1. Use the Discrete Time Ramsey equation and the Ramsey consumption function and explain what happens to the growth of consumption and to current consumption under the following circumstances:

(a) a rise in the rate of interest
(b) the individual becomes more impatient
(c) the individual unexpectedly inherits a house

ANSWER:
a) A rise in the rate of interest (holding the discount rate constant and assuming for simplicity an initial situation of $r = \rho$) implies positive growth of consumption. In turn, this means a reduction in current consumption (the present value of wealth falls).

b) If the individual's discount rate goes up, consumption growth is negative. The individual wants to consume a larger share of their life-time income now so current consumption goes up.

c) This will not affect the growth of consumption . i.e. the consumption path remains unchanged. However, it raises life-time wealth and hence consumption is higher now and in each subsequent period as compared with the situation before the unexpected windfall. The unexpected event increases permanent income and therefore consumption, there is going to be a jump up in consumption, to the new level consistent with the higher permanent income, when the event occurs.

2. What is precautionary saving? What assumptions are needed for precautionary savings to arise? Does precautionary saving resolve some empirical puzzles in consumption behavior?

ANSWER: Precautionary savings are savings that are accumulated for a rainy day, a form of insurance against uncertainty. It requires the introduction of uncertainty (e.g. in health or labor income) and technically the third derivative of the utility function has to be positive so that the marginal utility of consumption is convex. It explains why individuals seem to consume 'too little' early in life, and why then consumption rises with current income, and why people save 'too much' at retirement.

3. What is meant by the expression "excess sensitivity" of consumption? How do the assumptions of the simple PIH have to be amended to account for this finding?

ANSWER: By excess sensitivity is meant that consumption reacts too much to variations in current income that are predictable. PIH has to be amended with imperfect credit markets or simply by referring to precautionary savings.

4. Explain what is meant by the "excess smoothness" of consumption and why it may characterize behavior.

ANSWER: By excess smoothness is meant that consumption reacts too little (sluggishly) to news about permanent income. Instead of jumping immediately to the new level of consumption predicted by the PIH, consumption adjusts slowly. Again, liquidity constraints may be an explanation for this.

5. This question relates to the consumption function presented in Section 1.10. Suggest why the real interest rate may have a negative effect on consumption. Use an IS diagram to represent the consumption function and discuss how consumption and hence the IS curve responds (ceteris paribus) to,

(a) a higher proportion of creditors in the economy
(b) an easing of liquidity constraints (e.g. because of more competition in the credit sector)
(c) more uncertainty about future income growth
(d) lower overall wealth (e.g. due to the bursting of a housing price bubble.)

ANSWER:
A higher real interest rate would under optimizing behaviour suggest delaying consumption in order to profit from the higher return/consumption in the next period.

a) Consumption will rise by relatively less in response to lower interest rates: a steeper IS curve (see Fig. 7.3).

b) An easing of liquidity constraints will allow a number of households to borrow against future income. This will raise the MPC and make the IS curve flatter (pivots on the r axis - see Fig. 2.16).

c) Precautionary savings will go up. This would reduce the MPC and the size of the multiplier. IS curve becomes steeper (pivots on the r axis - see Fig. 2.16).

d) This would reduce consumption, lowering permanent income. IS curve shifts left.
The above answers can be related to the estimates presented in Section 1.10.

6. Compare the investment function of Chapter 2 ($I = A – b*r$) with the investment function in section 2.5 ($I = A – b_0*r + b_1*y$). Why is the additional output term in the equation? How would the following affect the IS curve (ceteris paribus):

(a) increased sales
(b) a change in competition law that will allow firms to exploit more economies of scale opportunities in the future.
(c) a fall in corporation tax
(d) a fall in the interest rate
(e) higher interest-sensitivity of investment
(f) higher output-sensitivity of investment

ANSWER:
Given borrowing constraints, investment is a function of current revenues/profits of a firm and this is why y is included in the second version of the IS curve

a) Might affect A or only y therefore it depends how we model it, shift of IS curve to the right in the former; incorporated in the multiplier effect in the second case.

b) changes A, profitability of investment.

c) Since profits are increasing in y, a rise in corporation tax reduces the multiplier making the IS curve steeper.

d) Movement south-east along the IS curve.

e) IS curve flatter.

f) .This is equivalent to a higher MPC in the consumption function. It has the same effect, i.e. increases the size of the multiplier, making the IS curve flatter.

7. Imagine you are running a safe house in the early 19th century. Assume there are 2000 gold coins deposited with you and that you have issued these people with deposit notes. You have lent 1800 gold coins.

(a) Apart from lending money, what is the essential service that you provide?
(b) What determines how much money you lend?
(c) Why will people rarely withdraw their gold?
(d) What is your implicit reserve-asset ratio?
(e) If an additional 200 gold coins are deposited, how many additional deposits will you create?
(f) Why may the calculation you made in (e) not be entirely accurate?
(g) In a neighboring village, a banker was unable to meet calls on his funds and he went bankrupt. You decide to increase your reserve asset ratio to 20%. Why is it a bad idea to call in loans you have already made in order to meet the higher ratio?
(h) An additional 1000 coins are deposited by people from the neighboring village. How many gold coins will you hold in cash and how many loans will you want to make if you decide to adjust to the more cautious reserve asset ratio?

ANSWER:

(a) The main function of a safe house was initially to provide a safe place to keep gold.

(b) I want to lend as much as I can because I earn interest but I must take account of the fact that I must have liquid assets should people choose to withdraw their gold coins.

(c) People will use deposit notes to exchange goods and to compare prices. Gold will in general not be used for day-to-day transactions.

(d) 10%.

(e) I will create an additional 2000 gold coins' worth (200*(1/10)), which means I lend 3600 gold coins in total.

(f) Cash drain and low uptake on loans.

(g) Calling back loans will signal that I am in trouble and will mean that less people will deposit with me and, more seriously, people may decide to withdraw their deposits so I risk going bankrupt myself.

(h) I now have 1400 in cash which means I lend 5600 gold coins worth in total.

8. What is the 'money multiplier'? What determines its size? What leverage does this give the central bank over the money supply?

ANSWER: The money multiplier is the amount by which an increase in high-powered money is converted to a change in the money supply. Its size depends on the cash to deposit ratio and the reserve to deposit ratio as shown in the formula: $\kappa = (1+cd)/(cd+rd)$. The central bank can first and foremost determine the money supply by creating high-powered money while keeping the banking multiplier in mind. Second, it can affect the banking multiplier: an increase in rd lowers κ and vice versa.

9. Why might the cash/deposit ratio and the reserve asset ratio be decreasing functions of the rate of interest? How does an interest sensitive money supply affect the LM curve? Illustrate using an example, comparing the new LM with the standard LM.

ANSWER: The cash/deposit ratio may be a decreasing function of the interest rate if higher interest rates 1) encourage people to borrow from non-bank financial intermediaries and 2) increase their deposits (this effect is reinforced if the deposit accounts pay interest). The reserve asset ratio may be a decreasing function of interest rates if banks hold excess reserves so that they are encouraged to lend more with higher interest rates. If κ increases with the interest rate for these reasons, this will make the LM curve more sensitive to the interest rate: it will be flatter. Fig. 2.3 can be modified to show this.

10. In Japan, the price of real estate dropped dramatically in the late 1980s. Many Japanese firms have long-term relationships with a so-called main bank. How would you expect a deterioration of the balance sheets of Japanese firms and of their main banks to affect investment? Would you expect smaller or larger firms to be most affected?

ANSWER: The fall in the price of real estate generated a loss of wealth for firms as well as households. This led to a deterioration in firms' balance sheets and they were unable to service their debts. Given the close relationship between firms and banks, these bad loans were concentrated in the so-called main bank. The incentive for the main bank was to keep lending to the firm so that the bad losses would not show up in its balance sheet. This reduced the ability of banks to lend for new investment projects. This had the effect of producing a cycle of adverse selection of loans by banks (i.e. to rollover bad debts of firms rather than to finance new projects), which worsened the macroeconomic situation. This in turn increased uncertainty about the health of the banking system. Since banks owned substantial stakes in firms, they were unwilling to call in the loans and bankrupt firms since this would further weaken their own wealth and depress their stock market value. This perpetuated the credit contraction cycle. Smaller firms, which

had less strong connections with a main bank and were less important for the bank, were therefore starved of finance for new investment.

11. What is the difference between the real and the nominal exchange rate? Give an example to explain this to a non-economist. Is an improvement in the terms of trade the same as an improvement in price competitiveness? Is an increase in the real cost of imports an improvement or a deterioration in the terms of trade?

ANSWER: Real exchange rate: θ = (price of foreign goods expressed in home currency)/(price of home goods) =(P*e)/P , while the nominal exchange rate e = (no. units of home currency)/(one unit of foreign currency). The real exchange rate is the rate at which home and foreign goods exchange for each other. While the nominal exchange rate only tells how many units of home currency are needed in exchange for one unit of foreign currency. The real exchange rate of a can of coke between the US and UK is the price of the drink in the US in terms of GBP divided by the 50 pence the can of coke cost in the UK. Under the simplifying assumptions set out in the chapter (where only manufacturing goods are imported and exported and prices are set in each country by home costs), the terms of trade and price competitiveness are each the inverse of the other. An increase in the price of imports is a deterioration of the terms of trade.

12. Explain what is meant by the passage in italics in the statement that the Marshall-Lerner condition relates to the impact on the trade balance of a change in the real exchange rate, holding the level of output constant. Apart from the price-elasticity of demand what extra information do you need to work out the effect on the trade balance of a change in the exchange rate?

ANSWER: Output is held constant because the aim is to see the partial effect of a change in the real exchange rate. For the partial equilibrium analysis, it is assumed that prices do not change as a consequence of volume sold (infinite elasticity of supply). It is also assumed that the initial trade balance is known. The Marshall-Lerner condition assumes an initial position of trade balance. With these assumptions and assuming the sum of the price elasticity of demand for exports and imports exceeds one, the volume effect will exceed the terms of trade effect (which increases the import bill for a given volume of imports) and the trade balance will improve. Once the assumption that output is constant is relaxed, the full effect of a change in the real exchange rate on the trade balance can be calculated. Holding the interest rate constant, given the marginal propensity to save and the tax rate, the increase in output associated with the rise in net exports can be calculated; this will be less than the increase in the level of output associated with trade balance. Hence there is a trade surplus in the new equilibrium. Output rises by more than absorption.

13. A small open economy has a government budget surplus and a trade deficit. Explain whether there is a private sector surplus, deficit or balance. Examine the consequences in the short run for output, the trade balance and the budget balance of a sudden fall in private consumption in this economy under (a) fixed exchange rates, (b) flexible exchange rates.

ANSWER:

$(s(y^{disp}) – c_0 – I) + (t(y) – g) = (x – m(y))$

Using the above, if (t - g) > 0 and (x - m) < 0 then the private sector financial balance must be in deficit. Fall in consumption under fixed exchange rates leads to fall in output. Trade balance must increase (no change in exports; fall in imports) and government surplus (t - g) must decrease (no change in g; fall in t). Under flexible exchange rates, there is a depreciation and in the new short-run equilibrium, output is unchanged with higher net exports and lower consumption. With $\Delta y = 0$ and increase in e, $\Delta BT > 0$ and $\Delta(t - g) = 0$.

14. What is meant by arbitrage in international financial markets? Give a numerical example to explain the concepts of the covered and uncovered interest parity conditions.

ANSWER: By arbitrage is meant the possibility of making a profit without bearing a differential risk. There would be an arbitrage opportunity if two equally risky assets or bonds provided a different return; this is ruled out in a well functioning international capital market as expressed in the UIP condition. The UIP states that any differential in terms of interest rate between home country and the world is compensated by an identical difference between the nominal exchange (spot) rate and its expectation. See footnote 15 for covered versus uncovered.

15. What assumptions must be made for the uncovered interest parity condition to hold? Explain what you would expect to happen to the domestic interest rate and the exchange rate in a small open economy following a rise in the demand for money, making clear the role of the UIP condition in this chain of events.

ANSWER: Assumptions: perfect capital mobility and perfect substitutability between domestic and foreign bonds. For the world interest rate to be exogenous, the economy must also be small. A rise in money demand would shift the LM curve to the left. However a home interest rate higher than the world one is not an equilibrium so there will be an immediate appreciation (or pressure to) of the nominal exchange rate as suggested by UIP. And depending on the exchange rate mechanism, the equilibrium will be re-established at the world interest rate by adjustment in the goods market as the ISXM curve shifts left (flexible ER) or by an induced increased in the money supply as foreign exchange reserves rise to maintain the exchange rate peg (fixed ER).

16. “Devaluation cannot affect the trade deficit because the latter must equal the difference between investment and saving, and neither of these magnitudes is affected by the exchange rate.” What is wrong with this argument in the context of an open economy with sticky prices?

ANSWER: It is wrong since devaluation affects savings via its effect on output.

17. Assume that wages, prices and the exchange rate are fixed.

(a) Will a fall in the budget deficit due to a cut in government spending always improve the trade balance? Explain your answer.

(b) What is the impact on output and the trade balance of a balanced budget increase in government spending? (For simplicity, consider a lump-sum tax.) Does the change in output differ from that in a closed economy following a balanced budget increase in government spending? if so, in what way? In the open economy case, what happens to private savings net of investment? Summarize what has happened to the sector financial balances.

ANSWER: This question would normally be set as an exercise for the material in Sections 1.1 and 1.2. It can obviously also be answered using the fuller model from later in the chapter.

(a) Yes. The key is what happens to output. Using the assumptions in Sections 1.1 and 1.2 + fixed exchange rates, then

$\Delta y = (1/(s_y + m_y))\Delta g < 0,$

therefore, $\Delta(x-m) = -m_y\Delta y \rightarrow \Delta(x-m) > 0.$

Also, $\Delta(t-g) < 0.$

Hence, the trade balance improves and so does the government deficit.

(b) A balanced budget increase in government spending with a lump-sum tax means that $\Delta g = \Delta t$. So,

$\Delta y = (1/(s_y + m_y))\Delta g - c_y\Delta t = (s_y//(s_y + m_y))\Delta g.$

Hence $\Delta y < \Delta g$: the BBM is less than one (its closed economy value), because of the extra leakage to imports.

Sector financial balances:

$(s_y y^{disp} – c_0 – I) + (t – g) = (x – m_y y)$

Because of the balanced budget assumption, the public sector deficit is unchanged. Since y rises, the trade balance deteriorates. Hence in the new equilibrium, there is a private sector financial deficit, which is being financed by borrowing from abroad (the counterpart of the trade deficit). We therefore have to show that savings have fallen, i.e. that disposable income has fallen although y has risen:

$\Delta y^{disp} = \Delta y – \Delta t = (s_y//(s_y + m_y))\Delta g – \Delta t = [(s_y//(s_y + m_y)) – 1]\Delta g < 0.$

18. Use the Mundell-Fleming model and assume perfect capital mobility. Suppose there is a fall in the world interest rate. (a) Does this have an expansionary or contractionary impact on output in a small open economy? (b) Does the trade balance improve or deteriorate? Explain your answer. Look at both fixed and flexible exchange rate regimes.

ANSWER: (a) It depends on the exchange rate regime. Under flexible exchange rates, the effect is contractionary. The fall in the world interest rate means that the domestic interest rate is above the world interest rate and therefore, there will be an immediate appreciation of the home currency which will lead to a fall in net exports and the ISXM shifting to the left until the new equilibrium where $i = i^*$ and ISXM' intersects LM. Under fixed exchange rates, it has an expansionary effect: given $i > i^*$ there will be an increase in foreign exchange reserves due to the higher demand for home bonds from holders of foreign bonds and given that the central bank is committed to maintain the peg. This leads to an expansion in money supply so the LM curve shifts rightwards to the new equilibrium (short-run) $i = i^*$ and LM' intersects ISXM.

(b) In both cases BT deteriorates. In the first case because of the appreciation and under fixed exchange rates because the larger output results in higher imports.

19. Consider two economies: the home country is Norway (currency is the Krone), and the foreign country is the US. State the Uncovered Interest Parity condition, assuming that the default risk is identical between the two countries. For each of the scenarios discussed below, assume that initially the US and Norwegian interest rates are identical and that the US interest rate remains unchanged throughout.

Scenario 1. The Norwegian interest rate is expected to remain above the US rate for one year. What relationship between the interest rate differential and change in the Krone exchange rate would be observed on average during the year?

Scenario 2. At the beginning of the year, the Norwegian government introduces a permanent increase in government spending. By the end of the year, the Norwegian and US interest rates are identical. Provide an account of the adjustment of the Norwegian economy during the year. What relationship between the interest rate differential and change in the Krone exchange rate would be observed on average during the year? You may assume that wages and prices do not adjust within the year. What light do your findings throw on the question of whether the UIP condition predicts exchange rate changes?

ANSWER : UIP: $i^N - i^{US} = (e^E_{t+1} - e_t)/e_t$

Scenario 1. Since it is not possible in a well functioning market (non arbitrage condition) for two identical assets to have different return. It has to be the case that the gain in terms of interest rate from holding Norwegian Bonds has to be offset by the capital loss in terms of exchange rate. Hence given the expected exchange rate, the Krone exchange rate appreciates immediately the interest differential opens up and depreciates over the course of the year. The average relationship observed is that a positive interest differential in favour of the Norwegian bonds is associated with the depreciation of the Krone.

Scenario 2. The increase in government expenditure in Norway causes aggregate demand to increase in Norway, the ISXM curve shifts to the right and the domestic (Norwegian) interest rate is above the US interest rate. The Krone appreciates and the ISXM returns to its initial position by the end of the year. By the end of the year net exports must have fallen by the amount by which government spending increased. A new short run equilibrium is established by the end of the year. The question suggests slow adjustment of output and exchange rate expectations over the course of the year. The average relationship observed is that a positive interest rate differential in favor of Norway is associated with an appreciation of the Krone exchange rate. Hence the key difference is that the expected exchange rate remains fixed in scenario 1 but not in scenario 2.

20. Compare the adjustment to medium run equilibrium after a fiscal contraction of a fixed and flexible exchange rate economy. What happens in the short run and during the adjustment to the medium run? Compare your results with the closed economy case.

ANSWER: First start with the short-run consequences. The ISXM curve shifts left because of the fall in exogenous demand; this leads to a point of intersection between ISXM and LM at an interest rate that is lower then the world interest rate. We know that this cannot be an equilibrium since we are assuming perfect capital market and perfect substitutability between domestic and foreign bonds.

In a flexible exchange rate regime: the adjustment to the short run equilibrium begins with the immediate depreciation of the nominal exchange rate. The ISXM shifts back to the initial position (the path depends on how exchange rate expectations are formed, see discussion in the chapter), therefore in the new short-run equilibrium, the level of output is unchanged but its composition is different (lower g, higher x - m). The AD curve shifts left because of the fiscal contraction, the PS(θ) shifts downwards given the depreciation (since agents consume both home and foreign goods and the latter are now more expensive). However, at the initial level of output the new level of real wages is too low (PS(θ) is below WS) and the the wage-price process kicks in. Wage setters require higher money wages, firms will increase prices in order to keep profit margins constant. There is a real appreciation of the exchange rate, exports decrease and the economy slides down the new AD curve. In the new equilibrium output is lower and there is a depreciation of the real exchange rate as compared with the initial equilibrium. What has happened to real wages? They are lower than in the initial equilibrium. And BT? This has improved.

In fixed exchange rate regime: the adjustment to the short-run equilibrium is accomplished through the decrease in money supply given the fall in reserves of foreign currency (if $i < i^*$, agents switch from home to foreign bonds). The short run equilibrium is achieved by a leftward shift of the LM curve, the level of output is now lower (the fall in y is accompanied by a fall in imports). The nominal and real exchange rate are unchanged, but there is a lower level of output and employment. Hence, turning to the medium run implications, real wages are too high, the process of wage-prices is the opposite of the one described above. The new medium run equilibrium coincides with the one reached in flexible exchange rate.

Comparison with the closed economy: Output falls in the short run but since the medium-run equilibrium is unique, the economy will return to the initial level of output in

the medium run either through the implementation by the central bank of its inflation targeting rule (it will cut the interest rate) or via the impact of falling inflation on the real money supply if the CB is following a monetary growth rate rule.

21. What is the difference between the wage-setting real wage curve in the open and closed economies; what is the difference between the price-setting real wage curve in the open and closed economies?

ANSWER: Wage setting curve is the same but for the fact that it takes explicit account of the consumer price index defined over domestic and foreign goods. Price setting curve is now a function of the real exchange rate.

22. Explain why there is a range of constant-inflation unemployment rates in an open economy. What determines how broad this range is? What effect do the following have on the slope of the ERU curve?

(a) a change in tastes: domestic consumers now prefer more foreign goods.

(b) new employment protection legislation makes real wages less sensitive to the level of unemployment.

(c) the country relaxes restrictions on foreign trade.

ANSWER: For the first part refer to Section 2.2 (see also the Appendix).

a) It makes the ERU flatter;
b) ERU steeper;
c) ERU flatter.

23. Compare the impact on inflation of an increase in union militancy in a closed economy with that in a fixed exchange rate open economy. How do the medium-run equilibria compare?

ANSWER: The increase in union militancy has the effect of reinforcing the bargaining power of the unions and therefore shifts the WS curve to the left both in closed and open economy. The ERU shifts left. In both equilibria there is a fall in output. What happens to inflation? In the closed economy, inflation goes up and the inflation-targeting central bank raises the interest rate to cut output in order to get the economy on to the new MR line (going through the inflation target and the new lower equilibrium output level). Inflation declines back to the inflation target.

In the fixed exchange rate open economy, the rise in militancy increases inflation. This reduces competitiveness in the economy and it moves to the south-west down the AD curve. Inflation converges down to the world inflation rate as the economy approaches the new medium-run equilibrium at lower output. In both cases, inflation in the new medium run equilibrium is the same as it was initially. In both cases, output is lower. In

the closed economy case, the real wage is unchanged (assuming that the PS curve is flat); in the open economy, the real wage is higher.

24. Assume that at time zero there is a rich country and a poor country. You are in a Solow world without technical progress. When the countries are observed at a later date, they are characterized by the same standard of living. Is this consistent with (a) absolute convergence; (b) conditional convergence? Specify your assumptions about technology, demography, tastes and policy.

ANSWER: Assume that there is no technological progress in the model and that the two economies have the same institutions, demography, tastes and policy. If further we assume that they have the same rate of population growth, we know that at time 0 the difference between the two countries is given by the capital stock. However, in the long run they will reach the same steady state and therefore this is consistent with absolute convergence. However, if we change our assumption to include a fixed technology (or different institutions) more efficient in the initially poor country we know that in the steady state the initially poor country will reach a higher standard of living and therefore the situation described in the question may also be consistent with conditional convergence.

25. Can shocks to technology explain macroeconomic volatility?

ANSWER: It is possible for shocks to technology to explain macroeconomic volatility. Shocks to technology lead to changes in the growth rate of output per worker (see Fig. 13.10 and Fig. 13.11). If there is a higher rate of technology growth this suddenly raises the rate of growth of output and output per worker. In general, however, we have to be cautious about explaining all volatility through long-run economic processes such as technological growth. As argued in Chapter 15, fluctuations in aggregate demand are likely to explain much of the short-run volatility in the economy.

26. If the savings rate falls permanently, what happens to welfare in the Solow-Swan model?

ANSWER: We can approach this question looking at welfare as output per worker or as consumption per worker. If welfare is measured as output per worker, a fall in the saving rate will certainly lower the steady state welfare of an economy since the new steady state is at a lower capital labor ratio and hence has lower output per worker. However, if welfare is interpreted as consumption per worker the effect of a reduction of the saving rate depends on whether the initial saving rate was above or below the Golden Rule saving ratio (saving ratio maximizing consumption in the steady state).

27. In the Solow model, assume the economy is initially in a steady state in which there is no growth of output per capita. At time t there is a sudden fall in the growth rate of the population and it remains at the new lower growth rate. Describe what happens to output growth and to the growth of living standards in the economy and why. Now assume there is labor augmenting technical progress: how does that affect the growth of the economy in response to a fall in the population growth rate?

ANSWER: To answer this question, it is best to use the 'alternative Solow diagram'. The question is asking for the reverse of the exercise in Fig. 7 and 8. If we assume that the rate of population growth falls from n1 to n2 at time t, then using the equation $g_Y = \sigma_K g_K + \sigma_L n$, we know that output growth falls immediately by $\sigma_L(n_1 - n_2)$. This is shown in the alternative Solow diagram by the downward shift of the g_Y curve. The economy then adjusts along the new g_Y curve to the new steady state at where $g_Y = n_2$. Since output growth falls by less than population growth, there is an immediate rise in the growth of output per head (from its initial growth rate of zero) at t followed by a gradual decline in the growth of output per head to zero once the new steady state is reached. The economic effects of the fall in population growth are best understood by using the standard Solow diagram. Lower population growth means there is 'too much' capital to equip new entrants to the labor force at the existing capital-labor ratio so the growth of the capital-labor ratio jumps up. The capital labor ratio thereafter rises slowly to its new steady state level, with its growth rate falling back to zero. If there is a constant rate of labor-augmenting technical progress, this simply adjusts the growth rates of output and of output per capita by the constant rate of technical progress, x.

28. In an economy characterized by a Cobb-Douglas production function and exogenous labor-augmenting technical progress, labor's share of income is 70% and the depreciation rate is 3% per annum. The economy is in a steady state with GDP growth at 4% per year and with a capital output ratio of 2. Find the saving rate and the marginal product of capital. At time t the saving rate in this economy increases to a new constant level, with the outcome that the economy converges to the Golden Rule steady state. What is the new savings rate, capital output ratio and marginal product of capital? Use diagrams with time on the horizontal axis to sketch the path of the capital-output ratio, the marginal product of labor and of consumption per effective unit of labor.

ANSWER: The economy is characterized by: $v^* = (K/Y)^* = 2$; $\delta = 0.03$ and $g_Y = n + x = 0.04$. Using Domar's rule, we can calculate the initial steady state saving rate: $v^* = s/(n+x+\delta)$, which implies that $s = 0.07 \times 2 = 0.14$. From the Cobb Douglas production function, $MPK = 0.3(K/Y) = 0.15$. The Golden Rule savings rate is equal to capital's share so $s_G = 0.3$. Hence the economy in the initial equilibrium has a savings rate below the Golden Rule rate. In the new steady state using Domar's rule again, we have $(K/Y)^{**} = 0.3/0.07 = 4.28$ and the MPK = 0.07 (since by the Golden Rule, MPK = $n+x+\delta$). The sketches will show: the K/Y rising gradually at time t and converging to its higher long-run value; the MPK falling gradually to its new lower long-run value; and consumption per efficiency unit initially dropping (since when the savings ratio goes up, consumption immediately falls: $((1 - 0.3) / (1 - 0.14) = 0.81)$ and then gradually rising to the new level, which is higher than it was initially.