). This shifts the AD curve down and a new long-run equilibrium E_1 where inflation is consistent with the inflation target materialize.

6. The ECB find it plausible that the structural rate of unemployment has increased considerably during the current economic crisis. Higher structural unemployment is (for a given supply of labor) consistent with a lower trend or structural output $\bar{y}$. This corresponds to a shift to the left in the LRAS curve. Hence, the analysis in question A.5 applies directly and therefore this theory describes that in comparison to a situation where no supply side effects have occurred the ECB should increase interest rates more aggressively when the negative demand shock fades.

7. It follows from the calculations in question 5 that $\bar{y} = \bar{y}_0$. In essence this is due to the fact that no demand shocks are present in the equation for the SRAS

curve (A.9) .Therefore the real interest rate prevailing in the new equilibrium may be found by inserting $y_t = \bar{y} = \bar{y}_0$ and $\tilde{v}_t = \tilde{v}$ into the condition for goods market equilibrium equation (A.1).and solving for $r_t = \bar{r}$:

$$y_t - \bar{y}_0 = -\alpha_2 (r_t - \bar{r}_0) + \tilde{v}$$

$$\Downarrow$$

$$\bar{r} = \bar{r}_0 + \frac{\tilde{v}}{\alpha_2}$$

The intuition behind this result is the following. Since natural activity is unchanged a permanent change in aggregate demand $\tilde{v} \neq 0$ has to be off-set completely by a change in the real interest rate so that aggregate demand is equal to the constant level for aggregate supply. In effect the real interest rate is changed so that the interest-sensitive components in aggregate demand are changed so that aggregate demand is equal to the constant level for aggregate supply.

B.

1. Though not necessary, the student may choose to explain equation (B.1) by stating the equation

$$1 + i = (1 + i^f)\frac{E^e_{+1}}{E} \tag{B.1.a}$$

from which (B.1) may be found by taking logs and using the approximation $\ln(1 + x) \approx x$ if x is small. Equation (B.1.a) is an arbitrage condition. The left-hand side of equation (B.1.a) measures the amount of wealth accruing to an investor at the end of the current period if one unit of the domestic currency is invested in the domestic capital market at the beginning of the period. The right-hand side measures the expected amount of wealth if the investor choose invest the money in the foreign capital market at the beginning of the period. In this situation the investor has to buy 1/E units of the foreign currency at the start of the period and invest this amount of foreign currency in the foreign capital market where it earns an investment return of i^f. At the end of the period the investor would then have ended up with an amount of wealth equal to $(1/E)\ \left(1 + i^f\right)$. At the time of the investment the investor believes this to be worth $\left(E^e_{+1}/E\right)\left(1 + i^f\right)$ when measured in domestic currency. Therefore, the above equation states that the expected end-of-period wealth from a domestic and a foreign investment has to be the same when measured in the same currency. Hence, the expected return must be the same. If not, investors would immediately sell bonds with the lowest expected rate of return (which drives down (up) the prices (interests) on theses bonds) and buy bonds with the highest expected rate of return (which drives up (down) the prices (interests) on these bonds). This arguments requires perfect capital mobility. Also, it should be noted that investors are assumed to be risk neutral. If investors are risk averse a positive risk premium for investing in the most risky asset should be added.

If the central bank conducts a fixed exchange rate policy which is perceived as fully credible then investors would expect the exchange rate to remain unchanged, *i.e.* $e^e - e = 0$. In this case (B.1) is reduced to $i = i^f$, meaning that the central bank has no possibilities to stabilize business cycles through

monetary policy. Monetary policy is impotent. It is reserved to defending the fixed exchange rate.

2. For a small open economy with a fixed exchange rate and free and perfect international capital movements the level for the interest rate is determined abroad. The underlying reasoning is given in the answer to exercise B.1. Hence, in this situation monetary policy cannot respond to changes in inflation. Instead changes in inflation will have an effect on competitiveness and thereby net exports. A rise in inflation reduces net exports by eroding the economy's international competitiveness.

   Under floating exchange rates the competitiveness effect is still in effect. However, under floating exchange rates a rise in inflation generates two additional effects stemming from the provided scope for an independent monetary policy. As domestic inflation increase the central bank may react by raising the domestic interest rate. This creates an additional downward pressure on aggregate demand, partly through the interest channel affecting domestic private demand (as was the case for the closed economy) and partly through the exchange rate channel as the currency tends to appreciate when the domestic interest rate increase compared to the interest rate abroad. This leads to an additional loss in competitiveness (relative to the isolated loss in competitiveness following the increase in inflation).

3. A permanent increase in domestic productivity increases the natural output. Hence, the LRAS curve shift to the right. As illustrated in the figure below a real depreciation of the currency results. Competitiveness has to improve in order to secure that net exports increase by an amount that is equal to the rise in natural output so that the goods market clears (aggregate demand equals aggregate supply) in the long run.

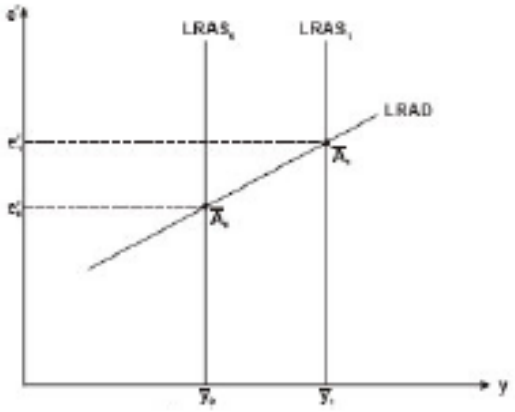

Figure B.1: The effect of a permanent positive supply shock

An improvement in competitiveness (the real exchange rate) is equal to a deterioration of the terms of trade. By definition the real exchange rate $E^r = EP^f/P$ where E is the nominal exchange rate and P and P^f is the price of domestic and foreign produced goods. The inverse of the real exchange rate, $1/E^r$, is referred to as the terms of trade.