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Examination, brief answers

Sustainable Development, NA0167.

1. (a) See lecture notes.
   (b) $\dot{Y}/Y = g_A[1 - \beta/(1-\alpha)]$.
   (c) The rental price of land, and the wage, both grow at the overall growth rate g_Y, whereas the rental price of capital is constant. The factor shares are all constant.
   (d) In the very long run this picture may be roughly correct. Barring colonization of space, land is the ultimate resource, which may well be the limiting factor for harvesting energy as well as supporting nature, production, agriculture, leisure, etc. And it is available in a fixed quantity. Thus its price will rise at the overall growth rate, which will be determined by the rise in productivity of labour.

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2. (a) $C_t = w_t l_{xt}$; $c_t = w_t B_{xt}/A_{xt}$.
   (b) (i) $100 \times \dot{p}_x/p_x = \theta_y - \theta_x$; (ii) $100 \times \dot{p}_x/p_x = \theta_y + \theta_b - \theta_x$; (iii) $100 \times \dot{p}_x/p_x = r$.
   (c) See lecture notes, and other sources.

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3. (a) No it hasn't. Evidence we discussed in the course concerns lighting and motive power from combustion of fossil fuels. More generally, there are myriad uses to which we can put energy today compared to 300 years ago. Each of these uses implies a completely new stock of (product-specific) 'energy-augmenting knowledge'.
   (b) Theory. In the simple one-sector model with independent knowledge stocks, a rise in the price of energy should drive a rise in energy-augmenting knowledge. Conversely, when prices are constant such knowledge should fail to grow. But the evidence cited in part (a) leads us to reject this model.

   In a multi-sector model energy-augmenting knowledge may rise despite a failure of energy prices to rise, due to substitution towards energy-intensive products. If this substitution process is very strong then a rise in energy price may actually *reduce* the energy share, and lead to a *fall* in energy-augmenting investment.

Evidence. Progress in energy-efficiency is not a stationary function of investment. In sectors such as lighting and transport there are well defined limits to energy efficiency: for instance, there is a limit to the amount of light (lumens) that can be generated from a given energy input, and there is a limit to the amount of motive power that can be generated from a given energy input. Furthermore, we are approaching these limits; LED lights and the latest internal combustion engines can be improved upon, but their efficiency cannot be doubled and doubled again. In the case of lighting, Fouquet claims that lighting efficiency increased by a factor of 1000 in the UK between 1800 and 2000. But the latest LED lights are at close to 50 percent of maximum efficiency, so only a factor of 2 remains available for the future.

On the other hand, note that efficiency improvements in some other sectors—such as domestic heating—may well be limitless, and we may be able to approach a long-run situation in which homes can be held at the desired temperature with zero external energy inputs.

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4. (a) i. $p_l Y_L = \alpha Y$ and $p_R r Y_R = (1-\alpha)Y$.
   ii. $w_l L = \alpha Y$ and $w_c C + w_d D = (1-\alpha)Y$.
   iii.
$$\frac{w_c C}{w_d D} = \left(\frac{k_c C}{k_d D}\right)^{\epsilon}.$$
   (b) i. The economy heads for the 'dirty corner': the dominance of D increases, i.e. k_d increases relative to k_c, and D increases relative to C.
   ii. The key point is that the regulator needs to get the economy to a point where $w_c C > w_d D$, at which point investment in boosting k_c is greater than investment in boosting k_d, and the economy moves (without the need for further intervention) towards the clean corner. A short sharp investment in clean technology might do the trick.
   (c) In my opinion the model is misleading and is liable to lead to failed policies; the short sharp investment suggested by the model is not likely to send the economy towards a clean corner in reality. Why not?
