Brief suggested answers

EGSD Examination, February 2016.

Note that longer answers may be required for full marks. For instance, it is important to show your working in calculation questions. And for discussion or essay questions my answers are intended as an outline.

1. (a)
   - i. $\dot{Y}/Y = \left(1 - \frac{\beta}{1-\alpha}\right) g_A + \frac{\beta}{1-\alpha}\dot{R}/R.$
   - ii. $w_r = \beta Y/R.$

   (b)
   - i. $\dot{w}_r/w_r = \left(1 - \frac{\beta}{1-\alpha}\right)(g_A - \dot{R}/R).$
   - ii. $\dot{w}_r/w_r = \rho$, so $\dot{R}/R = g_A - \frac{1-\alpha}{1-\alpha-\beta}\rho.$

   (c) The model of extraction is completely misleading, since in reality there are large inhomogeneous stocks of resources which are costly to extract. Given a more sophisticated extraction function we can understand why resource prices tend to be constant in the long run, and then the model predicts that resource extraction should track GDP, in line with the data. But the production function is too aggregated for us to really understand what is going on . . .

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2. (a) GDP is 16 houses per year, and the relative factors shares $w_l L/(w_r R) = 4$.

   (b)
   - i. GDP grows by a factor of 1.08, and the factor shares are unchanged.
   - ii. If the flow of trees declines, the initial effect is to raise the factor share of trees, causing investment in tree-augmenting knowledge, which increases. Hence the factor share drops back towards its initial level. Over time, even if the flow of trees approaches zero, continued increases in A_R can hold down the factor share of trees and allow continued growth in production. The number of houses which can be made with each tree then approaches infinity in the very long run.

   (c) Productivities A_L and A_R grow independently of one another, and there is no limit to A_R, which can approach infinity in the very long run. As the model stands this seems unreasonable: as long as houses are made out of trees it seems more reasonable to suppose that possible increases in A_R will be limited. Furthermore, we would expect growth in A_R to be linked to growth in A_L, since both should build on a common stock of general knowledge.

3. This question should normally be tackled in three stages: (i) What is the cause of the rapid growth? (ii) Does this imply that rebound effects are very powerful? (iii) What are the implications for the benefits of energy efficiency.

   Broadly, it seems to be true that the rapid growth in energy consumption—tracking global product up to 1974—is indeed largely due to changing consumption patterns. An important alterative explanation would be a lack of energy-augmenting technological progress, but we know that such progress has in fact been rapid.

   It is not true that this implies very powerful rebound, since the changes could be caused either by substitution effects (which are strongly linked to rebound) or income effects (which are not).

   To the extent that income effects are the cause (and it seems likely that they are an important cause) increases in energy efficiency do help to keep energy use down; without the historical improvements we have observed, the global increases in energy consumption would have been even larger.

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4. (a)
   1. $w_l L = (1-\alpha)Y$ and $w_r R = \alpha Y$, so the share of R relative to L is $\alpha/(1-\alpha)$.
   2. R will be produced using input D alone, and its price will be w_d.
   3. $\dot{R}/R = \dot{Y}/Y$, since w_r is constant.
   4. $\dot{R}/R = \dot{Y}/Y = \dot{D}/D = g_A$.

   (b)
   1. The social costs of using input D rise as Y rises. This slows growth in D slightly. However, at some time—let's call it T —we have $w_d + \psi Y = w_r$, and producers switch to input C from this point on. So the use of input D falls suddenly to zero.
   2. The model fits the broad patterns in the data: constant input prices, input use and pollution growing in line with GDP, and then a dramatic fall in pollution.

      Furthermore, the elements of the model make sense. For instance, the WTP to avoid a unit of pollution is likely to rise linearly in income. And the abatement model makes sense: at low damages, little pollution is abated and emissions increase. However, at some threshold cost it suddenly becomes optimal to abate almost all of the polluting emissions, due to a switch to other fuels (e.g. smokeless fuel instead of untreated coal) or due to the application of end-of-pipe technologies with essentially fixed unit costs (e.g. scrubbers in chimney stacks to remove pollutants such as SO_2.)

      Many extensions to the model could increase its applicability. For instance, we could allow less than perfect substitutability between the inputs, which would lead to a more gradual switch to the clean input. And we could allow for input-augmenting knowledge and DTC, which would also slow the transition and introduce potentially interesting policy dilemmas.