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

Macro B

Final Exam

August 20 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. It is useful to begin with equation (A.1) which describes development in the real exchange rate. The real exchange rate is defined by $E^r = EP^f/P$ where E is the nominal exchange rate and P and P^f is the price of domestic and foreign produced goods. The first difference of the log to expression is $\Delta e^r = e^r - e^r_{-1} = \Delta e + \pi^f - \pi$ which is the change in competitiveness in percent. Competitiveness improves if the real exchange rate's depreciate (e^r increase). The expression states that the changes in the real exchange rate is equal to the percentage change in the nominal exchange rate plus the difference in inflation rates in the foreign and domestic economy. Accordingly, when the nominal exchange rates are fixed any change in the real exchange rate (competitiveness) is the result of inflation differentials between the domestic and the foreign economies; $\Delta e^r = \Delta e + \pi^f - \pi = \pi^f - \pi$ because $\Delta e = 0$. Hence, when the exchange rate is fixed any changes in competitiveness is due to differences in the price development of domestic and foreign produced goods.

   Equation (A.1) is the aggregate demand curve for the open economy with a fixed exchange rate. The AD curve is downward sloping in a diagram where you have y at the first axis and π at the second axis. This is so because lower domestic inflation *ceteris paribus* is associated with an improvement of competitiveness. Hence, domestic produced goods become more competitive at both the export and home market. Therefore, a larger part of a given demand both abroad and at the home market is fulfilled by goods produced in the domestic economy. The sensitivity of domestic activity with respect to competitiveness is reflected by parameter β_1 in which inherits both the import and the export elasticities with respect to the real exchange rate. In the textbook these elasticities are called η_M and η_X respectively and the AD curve is flatter the larger both η_M and η_X as a given change in competitiveness is having a larger impact on net exports.

   The position of the AD curve depends on competitiveness in the previous period e^r_{-1} and changes in competitiveness makes the AD curve shift.

   Equation (A.2) is the aggregate supply curve for the open economy. In the

textbook the AS curve for the open economy is founded in an efficiency wage model (a shirking model), and the slope of the AS curve, γ, that tells how marginal costs via firms price setting behavior is translated into inflation. The student could notice that the AS curve for the open economy has the exact same functional form as the aggregate supply curve found for the closed economy. However, the economic intuition is different. For the closed economy the AS curve found in the text book rests on a so-called right-to-manage model.

2. As described above changes in competitiveness makes the AD curve shift form one period to the next. Hence the economy can not be in a stable long-run equilibrium unless $e^r = e^r_{-1}$. Then, from (A.3) it follows that in a long-run equilibrium $\pi = \pi^f$. Given that $\pi = \pi^f$ it follows from (A.2) that in the long-run equilibrium $y = \bar{y}$.

3. In period 1 the short run equilibrium where $y_1 < \bar{y}$ and $\pi_1 < \pi^f$ is determined simultaneously by the AS and AD curves that applies for that period; the position of AD_1 depends on e^r_0. In this situation the outside option for workers is deteriorated. Hence worker's incentive to shirk is reduced. As a result the required wage for encouraging workers not to shirk is lower. Thus, the increase in marginal production costs takes place at a slower pace. This in turn implies that a moderate rate of inflation is realized; $\pi_1 < \pi^f$. It follows from the discussion above that in period 2 the position of the AD curve AD_2 depends on e^r_1 which is predetermined. The AD curve shifts up in period 2 and $y_1 < y_2 < \bar{y}$ and $\pi_1 < \pi_2 < \pi^f$ because net exports are higher as competitiveness is improved. Also marginal production cost are higher. This is due to the diminishing marginal product in production. In addition it is optimal for companies to offer higher wages as higher employment induces an increase in worker's outside option. Hence, compared to period 1 inflation has increased and accordingly the improvement in competitiveness is smaller. This process continues with gradually smaller improvements in competitiveness than in the previous period until the economy settles in a long-run equilibrium. In the closed economy considered in the textbook wage claims are reduced when inflation is low. This is due to an assumption of static inflation expectations. So when a negative demand shock occur wage

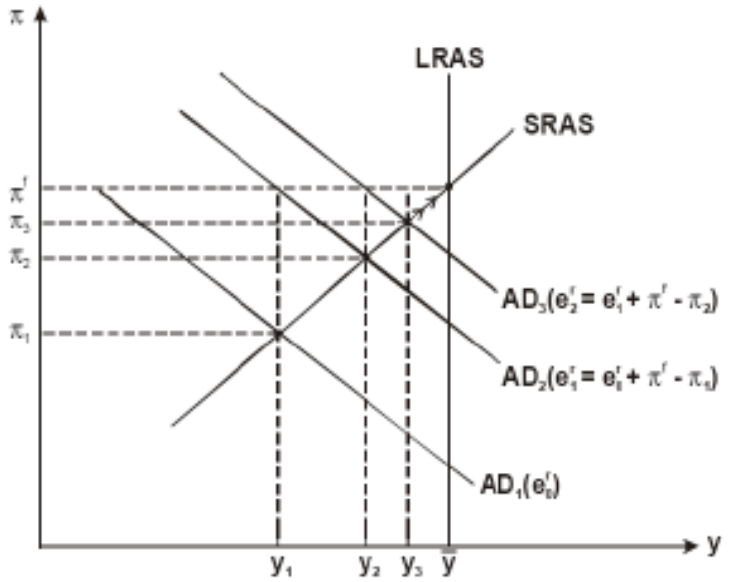

Figure A.1: The adjustment proces in the open economy with fixed exchange rates

claims in the next period are reduced on the back of a lower realized inflation in the current period. Also, the central bank plays a crucial role in the adjustment process. The central bank *ceteris paripus* responds to lower inflation by reducing the policy rate. This stimulates total private demand. In turn the outside option for workers is improved as employment is stimulated. Therefore higher activity makes workers opt for higher wage claims which in turn lifts inflation through the assumed mark-up pricing on higher marginal production cost. As inflation picks up the central bank gradually tighten monetary policy and therefore convergence takes place through a process where the output and inflation gaps are only gradually eliminated.

4. Equation (A.4) may be found by first equating (A.2') and (A.1'). This gives:

$$\gamma \hat{y}_t + s_t = e^r_{t-1} - \frac{1}{\beta_1}(\hat{y}_t - z_t)$$

Solving this for e^r_{-1} gives:

$$\begin{aligned} e^r_{t-1} &= \gamma \hat{y}_t + s_t + \frac{1}{\beta_1}(\hat{y}_t - z_t) \\ &= \frac{1+\gamma\beta_1}{\beta_1}\hat{y}_t + s_t - \frac{1}{\beta_1} z_t \end{aligned}$$

This expression may be substituted into equation (A.3') twice (for period t and $t-1$) and by substituting (A.2') for $\hat{\pi}_t$ leaves us with

$$\frac{1+\gamma\beta_1}{\beta_1}\hat{y}_{t+1} + s_{t+1} - \frac{1}{\beta_1}z_{t+1} = \frac{1+\gamma\beta_1}{\beta_1}\hat{y}_t + s_t - \frac{1}{\beta_1}z_t - (\gamma\hat{y}_t + s_t)$$

$$\Downarrow$$

$$\hat{y}_{t+1} = \beta\hat{y}_t + \beta\left(z_{t+1} - z_t\right) - \beta\beta_1 s_{t+1} \quad \text{where} \quad \beta = \frac{1}{1+\gamma\beta_1} \tag{A.4}$$

5. Equation.(A.4) is a first order difference equation according to which the output gap in the economy evolves. It follows from (A.2') and (A.3') that in case the process describing the output gap is stable and y_t converges to the long-run equilibrium value $\bar{y}$, then both the inflation gap $\hat{\pi}$ and the real exchange rate are described by stable processes and π converges to π^f and the real exchange rate is stable.

   Abstracting from shocks but the initial *i.e.* $z_t = s_t = 0 \; \forall \; t > 0$ the solution to (A.4) takes the form $\hat{y}_t = \hat{y}_0\beta^t$. Thus, the process given by equation (A.4) is stable because $0 < \beta = \frac{1}{1+\gamma\beta_1} < 1$ as $0 < \gamma, \beta_1 < 0$ and the economy converges to the long-run equilibrium values for activity and inflation, $\bar{y}$ and π^f respectively.

   The convergence process will be faster the larger β_1 and γ because β is a declining function in both parameters. If β_1 – the elasticity in foreign trade wrt. competitiveness – is large then foreign trade effects from a given change in competitiveness will be larger. This ensures faster convergence. γ is the slope on the SRAS curve. A larger value of γ means that domestic inflation reacts more to deviations in output from trend (or structural) output. Hence, a given deviation in activity from the structural level foster a larger change in competitiveness. Accordingly, the pace at which the economy moves towards the long-run equilibrium is faster.

6. Initially the economy is in a long-run equilibrium A_0 where $y_0 = \bar{y}$ and $\pi_0 = \pi^f$. Then government consumption is expanded. This increase total activity in the economy and thereby inflation is increased. A new short run equilibrium A_1 is established in period 1 where $y_1 > y_0 = \bar{y}$ and $\pi_1 > \pi_0 = \pi^f$. Relative to period 0 inflation has increased because marginal production

costs have increased as the marginal product of labour has declined and wages paid are higher (increase at a higher pace). The latter is related to the improvement in workers outside option as unemployment is reduced. Hence, companies are encouraged to pay higher wages in order to improve the employees incentive to work instead of shirk.

Competitiveness deteriorates as inflation is above inflation abroad; $e_1^r < e_0^r$. The erosion of competitiveness amounts to the change in inflation $\Delta\pi_1 = \pi_1 - \pi_0 = \pi_1 - \pi^f$. In period 2 where the positive demand effect from an expansionary fiscal policy disappear this erosion of competitiveness will have an effect on net exports in period 2 where the AD curve AD_2 is positioned exactly $\Delta\pi_1$below the AD_0 curve. In period 2 a new short run equilibrium is established where $y_2 < \bar{y}$ and $\pi_2 < \pi^f$. Hence, in period 2 competitiveness is improved albeit by less that the deterioration experienced in period 1. This is due to the factors influencing the wage setting reflected in the parameter $\gamma > 0$ (see the description above). From now on the usual adjustment process towards the long run equilibrium takes place. This process is described in the answer to question A.3. An illustration could look like the following.

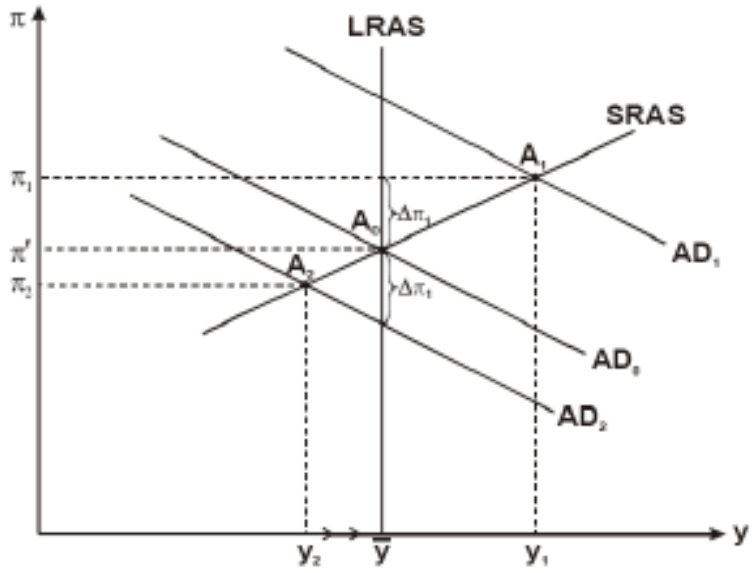

Figure A.2: The effect of a temporary expansion in government consumption in a open economy with a fixed exchange rate

7. In the absence of policy intervention, the economy would follow a process where it gradually adjust to the long-run equilibrium as described when answering question A.3. This is a slow process. According to the textbook with realistic values for the parameters it may take between 3-4 years for the economy to move just the halfway towards long-run equilibrium. To speed up the adjustment policy makers may opt for an unexpected devaluation in period 0 which improves competitiveness (by reducing the value of the domestic currency). Thereby the economy immediately jumps to a new short-run equilibrium where activity and inflation is higher.

   The devaluation is not expected and the new peg is perceived fully credible. Therefore, $e^e_{+1}$is not affected. Therefore $i = i^f$. This follows from the uncovered interest parity (UIP) which is a financial arbitrage condition whereby the return on domestically denominated financial assets is tied to the return on foreign denominated assets. Assuming investors are risk neutral and capital mobility is perfect domestic and foreign assets are perfect substitutes. In this situation investors may reallocate their portfolios instantaneously and without any costs so that the arbitrage condition stated below holds

$$1 + i = \left(1 + i^f\right) \times \frac{E^e_{+1}}{E},$$

   where E is the current exchange rate and $E^e_{+1}$is the expected exchange rate and i and i^f are the nominal interest rate in the domestic and foreign economy respectively. Using the approximation $\ln(1 + x) \approx x$ when x is small the uncovered interest parity (UIP)

$$i = i^f + e^e_{+1} - e,$$

   follows. If the fixing of the exchange rate is perceived perfectly credible we have that $e^e_{+1} = e$ and as an implication we have from the UIP that $i = i^f$. Hence the interest rate remains unchanged.

   Moreover when no future devaluations are expected ($\Delta e^e = 0$) $\pi^e = \pi^f$ which is consistent with a long-run equilibrium where competitiveness remains unchanged.

The figure below illustrates how an unexpected devaluation of the currency may be used to shorten the length of a recession. In period 0 the economy is in a deep recession given by the short-run equilibrium A_0. In the absence of policy intervention, the economy would gradually move up along the SRAS curve when adjusting to the long-run equilibrium. To speed up the adjustment policy makers unexpectedly devaluate the currency immediately shifting up the AD curve and the economy jumps to a new short-run equilibrium, A_0' in period 0. Thereby the adjustment time is reduced by the time it would have taken for the economy to move from A_0 to A_0' through the gradual improvement in competitiveness generated by a protracted period of high unemployment.

The policy does not affect the long-run equilibrium which remains $\bar{A}$. This is so because the devaluation does not affect the supply side of the economy and hence the LRAS curve remains vertical at $y = \bar{y}$.

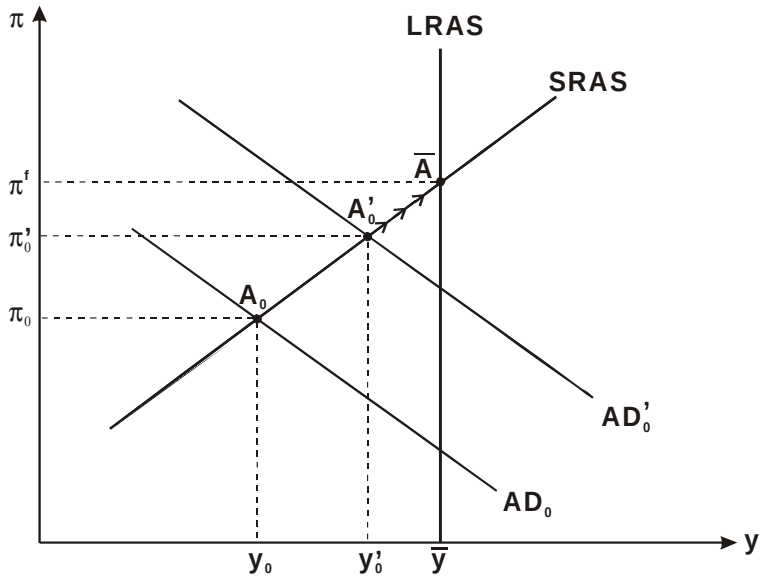

Figure A.3: Speeding up adjustment through an unanticipated devaluation

The above mentioned assumptions om private sector behavior are somewhat unrealistic. First of all it is unlikely that the announced new target level for the exchange rate is perceived fully credible. Instead both price setting at most notable financial and markets may entail expectations of future

reductions in the value of the currency. This will increase interest rates and spur wage and consequently price inflation. Hence, the output effects may be reduced.

B.

1. It is sufficient to explain that fluctuations in employment leads to welfare losses when the marginal product of labor (MPL) is declining and/or the marginal rate of substitution (MRS) which measures the additional income necessary to compensate the worker for the loss of leisure is increasing. Distortions means that $MPL > MRS$ so that the the amount necessary to compensate the worker for supplying the additional labor is exceeded by the additional amount of output produced by this additional labor. If in this situation an economic boom leading to an increase in employment is followed by a recession leading to an (numerically) equally sized decline in employment (relative to structural employment), then the welfare gain during the boom is lower that the welfare loss during the recession Accordingly fluctuations in employment leads to welfare losses. An illustration could look as the figure below. When the economy is booming a welfare gain amounting to the area A+B is obtained. However, in recession the welfare loss C+D is even bigger.

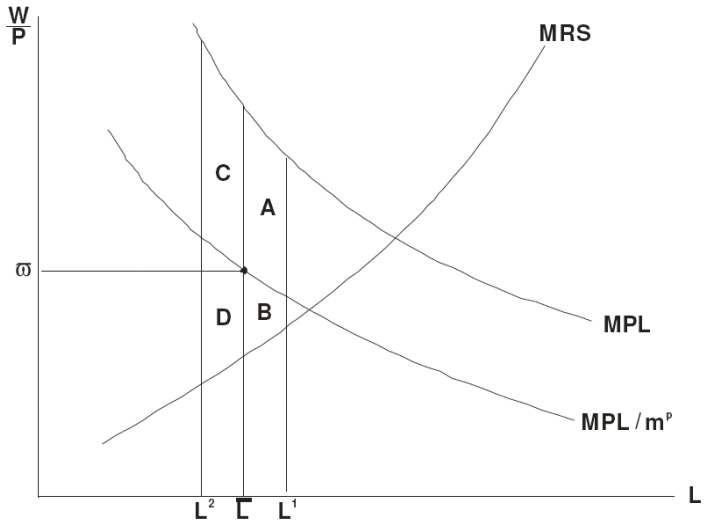

Figure B.1: Welfare losses from fluctuations in employment

It could be added that policy makers are concerned about fluctuations in

output because for the following reason. Assuming consumers have declining marginal utility in consumption, the marginal utility gain from a given increase in consumption is lower than the marginal utility loss from an equally sized drop in consumption. As a consequence, consumers prefer to experience constant levels of consumption over time. That income is volatile over time does not exclude the possibility of consumers smoothing consumption by using private capital markets. However, if these are not perfect some consumers might find themselves unable to smooth consumption. In addition, problems of moral hazard and adverse selection may limit the scope for consumption smoothing through insurance markets.

The target for activity should be the structural output. The above analysis shows that $MPL > MRS$ when employment and hence activity is at the structural level. Hence at the structural level activity is below the efficient level. However, systematically pushing activity above that level would lead to an ever increasing inflation. This follows from the AS curve (Eq. (A.2) in problem A).

It is socially desirable to stabilize inflation around a constant target value because it 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.

Even a stable positive inflation rate is socially costly due to so-called 'shoe leather costs', 'menu costs', relative price distortions due to staggered price setting. In addition, the tax system may fail to distinguish between nominal and real income from capital. As long as the rate of inflation is kept low these cost are likely to be small. Also, the target value for inflation should not be too large as high inflation often is associated with fluctuating inflation. On

the other hand the target value should not be too low. Policy makers should take into account that a very low inflation rate and hence a low level of nominal interest rates reduces the scope for a cut in the real interest rate 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. To sum up there is a trade of between on the one hand the cost of inflation and on the other hand the risk of ending up in a liquidity strap and a limited scope for reducing real wages through (unexpected) high inflation.

2. The uncovered interest parity (UIP) is essential when explaining the "impossible trinity". UIP which is a financial arbitrage condition (or rather absence of arbitrage) whereby the return on domestically denominated financial assets is tied to the return on foreign denominated assets may be stated as

$$i = i^f + e^e_{+1} - e,$$

where i is the domestic interest, i^f is the interest rate abroad and $e^e_{+1} - e$ is the expected reduction in the value of the domestic currency. If investors are risk averse a risk premium is added. If the value of the domestic currency is expected to be reduced (and increase in e) the domestic interest rate has to be larger than the foreign interest rate so that the expected investment return is the same when measured in the same currency.

The "impossible trinity" may be shown by assuming that two of the three policy goals are upheld. Then the third can not be obtained.

If cross-border capital flows are free and the exchange rate is fixed then from the UIP it follows directly that $i = i^f$. Hence, monetary policy can not be independent. If $i < i^f$ capital will flow out of the domestic economy. Investors sell domestic denominated assets (and thereby domestic currency) and buy foreign denominated assets (and thereby foreign currency). The central bank has to sell foreign currency and buy domestic currency to maintain a fixed exchange rate. However eventually the foreign exchange reserves are exhausted and the central bank can not defend the exchange rate any more. If $i > i^f$ capital will flow into of the domestic economy. This creates a pressure for an

appreciation of the domestic currency as the foreign reserve keep growing.

If cross-border capital flows are free and monetary policy is independent, $i \neq i^f$, then $e^e_{+1} \neq e$ which is at odds with a fixed exchange rate.

If monetary policy is independent, *i.e.* $i \neq i^f$ and the exchange rate is fixed $e^e_{+1} = e$ then UIP stresses that capital can not move freely across borders as it would take an infinite foreign exchange reserve to uphold a fixed exchange rate.

3. The connection between the short term and the long term interest rates (effective yield) is described by the yield curve. The current long term interest rate is determined by the current and the expected future short term interest rates. The central bank can control the short term interest rates (through the policy rate). The long term interest may be influenced by movements in short term interest rate and the central banks willingness to secure stability of output and inflation.

   Formally this connection may be described by financial arbitrage condition

$$\left(1 + i^l_t\right)^n = (1 + i_t) \times \left(1 + i^e_{t+1}\right) \times \left(1 + i^e_{t+2}\right) \times ... \times \left(1 + i^e_{t+n-1}\right) + \varepsilon_t, \quad \text{(B.3.1)}$$

   where i^l_t is the long-term interest rate in period t, i_t is the short-term interest rate at period t and i^e_{t+j} is the expected short-term interest rate in period $t + j$. ε_t is a risk premium risk averse 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.

   The left-hand side of (B.3.1) is the total amount a borrower should pay back at time $t + n$ when using a fixed long-term interest rate. The right-hand side of (B.3.1) is the total amount of money a borrower expect to pay back at time $t + n$ using the short-term interest rate which is "rolled over" each period at the expected short-term interest rate.

   If investors are risk neutral $\varepsilon_t = 0$ and using the approximation $\ln(1 + x) \approx x$

(B.3.1) may be rewritten as

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

$$\Downarrow$$

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

$$\Downarrow$$

$$i_t^l = \frac{1}{n}\left(i_t + i_{t+1}^e + i_{t+2}^e + ... + i_{t+n-1}^e\right). \tag{B.3.2}$$

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