

What Could the 'New' Growth Theory Teach Smith or Ricardo?

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Abstract

The paper contains a report of a discussion between Adam Smith and David Ricardo serving on a newly installed research evaluation committee 'On the Advancement of Knowledge in Growth Economics, Paying Special Attention to the Contribution of "New" Growth Theory'. The two economists screen some of the most prominent 'new' growth models and assess their original novelties. They argue that the main contribution of these models boils down to the suggestion that there is a technology producing a surrogate for what used to be called 'labour'. That factor has been given new names and enters the stage as 'human capital' or 'knowledge'. In this way labour is rendered an accumulable factor, generated endogenously, and thus cannot constrain economic growth via a falling rate of profit due to diminishing returns to capital as capital accumulates.

1. Introduction

In many countries, departments of economics as well as other departments are nowadays subject to recurrent assessments of the quality of their work, especially the research performed by their members. In Britain this activity is known as the Research Assessment Exercise. While there appears to be fairly wide agreement within the profession that

such assessments might be a good thing, at least in principle, there is much less agreement about how they should be carried out and whether the way in which they are in fact done can be expected to yield a fair judgement on the strengths and weaknesses of economics departments. It would of course be very unwise for me to enter into a discussion of this hot topic, of which I understand so little, and I can assure you that I will not do so. I shall rather deal with a first attempt to realize a proposal of which you may not yet have heard. It has been suggested that the now common cross-section assessment should be complemented by a time-series assessment aimed at evaluating the relative speeds with which the different scientific disciplines and their various branches progress. Applied to our subject, the question is what can be said about the advancement of economic knowledge in general and in special fields in particular.

Next the questions were addressed which area to examine and whom to commission to the intertemporal assessment of economics. Growth theory was chosen for obvious reasons and just at this point someone drew attention to a fundamental breakthrough in medicine which had made it possible to bring dead people back to life. On mature deliberation it was then easy to select Adam

Smith and David Ricardo. Reanimated, the two economists, after some hesitation, accepted to serve on a committee 'On the Advancement of Knowledge in Growth Economics, Paying Special Attention to the Contribution of "New" Growth Theory'.

Smith and Ricardo met in a place mid-way between Glasgow and Gloucester, in a charming town by the name of Stoke-on-Trent, where they were offered an impressive chamber in which they could work and had access to all the relevant literature. After some weeks of reading they decided to structure their following discussion. They wanted to begin with a brief investigation of the *scope* of 'new' growth theory, then turn to the *method* in terms of which the problem was studied, and finally approach the *content* of the theory. As regards the latter task they agreed to deal first with major building blocks of the theory and subsequently to study how these blocks were combined. They decided to concentrate on fundamentals and set aside what may be considered peripheral to the main argument. This also made them focus attention on what may be called the first generation of contributions to 'new' growth theory, because these defined the confines within which the resulting avalanche of theoretical literature was to unfold.

By inexplicable luck it fell upon me to report on their conversations while working on the assessment. In the following I provide a summary account of what I had the privilege to hear and see. It goes without saying that none of the views put forward in the sequel are my responsibility. If you should dislike them you must not put the blame on me; I am only the messenger. The unfortunate habit in antiquity of decapitating those who brought bad news (and were generally good at running) may have been one of the causes of the eventual decline of those nations.

My report is in the form of a dialogue

between Smith and Ricardo. This keeps close to what actually happened. It goes without saying that I am bound to read out what they said. If I didn't you might be inclined to think that what follows is an invention of my mind. So please forgive me for not speaking freely to you; it is in the interest of undiluted scholarship and truth.

2. *They and us*

Smith: On the whole I was rather disappointed how little the majority of modern authors know about what we have done. Whilst there are occasional references to our works ...

Ricardo: There are many more to yours than to mine!

Smith: It's kind of you to say this, my dear David, but being referred to more often doesn't mean much. I have the feeling that to praise an author is sometimes just a pretext *not* to take into account what he has written. There are also statements that I found amazing. Listen, for example, to the following dictum of Martin Weitzman of Harvard University: 'Before Robert Solow and his co-conspirators did serious growth accounting[,] economists did not think too systematically about the sources of economic growth...' (Weitzman, 1996, p. 207). What does he think we were doing?

Ricardo: I understand your disenchantment, Adam, but don't forget that the judgement came from an American, and, as we know, they occasionally have a tendency to grossly exaggerate things and present their ideas as if they were totally original and novel. British people are different.

Smith: I wonder! But let's get back to our main topic and discuss the scope of the 'new' growth models.

3. *Scope*

(Smith:) As you know, Adam Ferguson coined the beautiful phrase that history is 'the result

of human action, but not the execution of any human design' (Ferguson, [1767] 1793, p. 205). We considered the explanation of human history one of the most important, if not *the* most important problem of the social sciences. The explanation sought included an investigation of the nonintended consequences of purposeful action and a discussion of the possibilities and limits of statesmanship. What was at stake was, in the words of John Hicks (1969), the development of a 'theory of economic history'. We accepted this challenge and, I dare say, with some little success.

Ricardo: I think this is a fair description of what *you* did. My concern was much more limited.

Smith: You're a modest man, David. Be that as it may, the grandiose question of what shapes the long-term development of the economy is again high on the agenda. This should be some comfort to us. We may ask now: Has growth theory progressed since our days? Or: What could the 'new' growth theory teach us?

4. Method

Ricardo: As I see things there is not only a revival of interest in the old questions but also in the method of analysis proposed by us, namely, the method of *long-period* positions, or 'equilibria', in the language of the 'new' growth theorists, characterised by a *uniform* rate of profit. More precisely, these authors focus attention on what is but a very special case of such positions, that is, *steady states* of the economy. As you will have read, the long-period method which was used by essentially all economists, classical and neoclassical alike, until the late 1920s was then replaced by the new methods of *temporary* and *intertemporal equilibrium*, pioneered by Hayek, Lindahl and Hicks. There is no time to go into the details of this

break with the traditional method here. Suffice it to say that in temporary equilibrium theory in general and in intertemporal equilibrium theory until a few decades ago the time horizon was assumed to be finite and, therefore, arbitrary. The introduction of an *infinite* horizon turned out to be critical (see also Burgstaller, 1994, pp. 43-8). It pushed the analysis inevitably towards the long period. This was clearly spelled out, for instance, by Robert Lucas, who observed that

for *any* initial capital $K(0) > 0$, the optimal capital-consumption path ($K(t)$, $c(t)$) will converge to the balanced path asymptotically. That is, the balanced path will be a good approximation to any actual path 'most' of the time.

and that 'this is exactly the reason why the balanced path is interesting to us' (Lucas, 1988, p. 11).

Lucas thus advocated a (*re*-)switching from an intertemporal analysis to a long-period (steady-state) one. Since the balanced path of the intertemporal model is the only path analyzed by Lucas, the intertemporal model may be regarded simply as a step to obtain a rigorous long-period setting (see also King and Rebelo, 1993). (Paraphrasing a dictum put forward by Paul Samuelson in a different context, we may say that intertemporal analysis is a *detour* with regard to long-period analysis). Moreover, concentrating on the 'balanced path', capital in the initial period *cannot* be taken as given alongside other 'initial endowments'. As a consequence, income distribution cannot be determined by demand and supply of the respective factors of production.

Smith: What you said is very interesting. Whilst I am not at all happy with the narrowing of our notion of long period to

steady states, in terms of scope and method I already begin to feel somewhat at home. But what about the content of the theory? Since the saving-investment mechanism is at the heart of every theory of accumulation and growth, I suggest we start with that.

5. Consumption, saving and investment

Ricardo: I must confess that I was very surprised to see that these models know essentially only a single agent. You will remember that our approaches were criticized for being insufficiently microeconomic, because we knew only three kinds of agents and economic roles associated with them - workers, capitalists and landlords. Yet many if not the majority of contemporaries seem to find nothing wrong with the single-agent abstraction mongering. It is even assumed - can you believe it? - that the 'representative agent' is immortal and immutable, which follows from his - or is it her? - concern with maximizing an intertemporal utility function over an infinite time horizon. The exercise then consists of choosing the path of consumption that maximizes the integral of instantaneous utility:

$$\int_0^{\infty} e^{-\rho t} \frac{1}{1-\sigma} [c(t)^{1-\sigma} - 1] dt \quad (1)$$

subject to $Y = c(t) + \dot{K}$, where Y is net national income, $c(t)$ is consumption at time t , \dot{K} is net investment which is the derivative of the capital stock K with respect to time, ρ is the rate of time preference or discount rate, and $1/\sigma$ is the elasticity of substitution between present and future consumption ($1 \neq \sigma > 0$). In the literature, the discount rate is occasionally dubbed 'required rate of return', since it gives the break-even level of the profit rate: with the rate of profit larger

(smaller) than the discount rate, savings will be positive (negative). As becomes already clear at this stage, the models generally know only a single consumption good, which is commonly taken to be identical with the physical capital good.

Smith: This is indeed an amusing way of dealing with the complex issue of 'microfoundations'. It seems to me that the 'representative agent' could claim with greater authority than Louis XIV: 'L'État c'est moi!' Setting aside a variety of behaviour and thus selection strikes me as neglecting some of the most important aspects of any real process of growth and development. It should also be pointed out that this optimizing approach leads to various difficulties, logical and other, which raise serious doubts about its usefulness. For example, no allowance is made for the fact that consumption takes time; as income per capita rises, the problem of *when* to consume ever larger quantities of the single consumption good cannot be evaded (cf. Steedman, 1995). Robert Solow, for perfectly good reasons, it seems, maintained: 'the use made of the inter-temporally-optimizing representative agent ... adds little or nothing to the story anyway, while encumbering it with unnecessary implausibilities and complexities' (Solow, 1994, p. 49).

What I also find peculiar is that ρ - which, as we shall see, plays a crucial role in the argument - is commonly assumed to be given from outside the system and constant. In contradistinction, John Stuart Mill and after him many others, including John Maynard Keynes, stressed that 'The minimum rate of profit varies according to circumstances' (Mill, [1848] 1965, p. 736). Considerations of this kind made me advocate the view that a fall in the rate of profit need not necessarily entail a fall in the rate of accumulation.

Ricardo: It should also be noted that because

there is no real distinction between savers and investors there is none between savings and investment. Say's law is taken to hold full sway. The problem of effective demand and unemployment is simply set aside, whereas in my controversy with Malthus I was at least keen to argue my case, perhaps overkeen, I now recognize. Indeed, I am in sympathy with the thrust of a statement by Edmond Malinvaud put forward only a few years before the take-off of 'new' growth theory. *Vis-à-vis* the unemployment figures in the OEEC he wrote:

Students of economic growth will easily accept two ideas put forward ..., namely that some disequilibria may be sustained over rather long periods, and that the existence of these disequilibria significantly reacts on the growth process, to speed it up, slow it down or change its course. ... [A]n essential part of any theory of economic growth should be the representation of investment, and it seems to me that both excess capacity and profitability have an important role to play in this representation. (Malinvaud, 1983, p. 95)

6. Production

Smith: I think Malinvaud has a good point. And there are others. Did you notice, David, that in this literature production as a whole is represented in terms of what are called *aggregate production functions*?

Ricardo: I did indeed and was baffled, because I could not believe that all the different productive activities in any real economy can be portrayed in such a way. How do you aggregate lorries, conveyor belts, personal computers etc. to a 'quantity of capital' for the economy as a whole, and similarly with regard to the social product?

Looking up the modern literature on capital theory and aggregation I saw my scepticism fully corroborated. Franklin Fisher (1993), for example, has made it abundantly clear that there is no such thing as an aggregate production function. And Andreu Mas-Colell stressed that 'modelling the world as having a single capital good is not *a priori* justified' (Mas-Colell, 1989, p. 508), and I doubt that it can be justified *a posteriori*. However, these results don't seem to be taken seriously in the literature under consideration.

Smith: Well, there are at least occasional hints that something is dubious. After having discovered that an earlier formulation of his is inconsistent with the assumption that research is a nonrival good, Paul Romer added that this

may seem a trifling matter in an area of theory that depends on so many other short cuts. After all, if one is going to do violence to the complexity of economic activity by assuming that there is an aggregate production function, how much more harm can it do to be sloppy about the difference between rival and nonrival goods? (Romer, 1994, p. 15)

I kept wondering where to stop this process.

Ricardo: I came across an even more puzzling passage by the same author. In the context of a discussion of some people's opposition to mathematical formalism he stated:

Only 30 years ago many economists still objected to a mathematical statement of the relationship between output and capital in terms of an aggregate production function and an aggregate stock of capital, $Y = f(K, L)$. (Romer, 1996, p. 202)

I hope he doesn't imply that Fisher is not a

good mathematical economist. As if the question was against pro or con mathematical formalism as such and not pro or con cases of silly mathematical formalism.

Smith: I agree. More generally, I found that many modern writers have a pronounced concern for *spurious* precision. They put into algebra what perhaps cannot yet be put into mathematical language because the phenomena under consideration have not yet been studied with sufficient care. Faith does not seem to be a scarce good in contemporary economics. Are 'microfoundations' not required in production theory?

7. A falling rate of profit

(*Smith:*) But let's get to the core of the matter. We are told that 'The key property of endogenous-growth models is the absence of diminishing returns to capital' (Barro and Sala-i-Martin, 1995, p. 39), that is, the absence of any falling long-term tendency of the rate of profit. Since you did not approve of my explanation of the falling tendency of the profit rate for reasons which I think I now understand, it would be good if you could summarize what, in your view, is responsible for any such tendency. Your argument may then serve as a foil against which we can discuss the mechanisms invoked by the 'new' growth theorists to prevent the rate of profit from falling.

Ricardo: This is very kind of you. I shall try to set the stage for our discussion in terms of a highly stylised representation of what I called the 'natural' course of the economy. By this I meant the purely hypothetical path an economic system would take in the absence of any technical progress. For simplicity, and perfectly in line with much of 'new' growth theory, I shall assume a one-commodity economy. The only commodity produced is dubbed 'corn'. You may have heard that there is some controversy whether in my lost papers

on Profits of 1814 I held such a 'corn model'. Unfortunately, I have forgotten whether I did or didn't, which however is of no import for the rest of my argument. With corn of a given quality as the only capital good there simply cannot arise the problem of what is meant by a given 'quantity of capital' or by an 'increase' of that quantity.

Assuming, in addition, the real wage rate of workers to be given and constant, the rate of profit is bound to fall due to extensive and intensive diminishing returns on land. On the premise that there are only negligible savings out of wages and rents, a falling rate of profit involves a falling rate of capital accumulation. Assuming that the marginal propensity to accumulate out of profits, s , is given and constant, a 'classical' accumulation function can be formulated:

$$g = \begin{cases} s(r-r_{min}) & \text{if } r \geq r_{min} \\ 0 & \text{if } r < r_{min} \end{cases} \quad (2)$$

where $r_{min} \geq 0$ is the minimum level of profitability which, if reached, will arrest accumulation (cf. *Works*, I, p. 120). My 'natural' course will necessarily end up in a stationary state. Notice that the rate of accumulation is *endogenously* determined. The demand for labour is governed by the pace at which capital accumulates, whereas the long-term supply of labour is regulated by a population mechanism.²

Let me illustrate the case with the help of the familiar figure 1 (cf. Kaldor, 1956). For simplicity I set aside seed capital: capital consists only of wages. In the most simple conceptualization possible, the one entertained here, labour is seen to be in long-run elastic supply at a given real wage rate, which is taken to equal OW . The curve $CEGH$ is the marginal productivity of labour-cum-capital. Then, if the amount of labour-cum-capital

applied is L_1 , the area $OCEL_1$ gives the product, $OWDL_1$ gives total capital employed, and BCE total rent. Profit is determined as a residual and corresponds to the rectangle $WBED$. The rate of profit can be determined as the ratio of the areas of two rectangles which have the same basis and, therefore, it equals the ratio WB/OW . Obviously, if a positive profit rate implies a positive growth rate (i.e., $r_{min} = 0$), the economy will expand until labour-cum-capital has reached the level L .

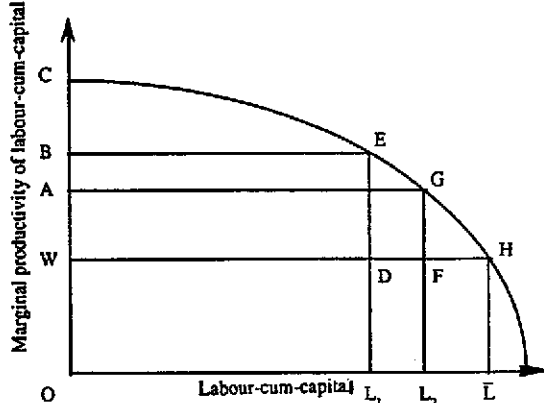


Figure 1: Diminishing

The important point to note here is that the work force needed in a given moment of time is considered to be generated by the accumulation process itself. In your words, Adam: 'the demand for men, like that for any other commodity, necessarily, regulates the production of men: quickens it when it goes on too slowly, and stops it when it advances too fast. It is this demand which regulates and determines the state of propagation in all the different countries of the world' (*WN*, I.viii.40).³ Labour can thus put no limit to growth because it is 'generated' within the growth process. The only limit to growth can come from other *nonaccumulable* factors of production, that is, natural resources in general and land in particular. It is the

'niggardliness of nature' which is responsible for the falling tendency of the rate of profit.

8. Solow's model

Smith: Well done, David! I think I now also understand Solow's model much better (cf. Solow, 1956). Whilst you and I put forward an approach which subsumed the supply of labour under the needs of capital accumulation, Solow subsumed land (and natural resources) under capital. Therefore, labour assumes in his model a position that may be compared to that of land in yours. And very much as in your argument the rate of profit is taken to fall as the accumulable factor - capital - grows relatively to the nonaccumulable factor. Outside the steady state, both the actual rate of growth and income distribution are *endogenously* determined, whereas in the steady state the rate of growth equals the *exogenously* given natural rate of growth. But the rate of profit as well as the real wage rate are still *endogenous*. I may illustrate this in terms of the very familiar figure 2. The endogenously determined steady-state rate of profit $r(k^*)$ is given by the slope of the tangent at P.

Now let me ask you a question and add a speculation. The question is: Would it be very misleading to say that compared to the Solovian model in the 'new' growth literature the situation is reversed in the following sense: *the steady-state rate of profit is exogenous, whereas the steady-state rate of growth is endogenous*? And the speculation is: With the rate of profit at centre stage of the 'new' growth models, in order to have perpetual growth, the rate of profit must not fall to r_{min} or ρ . Hence, in terms of figure 1 I see essentially three research strategies: provide arguments that guarantee *either* that the curve giving the marginal product of labour-cum-capital does not fall, but is a line

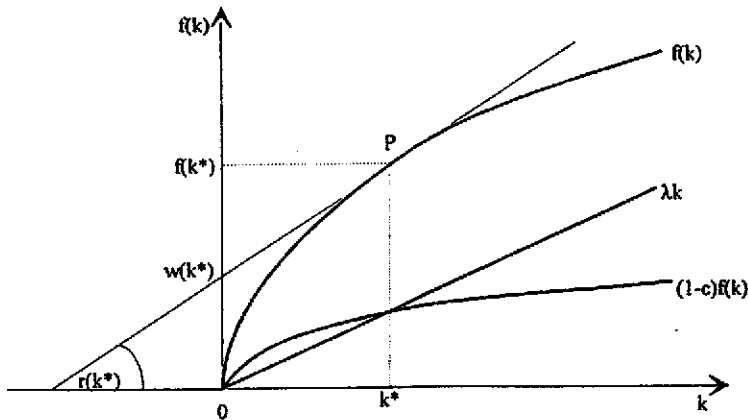


Figure 2

parallel to the abscissa, or falls, but its fall is bounded from below, or instead of falling rises.

Ricardo: As regards your question: No, it wouldn't be very misleading. As regards your speculation: it provides a most useful systematic framework for the following discussion. Let me begin with the so-called 'linear' or 'AK models'.

9. 'AK' models

(Ricardo): If in Solow's model there was no labour needed in production, or if labour was a free good, then the marginal product of capital could not fall as capital accumulates. This is precisely the route taken by one class of 'new' growth models: whereas Solow had only removed land from the scenery, they remove also labour, that is, all nonaccumulable factors, and assume that all inputs are 'capital' of some kind. You could say that these are Solovian models *sans travail*. Beauty is sought in simplicity. The most elementary version of this class of models assumes that there is a linear relationship between total gross output, Y , and a single factor capital, K , both consisting of the same commodity:

$$Y = AK \tag{3}$$

where $1/A$ is the amount of that commodity required to produce one unit of itself. The *surplus product* or net output equals $Y - \delta K$, where δ is the exogenously given rate of depreciation. The surplus is assumed to be appropriated entirely in the form of *profits*. The net rate of return on capital r is what my friend Malthus would have called a 'material rate of produce' and is given by:

$$r = \frac{Y}{K} - \delta = A - \delta \tag{4}$$

The saving-investment mechanism jointly with the assumption of a uniform rate of growth then determines a relationship between the growth rate g and the profit rate. Rebelo (1991, pp. 504 and 506) obtains either:

$$g = \frac{A - \delta - \rho}{\sigma} = \frac{r - \rho}{\sigma} \tag{5}$$

or:

$$g = (A - \delta)s = sr. \tag{6}$$

Equation (5) is obtained when savings are determined on the basis of intertemporal utility maximization, whereas equation (6) is obtained when the average propensity to save

s is treated as a given parameter. Hence, in this model the rate of profit is given by *technology*, i.e. exogenously, just as you said, Adam, and the saving-investment mechanism determines the growth rate.

Smith: The model strikes me as a simplified version of the (in)famous 'corn model and a replica ($\delta = 0$) of Frank Knight's 'Crusonia plant model':

We may think of our Crusonia as living on the natural growth of some perennial which grows indefinitely at a constant (geometric) rate, except as new tissue is cut away for consumption. We assume that it requires no cultivation or other care, and we must ignore any 'labour' which may be involved in gathering or simply 'eating' the product. (Knight, 1944, p. 30)

Knight stressed that 'The resource must, of course, be of the nature of capital' and added: 'In an economy of the type postulated, the only problem of choice presented to the "management" will be the determination of the rate of consumption, which is the same as saying the rate of saving and investment or of disinvestment' (ibid., p. 30).

Ricardo: This is a valid observation, Adam. Compared with the 'corn model' there are two differences: (i) the input of 'corn' in the AK model is treated as a durable capital good; and (ii) land is a free good. As regards the problem of depreciation, let me mention in passing that I find the assumption of an exogenously given rate of depreciation highly problematic. But let me turn immediately to the implicit assumption that land is a free good. When I once engaged in the fancy thought experiment of what would happen if land and natural resources of the best quality were available in unlimited amount, I did not

of course think I could thereby anticipate what towards the end of the 20th century would be considered an innovative idea. Let me remind you of what I wrote:

Profits do not *necessarily* fall with the increase of the quantity of capital because the demand for capital is infinite and is governed by the same law as population itself. They are both checked by the rise in the price of food, and the consequent increase in the price of labour. If there were no such rise, what could prevent population and capital from increasing without limit? (Ricardo, *Works*, VI, p. 301)

With land as a *free good*, costs of production of the amount of corn constituting the given real wage rate would be constant. In this case - see figure 3 - the graph giving the marginal productivity of labour-cum-capital would be a horizontal line and therefore the rate of profit would be constant whatever the amount of labour-cum-capital. As a consequence, the system could grow forever provided $r > r_{min}$.

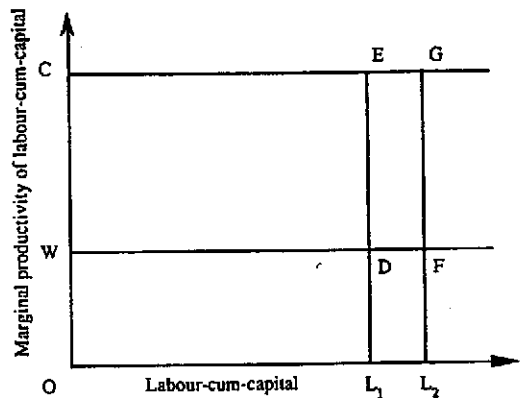


Figure 3: Land as a free good

The AK model is now immediately recognized as describing a world similar to the one contemplated in my thought

experiment, provided that labour is set aside and $\delta = 1$. Even the saving-investment mechanism is essentially the same: in the case of equation (5) $\sigma = 1/s$ and $\rho = r_{min}$ (provided that $r > r_{min}$); in the case of equation (6) $r_{min} = 0$. Hence, the version of the 'new' growth theory under consideration is but a further simplification of the most elementary of my growth models. I, for one, can hardly be accused of having taken that case too seriously. Schumpeter (1954, pp. 472-3) used to chastise what he dubbed the 'Ricardian Vice', that is, the habit of applying results derived from simple 'one-way relations' to the 'solution of practical problems'. What would he have said about the policy recommendations that abound in the 'new' growth literature?

Smith: You appear to dislike the idea of *Ricardian vice* - perhaps because compared with you Schumpeter was not exactly what one would call successful, *financially speaking*?

Ricardo: Well, may be ... Since you don't seem to show signs of boredom as yet may I take one more minute and talk briefly about the set of linear models that differentiate between physical and human capital? I refer particularly to a paper by King and Rebelo (1990).

Smith: How could I stop you?

10. Physical and human capital

Ricardo: In the context of a discussion of the labour displacing effects of machinery I once went to the extreme and imagined a world in which machine power has entirely replaced labour power. I wrote:

If machinery could do all the work that labour now does, there would be no demand for labour. Nobody would be entitled to consume any thing who was not a capitalist, and who could not buy

or hire a machine. (*Works*, VIII, pp. 399-400)

Smith: So what you are alluding to is that in some of the 'new' growth models all people are in fact capitalists of sorts.

Ricardo: Exactly. This is also why the idea of a 'representative agent' is somewhat congenial to these kinds of models. On the other hand, the existence of different kinds of agents cannot sensibly be denied. In particular, there *are* workers. The 'new' growth theorists seem to feel entitled to subsume workers under capitalists as a consequence of conceiving of the capacity to work as a *special* kind of capital: 'human capital'.

Smith: This appears to me to be an important point. Authors like King and Rebelo (1990) draw indeed a strict analogy between an item of fixed capital and skilled labour. The production functions relating to the two kinds of capital have the two kinds of capital as the only inputs and are assumed to be homogeneous of degree one and strictly concave. There are no diminishing returns to (composite) capital for the reason that there is no nonaccumulable factor such as simple labour that enters into the production of the accumulable factors. In contradistinction to the above model of Rebelo there is a *choice of technique problem*. The rate of profit is now uniquely determined by the technology and the maximization of profits.⁴ With the rate of profit ascertained in this way, the growth rate of the system is then determined in the usual way by the saving-investment equation.

Ricardo: Are you happy with this conceptualisation of human capital?

Smith: Hardly. First, the assumption entertained in this model, but also in that of Lucas (1988), that the formation of human capital does not involve any unskilled labour as an input is difficult to sustain: the whole

point of education processes is that a person's capacity to perform unskilled labour is gradually transformed into capacity to perform skilled labour. Second, more than two centuries ago I wrote:

A man educated at the expence of much labour and time to any of those employments which require extraordinary dexterity and skill, may be compared to one of those expensive machines. The work which he learns to perform, it must be expected, *over and above the usual wages of common labour*, will replace to him the whole expence of his education, with at least the ordinary profits of an equally valuable capital. (*WN*, I.x.b.6; emphasis added)

While I also drew a parallel between fixed (physical) capital and human capital, I was careful to keep a reference to the wage rate paid to workers performing 'common labour'. I don't see how that kind of labour could be made to vanish. And if it cannot, then assuming that there is no such thing as 'common labour' amounts to assuming that it is a free good ...

11. *Nonsubstitution theorem*

Ricardo: ... which in turn amounts to assuming that the wage rate is given from outside. This procedure bears a close resemblance to the *asymmetric* treatment of the distributive variables characteristic of our approach in which profits emerge as a residual. Yet there is a substantial difference here. The notion that in conditions of free competition the services of certain factors of production, such as some qualities of land, which are in excess supply assume a zero price - the so-called 'Rule of Free Goods' - was a standard element in what is known as

classical rent theory. However, with respect to labour we only allowed an excess of labour to drive the wage to a *positive* minimum, reflecting social, historical and moral elements.

This brings me to a further observation. The authors of these models don't seem to be aware that they have simply put forward special cases of the so-called *nonsubstitution theorem* (see, for example, Samuelson, 1961). The theorem states that with (i) constant returns to scale, (ii) a single primary factor of production only (homogeneous labour) and (iii) no joint production, and taking the real wage rate as given from outside the system, the price of human capital in terms of the consumption good and the rate of profit are uniquely determined. The theorem implies that generally only one technique can be used in the long run. The growth models under consideration satisfy conditions (i) and (iii). As regards condition (ii), a special form of the Theorem is needed because of the absence of any primary factor (or a primary factor with a zero remuneration).⁵ It hardly needs to be stressed that compared to these models the famous von Neumann growth model (von Neumann, [1937] 1945) is a *good* deal more general.

Smith: Let me summarize. In the class of models considered so far the role played by 'human capital' may be compared to the role played by 'labour' in our approaches: both factors of production are taken to be generated *endogenously*. The linear models thus replicate in elementary terms the *logic* of some two centuries old theory.

12. *A convex technology with returns to capital bounded from below*

Ricardo: True. Let me add, as an afterthought, a constellation that is mildly less fancy than the one depicted in figure 3. Assume that land

is differentiated into infinitely many classes: there is a continuum of different qualities - and all qualities superior to quality m are available in limited supply, whereas land of quality m is available in unlimited supply. Then the old story can be told anew except for a small modification. With the system growing forever and assuming continuous substitutability between labour-cum-capital and land, lands of quality 1 to $m-1$ will eventually become scarce and the rate of profit will gradually fall to the level associated with land of quality m - given by the dashed line in figure 4. On the assumption that the corresponding rate of profit is larger than $r_{min} \geq 0$, the system would grow indefinitely at a rate of growth which would asymptotically approach its lower boundary.

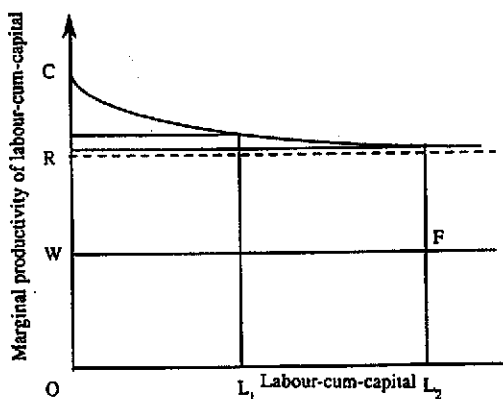


Figure 4: Returns to capital-cum-labour bounded from below

Interestingly, the properties of this case have recently been mimicked by Jones and Manuelli (1990). They preserved the dualism of an accumulable and a nonaccumulable factor as in Solow, but restricted the impact of an accumulation of the former on its returns by an *ad hoc* modification of the aggregate production function. The special case contemplated by them is:

$$\varphi(k) = f(k) + bk, \quad (7)$$

where $f(k)$ is the previously hallowed, but no longer sacrosanct Solovian production function, and b is a positive parameter. As capital accumulates and the capital-labour ratio rises, the marginal product of capital will fall, approaching asymptotically its lower boundary b . With a given propensity to save s and assuming capital to be everlasting, the steady-state growth rate g is endogenously determined: $g = s(b - r_{min})$. Assuming on the contrary intertemporal utility maximization, the steady-state rate of growth is given by $g = (b - \rho)/\sigma$. The rate of growth is positive, provided the technical parameter b is larger than r_{min} or ρ .

This prompts me to the following observation. All the papers referred to have been published in so-called 'core' journals. The term 'Diamond list' is said to be one of the most often heard terms these days in economics departments in the U.K. But it would seem to me that one had better *read* what is commonly praised before passing a judgement on whether it is in fact praiseworthy.

Smith: You may recall the 'paradox of value' which I illustrated in terms of the water and diamond example. There I wrote that diamonds - that is, things 'which have the greatest value in exchange have frequently little or no value in use' (*WN*, I.iv.13). *Frequently*, not always. Still there are the problems of deception and pressures to conformity. But this is too big a theme to be dealt with now.

13. Increasing returns to capital bounded from above

(*Smith*): So far we have seen two types of models: one in which decreasing returns to capital - a falling rate of profit - are prevented by juggling away *any* nonaccumulable factors, the other in which the impact of those factors

is contained by some *ad hoc* assumption concerning technology. Let us now turn to a further class of models. These have recourse to *positive external effects* associated with self-seeking behaviour: these externalities are taken to offset any fall in the rate of profit as capital accumulates. The basic idea underlying these kinds of models can easily be illustrated in terms of another modification of the basic diagram used so far: the remaining possibility is increasing returns to capital, depicted in figure 5. Clearly, if these returns were rising and unbounded from above, the growth rate might rise over time and tend towards infinity, which is not a very sensible thing to assume. The steady-state framework adopted by the 'new' growth theorists requires them to introduce *ad hoc* some upper boundary to returns to capital.

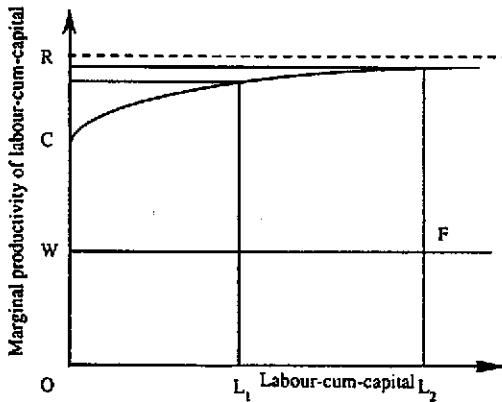


Figure 5: Increasing returns

Ricardo: Externalities is clearly your field, not mine. However, whilst in your discussion of the division of labour you allowed both positive and negative externalities, in many models now there are only positive ones.

Smith: This is indeed the case with regard to the models of Lucas (1988) and Romer (1986) which we must now investigate. But before we do that let me add a remark on

figure 5. In order to be able to preserve the notion of a *uniform* rate of profit, it has to be assumed that the increasing returns are *external* to the firm and exclusively connected with the expansion of the market as a whole and the social division of labour. This implies that whereas in the case of decreasing returns due to the scarcity of land (cf. figures 1 and 4) the product was given by the area under the marginal productivity curve, now the product associated with any given amount of labour-cum-capital is larger than the area under that curve.⁶ The cases of decreasing and increasing returns are thus not symmetrical.

I begin with a first subgroup of models contemplating the role of positive externalities for economic growth, that is, models in the tradition of Lucas (1988), which emphasize spillovers from human capital formation.

14. Human capital formation and externalities

(Smith:) Lucas assumed that agents have a choice between two ways of spending their (non-leisure) time: to contribute to current production or to accumulate human capital. It is essentially the allocation of time between these two alternatives that decides the growth rate of the system. Lucas conceptualizes the process by means of which human capital is built up *ad hoc* by:

$$\dot{h} = \upsilon h^{\xi}(1-u) \tag{8}$$

where u and ξ are positive constants. Whilst he indeed begins with (8), he quickly finds himself obliged to consider (8) with $\xi = 1$, because this is the only assumption consistent with steady-state growth. Equation (8) is thus a kind of 'production function' of human capital by means of human capital, where the average product is constant and equal to υ . It