AN UNDERGRADUATE'S GUIDE TO THE MACROECONOMICS OF EIGHTEENTH CENTURY BRITISH ECONOMIC GROWTH

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1. The eighteenth century

This chapter presents an introductory overview and analysis of the economy of the eighteenth century conducted at a highly aggregative level. It also aims to give the reader some insight into the methodological standpoint of economists' economic history, in particular into the virtues and limitations of macro model building in the study of the advent of industrialisation.

I. The key changes

At this early stage the behaviour of only a few strategic economic variables will be considered. Furthermore, in order to simplify the exposition, the main concern will be with general orders of magnitude and directions of change and little attention will be given to the important problem of the detailed accuracy of individual series. For the moment we can rely largely on the pioneering estimates of Deane and Cole (1969), even though the underlying data is often very questionable and the numbers given in Tables 1 and 2 are sometiems frankly conjectural (Crafts 1974, 1976; Deane and Cole 1969; ch. 1, 2, 5, 8, 9; Wright 1964). In this section the treatment will be descriptive, although, as will become apparent, the choice of the variables to be discussed is very much a reflection of economic models of growth and development. Thus the quantitative aspects of the progress of the economy which principally concern us are the rate of growth and composition of output, the rates of growth and changing use of factors of production, and the level and distribution of income.

Table 1. Growth rates of macroeconomic variables (per cent per annum).

	1710-40	1740-80	1780-1800
real income	0.5 (0.2)[a]	1.0	2.0
real income/head	0.5 (0.2)[a]	0.3	1.0
industrial output	0.7	0.9	2.8
home industries	0.2	0.4	1.1
export industries	1.0	1.3	4.0
exports by volume	0.8	0.9	5.7
agricultural output	0.7 (0.0)[a]	0.5	0.6
population	0.0	0.7	1.0
capital stock[c]	0.5-1.0	1.0-1.5	1.5-2.5
land[c]	0.0	0.4	0.4
agricultural/industrial prices	-0.8	0.6	1.7
real wage rate[b]	0.7	0.1	-1.6

a. Figures are from Crafts (1976); figures in parentheses are from Deane and Cole (1969).

b. General average as given in Deane and Cole (1967: Table 5) deflated by Schumpeter-Gilboy cost of living index (Mitchell and Deane 1962: 468-9).

c. Figures are particularly doubtful; for capital stock see text; for land a guess based on numbers of enclosure bills and Deane and Cole's discussion (1969:68).

Source: derived from Deane and Cole (1969: Tables 2, 5, 19, 20, 23, 85).

Table 2. Some components of economic activity.

	1700	1800
Components of National Expenditure (per cent)		
Merchandise Exports	6	14
Investment (NCF/NNP)	3-5	6-7
Factor Shares (per cent)		
Wages	25-40	45
Rents	25	20
Profits	35-50	35
Sectoral Shares in Output (per cent)		
Agriculture	40	32
Manufacturing	21	30
Sectoral Shares in Employment (per cent)		
Agriculture	70-80	35
Manufacturing	10-30	30

Source: derived from Deane and Cole (1969: Tables 30, 35, 80 and p.137, 263).

Although the picture given by Tables 1 and 2 would probably be acceptable in broad outline to a majority of economic historians and the major discussion of these figures will be conducted in the context of the models reviewed in later sections, a few preliminary and cautionary remarks may be helpful at this point.

(i) The periodisation adopted may occasionally distort, for example, the use of 1780 as a break-point gives a rather misleading picture of trade growth because of the American War of Independence. The figures are not good enough to be very confident about short term changes in rates of growth but the acceleration of the last two decades in the rate of growth of real output, real output per head, industrial output and exports seems well established. Some increase in these growth rates at sometime in the mid-century also seems probable. The pattern of agricultural output growth is contentious and this is a major factor complicating both the description and the analysis of eighteenth century growth (Crafts 1976).

(ii) The faster industrial output growth at the end of the century was concomitant with a rapid rise in agricultural prices compared with industrial prices. The real wage rate figures are very sensitive to changes in agricultural prices and this is largely responsible for the contrast between 1710-40 and 1780-1800. Figures for real wages must, of course, be regarded as unreliable (Hobsbawm 1957).

(iii) The overall rates of growth of output are not high by twentieth century standards, but population growth rates were also much below the 2½ per cent or so common in today's developing countries (World Bank

1974:1-38). Moreover, the growth performance of the economy prior to 1780 was not dissimilar to that of other areas of Europe, for example, France (Rostow 1975: 168).

(iv) Even in the early eighteenth century the economy appears to have had considerable potential for the accumulation of capital. Incomes per head were higher than in many developing countries in the post 1945 era; a figure of about $200 1965 U.S. has been suggested (Maddison 1967: 308). It has also been argued that population growth was restrained by a number of preventive checks, which prevented population size reaching the maximum consistent with subsistence (Wrigley 1969: Ch. 3-4). Moreover, income was distributed very unequally; in 1688 the top 5 per cent of the population received about 25 per cent of income. Even if they had lived at three times the per capita consumption level on which the other 95 per cent survived this could still have allowed a savings rate of 13 per cent of national income (Kuznets 1974: 142).

(v) Measurement of sectoral shares in output and employment and factor shares in the distribution of income is extremely difficult because of the limited extent of specialisation in the early eighteenth century and its increase later on. The most noticeable feature is the decline in agriculture's relative share, which probably gathered pace in the late eighteenth century. However, the absolute size of the agricultural labour force is generally thought to have gone on rising in terms of absolute numbers to a peak of 2.1 million in 1851 (Deane and Cole 1969: 143).

(vi) The very slow rise of the share of investment in national expenditure contrasts with the predictions of many development theorists of the 1950s (Lewis 1955: 208, Rostow 1960: 41). This in itself is intriguing but it raises another important point, namely that such macro indicators as the investment rate, or for that matter the rate of economic growth, may be very insensitive to many major changes. They are summary statistics which discard information and give a very different perspective on events than is obtained from following the fortunes of a glamour industry or from examining regional differences. In particular, the relatively stable investment rate should not be allowed to detract from the point that there was a considerable change in the composition of investment by the end of the centry partly associated with the well known spectacular inventions in cotton textiles, the iron industry etc.

(vii) Qualitative changes in the economy also do not feature in Tables 1 and 2, of course. Even restricting coverage of these to a very narrow range of 'economic' changes, it is still necessary to mention that the second half of the century saw the beginnings of the modern factory system, that the century as a whole saw the extent of proletarianisation of the labour force far surpass anything in the rest of Europe (Saville 1969) and that by the 1780s it could be argued that there had been a change in the nature of technological progress from a sporadic toward a more self-sustaining and reinforcing advance (Landes 1969: 3). For these reasons alone it might be said that 'advanced' as Britain had become by 1700 there had been a further major change in the nature of the economy by 1800, which is inadequately reflected in Tables 1 and 2.

(viii) A well-known controversy exists over the date and definition of the 'industrial revolution' and to what extent an evolutionary as opposed to a revolutionary interpretation of economic change in the eighteenth century should be preferred (Flinn 1966: Ch. 1). Let us define industrial revolution as a period of rapid structural change in the economy, involving a rapid rise in industrial output, the share of output in manufacturing and factory based activity, based on major technological innovations. Then looking at Tables 1 and 2 the following observations seem in order. The figures are not accurate enough to detect a 'turning point' even if the concept is appropriate (Whitehead 1970). The picture we get is not of a static economy in, say, the first half of the eighteenth century. There is a fundamental structural change occurring by the end of the eighteenth century, although when viewed from the perspective of the economy overall, rather than the glamour indutries, not with spectacular rapidity.

II. Problems of explaining the changes

An interesting question of the type posed by economists' economic historians is 'why did the changes occur?'. This kind of question is not easy to answer; this point is illustrated by the huge variety of 'explanations' which have been advanced to account for the advent of the industrial revolution (Hartwell 1965: 167-8). The basic underlying source of the difficulty is that the changes in question were the outcome of uncontrolled experiments.

A simple comparison of the state of the economy at the beginning and end of the century or of movements of economic time series within the century is clearly inadequate to explaining economic changes. We see a large number of changes but have no way of distinguishing which are 'cause' and which are 'effect'.

So, for example, the mere observation from Table 1 that there was an increase in both the rate of growth of population and the rate of growth of income in the second half of the eighteenth century does not tell us whether the two phenomena were merely coincidental or not. If there is some real relationship between the two variables there remains unresolved the question of the direction of causality, did population growth lead to economic growth or vice versa?

In practice there are a number of contemporaneous relationships operating in the economy and we could think of the economy as best described by a set of simultaneous equations. This simultaneity in economic life is a source of major problems in the explanation of economic change.

The simultaneity of the economic system points to both the use for theory in and the difficulty of answering counterfactual questions of the kind implicit above, namely 'would faster population growth have stimulated or hindered the growth of incomes per head?'. There are potentially a number of feedback (general equilibrium) effects to discover and consider. For example, population growth may impinge on the growth of incomes via its effects on demand, wage rates, incentives to innovate etc, thus on living standards and hence perhaps feeding back to population growth itself.

The selection of any particular group of features of the economy in the earlier period as responsible for the progress to the latter state obviously also invites the *post hoc ergo propter hoc* fallacy. To guard against these dangers it would be desirable to have a hypothesis of how any particular putative causal factor operated to change the economy which yielded predictions testable against observed data.

These considerations have encouraged new economic historians to use explicit models from economic theory to aid the process of explanation. These models aim deliberately to vastly simplify reality in the interests of isolating the behaviour of a few strategic variables in order to gain insight into the mechanism of change.

In the following sections we will use some elementary models to confront the events catalogued in Tables 1 and 2. Prior to that some comments on the use of economic models in economic history seem to be called for as an aid to a critical appreciation of the later sections.

It may be objected that models should not be used because they are unrealistic and basedon ahistorical assumptions. In one sense this criticism is beside the point; models are constructed so as to be unrealistic, to avoid dealing with a one inch to one inch scale map of reality. In order to attempt explanation we have to 'start with a finite number of specified variables ... otherwise, we cannot derive testable conclusions' (Blalock 1964: 15); indeed it can be claimed that all explanation is based on models but that old economic history left them implicit (Fogel 1973: 138-143). Realism of assumptions is not necessary to the obtaining of insight into events; economic models have in fact often been thought of by economists specifically as 'parables' (Solow 1970: 1). Moreover even the very 'facts' which are the explicandum represent a theoretical simplification and organisation of data from the raw picture of one damned thing after another (Elton 1967: 11).

In another sense, however, there is an important point to be remembered, namely that a model's predictions may be very sensitive to the precise nature of its assumptions. One particularly significant feature and major source of difference between models will be which variables are modelled as exogenous, that is determined outside the system, and which are endogenous, that is determined inside it. Given that some variables must be ('unrealistically') modelled as exogenous, but that the choice as to which is the modeller's, it can be argued that the relevant criterion for assessing models is not unreality per se but the light thrown on the question being asked. For example, much of modern growth theory grew up in an attempt to ask about the stability and propensity to Keynesian problems of capitalist economies in the long run (Sen 1970: 21). For such purposes it was an illuminating simplification to assume technological progress exogenous; however, use of the same models and assumption to investigate the origins of the industrial revolution may obscure rather than clarify.

We can never prove the validity of a model; what we can do is ask whether or not its predictions are refuted by the available data. If they are not, then the appropriate inference is 'not refuted' rather than proved. Frequently we can find several models consistent with the null hypothesis of no difference between their predictions and the data and there may always be another as yet unspecified model which will also meet this criterion. We will often therefore be in a position where the use of one model rather than another really represents a different way of 'organising the story', each consistent with many of the facts, vidé the various accounts of the depression in the U.S. (Temin 1976: 53).

III. Some elementary macro models of economic growth

An examination of the time series for the British economy in the eighteenth century prompts two very obvious questions. First, what was the effect on the economy of the acceleration of population growth? Second, how was the economy able to increase the rate of economic growth and begin the industrial revolution apparently with so little change in the investment rate? As a first step to obtaining some partial insights into these issues we can make use of a Harrod-Domar type model of economic growth, sometimes used in the analysis of developing economies (Coale and Hoover 1958: Ch. 1).

The version of the model to be used here is as follows.

$$Y = C + I \qquad (1)$$

$$Y - C = S \qquad (2)$$

$$S = I \qquad (3)$$

$$S = sY \qquad (4)$$

$$I \equiv \Delta K \qquad (5)$$

$$K = vY \qquad (6)$$

$$\Delta K = v\Delta Y \qquad (7)$$

So, substituting (4) and (5) into (3), we have

$$sY = \Delta K \tag{8}$$

and using (7)

$$sY = v\Delta Y \tag{9}$$

$$\frac{\Delta Y}{Y} = \frac{s}{v} \tag{10}$$

Also using (3), (4), (5) and (6) we have

$$\frac{\Delta K}{K} = \frac{sY}{vY} = \frac{s}{v} \tag{11}$$

Equations (1) through (4) represent a standard 'Keynesian Cross' income determination model. Equation (5) says there is no depreciation in the model, we are dealing with net product and net investment. Equations (6) and (7) relate the capital stock and increase in the capital stock to output and increase in output through v the net capital to output ratio. It is crucial to note that v is assumed to be constant and represents both the average and the marginal capital to output ratio. For our purposes $K = vY$ can be regarded as a technical relation of production.

The model says that both the rate of growth of income and the rate of growth of the capital stock will be equal to the savings rate divided by the net capital to output ratio. Faster growth would be achieved by higher savings rates and/or lower net capital to output ratios and hence the model focuses our attention on the value of these variables in the eighteenth century. Another prediction of the model is that in order to deal with an increase in population growth without incurring a fall in the rate of growth of income per head either a rise in the savings rate or a fall in the net capital to output ratio would be required. Moreover, the higher the net capital to output ratio the greater would be the rise in the savings rate needed to compensate for a given rise in the population growth rate, and hence the greater the reduction in consumption suffered in the short term. These points are illustrated in Table 3.

Table 3. Illustrative calculations using the Harrod-Domar type model.

v	s	Δpop/pop	ΔY/Y	Δ(Y/P)/(Y/P)[a]	s^{*b}
2.5	1.2	0.0	0.58	0.48	3.7
2.5	1.2	1.0	0.48	-0.52	
2.5	5.0	0.0	2.00	2.00	7.5
2.5	5.0	1.0	2.00	1.00	
4.0	1.2	0.0	0.30	0.30	5.2
4.0	1.2	1.0	0.30	-0.70	
4.0	5.0	0.0	1.25	1.25	9.0
4.0	5.0	1.0	1.25	0.25	

a. The rate of growth of income per head.

b. Savings rate needed to maintain the growth rate of income per head in the face of a 1% rise in the rate of population growth.

It should be noted that estimates of the net capital to output ratio and the net investment rate are not very reliable for the eighteenth century and that we have no direct estimates of the rate of growth of the capital stock. However, assuming the validity of the model, we can look at an era ex post and deduce v given s and $\Delta Y/Y$. If we do this we might infer v at about 7-10 at the start of the eighteenth century and at about 3 at the end of the century. So our interpretation of the eighteenth century based on Deane and Cole's estimates reported in Table 1 would seem to be that savings rates were low and rose little and that increased income per head occurred because population growth was not high and was outweighed by a falling capital to output ratio. The apparent fall in v could perhaps be attributed to technological progress and the low amounts of capital needed by the new technology (Crouzet 1972: 37); economic growth would seemingly be due to technological progress rather than very rapid capital accumulation.

However, the inferred net capital to output ratio of 7-10 at the start of the century appears most implausible. First it is very high compared with the known range of historical experience (Kuznets 1974: 132). Secondly Gregory King's estimates for 1688 yield a reproducible capital to output ratio of about 2.3 to 1 which is very similar to the figure derived from Colquhoun for the early nineteenth century of 2.7 to 1 (Deane 1973: 355).

King's figures used by Deane and Cole to guess the net investment rate for the early eighteenth century may well not properly exclude replacement investment and hence overestimate the net investment rate.

An alternative use of the Harrod-Domar type model could assume $v = 2.5$ (based on the contemporary estimates and the Kuznets review), to infer the net investment rate at about 1.2% at the end of the seventeenth century. This interpretation of the eighteenth century would see rises in the growth rate of income per head as the result of a slowly rising savings rate sufficient with the aid of a low capital to output ratio to outweigh population growth.

This view is perhaps rather more likely, but in light of the crudity of the numbers there must remain some doubt as to how far rises in s as opposed to falls in v should be 'credited with' the achievement of the growth of incomes per head. In either version of the story the model sees population growth as putting pressure on living standards. The second version of the story is reflected in the top half of Table 3; its assumptions are also responsible for the inferred estimates of the rate of growth of the capital stock in Table 1.

There are two crucial points to notice about the insights to be drawn from the preceding use of the Harrod-Domar type model. First it should be noted that the validity of the model was assumed, not tested, and the story was constructed on the basis of those assumptions. Secondly the model embodied some very strong assumptions, for example a constant v and in effect a supression of the role of factors of production other than capital. Furthermore s, v and population growth were treated as exogenously given parameters rather than allowing for interactions between them; thus, for example, the rise of the investment rate is left unexplained.

Taking these two points together it might well be suspected that the answers to the two questions posed depend very strongly on the assumptions of the model and that the insights obtained are limited to a kind of *ex post* accounting for growth.

It seems desirable therefore to consider further the questions of the roles of capital accumulation and population growth in eighteenth century economic growth by employing models which relax some of the stringent assumptions of the Harrod-Domar type model. A first step towards this will be to use another one sector macro model of economic growth, this time of the neoclassical type. This kind of model has had considerable appeal for economic historians (McCloskey 1970, Williamson 1973). It differs from the Harrod-Domar type model in that it explicitly introduces a production function allowing for substitutability between factors of production and hence drops the idea of a constant, technologically fixed v. v becomes endogenous rather than exogenous to the model.

We can retain all the first five equations of the Harrod-Domar type model. We add to them

$$Y = f(K, L) \qquad (12)$$

$$\frac{\Delta L}{L} = n \qquad (13)$$

$$\frac{\Delta K}{K} = \frac{sY}{K} \qquad (14)$$

which is obtained using (4) and (5). Equation (12) is an aggregate production function, relating the amount of output produced to the amounts of capital and labour used in production and assumed to exhibit constant returns to scale and positive but diminishing marginal products to both factors of production. Equation (13) asserts that the rate of growth of labour inputs is at the exogenously given rate n; for now we can assume that n is also the exogenously given rate of population growth. Equation (14) is identical to equation (11) except that Y/K is now assumed variable. It should be noted that if output is growing faster than capital the rate of growth of the capital stock is rising and vice versa. There is no technological progress in the model. The workings of the model are illustrated in figures 1 and 2.

Figure 1. The Aggregate Production Function.

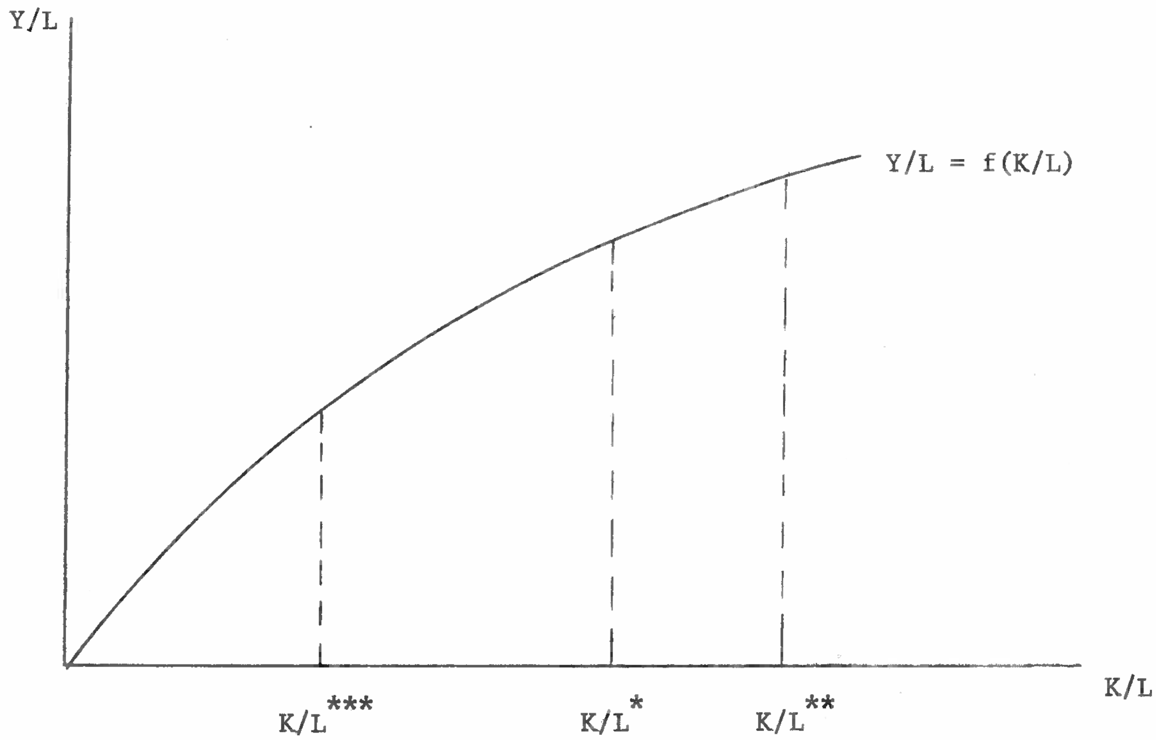
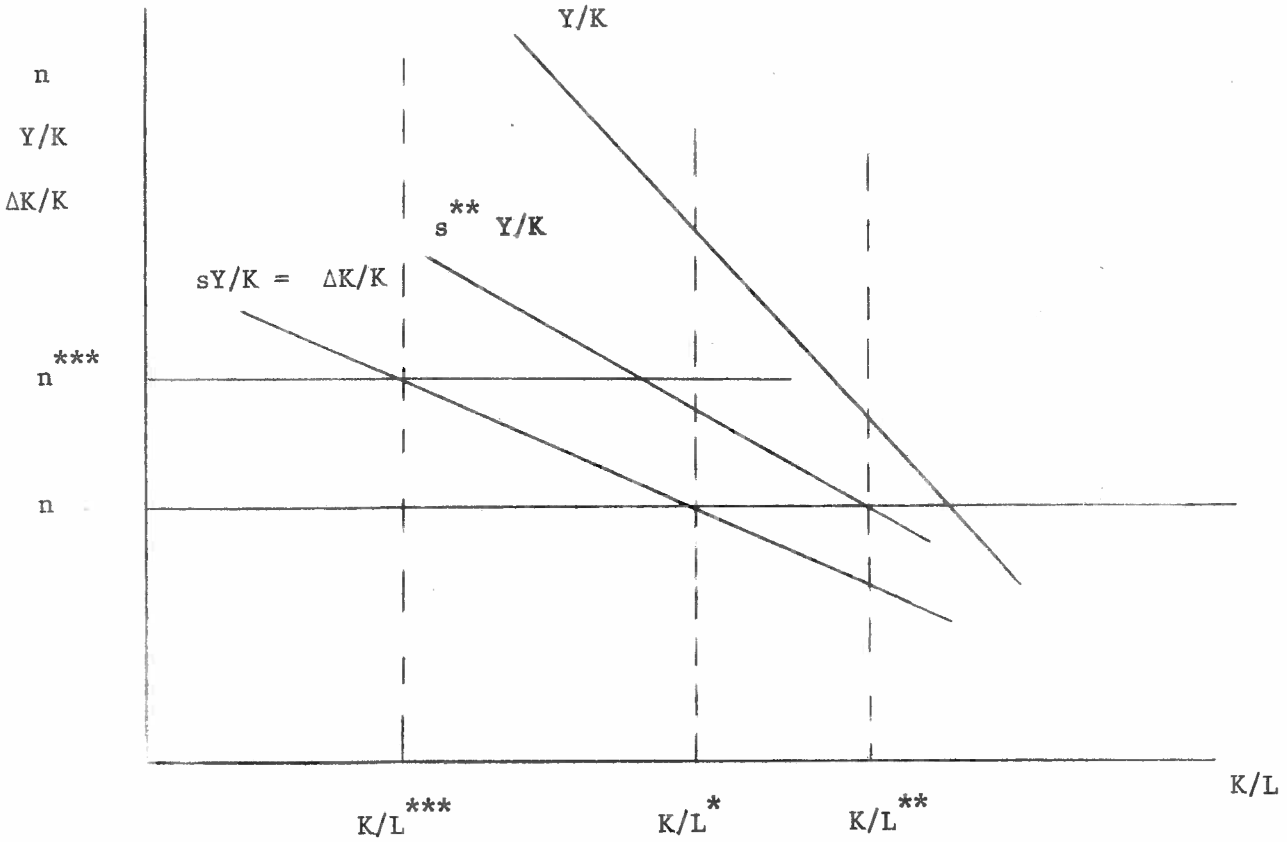


Figure 2. The Equilibrium Capital to Labour Ratio.



From the assumption of diminishing marginal productivity of capital we know that as K/L increases Y/K falls and hence sY/K = ΔK/K falls. The rate of growth of the capital stock is thus an inverse function of the capital to labour ratio. If, however, the capital stock is growing at a rate faster than the rate of growth of the labour force n, then K/L must be rising and hence the rate of growth of the capital stock must be falling and vice versa. In figure 2 with labour force growth at n and capital stock growth at sY/K the capital to labour ratio tends to the stable equilibrium value K/L^*.

At K/L^* the rate of growth of the capital stock and of the labour force are the same and there is a constant capital to labour ratio. With the capital to labour ratio constant so is the capital to output ratio also constant and hence the rate of growth of output is in equilibrium equal to the rate of growth of the capital stock and hence to the exogenously given rate of growth of the labour force.

It is now straightforward to observe the main predictions of the model. A rise in the savings rate to s^{**}, giving $\Delta K/K = s^{**} Y/K$ brings no change in the equilibrium rate of growth of the capital stock and from figure 2 we can see that output growth will also be unaffected and will remain equal to the rate n; the result of the higher savings rate will be a once for all rise in the equilibrium K/K to K/L^{**} and hence a once for all rise in output per head is predicted using figure 1. A rise in the rate of growth of the labour force to n^{***} we see from figures 2 and 1 both increases the equilibrium growth rate to n^{***} and produces a once for all decrease in both K/L to K/L^{***} and also in output per head.

The main visions of the model are of an economy which can adjust to the rate of growth of exogenously given factors of production and in which the rate of growth is in equilibrium unaffected by the savings rate. This model would not therefore see it as surprising that the economic development of the eighteenth century took place without spectacular rises in the savings rate.

Before applying this vision to the British economy of the eighteenth century it would seem helpful to restate the model in a way which allows for technological progress and draws attention to the relationships between the rates of growth of individual factors of production and the rate of growth of output.

Thus we modify equation (12) to allow for technological progress such that

$$Y = f(K, L, t) \qquad (12a)$$

We can now decompose (12a) to illuminate the 'sources of growth' of output as follows

$$\Delta Y = (MPK) . \Delta K + (MPL) . \Delta L + \frac{\Delta Y}{\Delta t} \qquad (15)$$

where MPK is the marginal product of capital, MPL is the marginal product of labour and $\Delta Y/\Delta t$ is that part of the increase of output due to the passage of time alone.

Dividing both sides by Y we get

$$\frac{\Delta Y}{Y} = \frac{MPK}{Y} . \Delta K + \frac{MPL}{Y} . \Delta L + r^* \qquad (16)$$

where $r^* = (\frac{\Delta Y/\Delta t}{Y})$. r^* is often termed 'the residual' and represents the rate of growth of output which would occur if there were no growth in factors of production and we can for the time being regard it as equivalent to technological progress.

Multiplying the first term on the right hand side of (16) by K/K and the second term by L/L we get

$$\frac{\Delta Y}{Y} = (\frac{K}{Y} . \text{MPK}) . \frac{\Delta K}{K} + (\frac{L}{Y} . \text{MPL}) . \frac{\Delta L}{L} + r^* \qquad (17)$$

The terms in brackets represent the proportional change of output divided by the proportional change in capital and labour respectively; they are thus the partial elasticities of output with respect to capital and labour. Equation (17) says that growth of incomes results from growth of factors of production and technological progress; more precisely it says that the rate of growth of output is the sum of the rate of growth of the capital stock multiplied by the elasticity of output with respect to capital and the rate of growth of labour multiplied by the elasticity of output with respect to labour and 'the residual'. This is a perfectly general expression for the ex post 'sources of economic growth', and is a useful point of reference for subsequent discussion in this chapter.

Let the elasticity of output with respect to capital be α and with respect to labour be β. If the factors of production were paid their marginal products, it is easy to see that α would be the share of profits in national income and β the share of wages.

In the special case of the neoclassical model we know from our earlier discussion that $\Delta K/K = sY/K$ and that in equilibrium $\Delta Y/Y = \Delta K/K$. Using (13) we can for this model rewrite (17) as

$$(\frac{\Delta Y}{Y})_{eq.} = \alpha(\frac{\Delta Y}{Y})_{eq.} + \beta n + r^* \qquad (18)$$

and hence

$$\left(\frac{\Delta Y}{Y}\right)_{eq.} = \frac{\beta n}{1-\alpha} + \frac{r^*}{1-\alpha} \quad (19)$$

This result is a more general statement[1] of the point we derived from our diagrammatic approach under the assumptions of constant returns to scale and no technological progress with which figures 1 and 2 were drawn. Those assumptions imply $\alpha + \beta = 1$ and $r^* = 0$; it is easy to see in this case that equation (19) would simplify to $(\Delta Y/Y)_{eq.} = n$.

As far as population growth is concerned it is easy to find a condition for per capita income growth using (19), namely

$$n < \frac{r^* + \beta n}{1-\alpha} \quad (20)$$

which implies $r^* > (1-\alpha-\beta)n$. If there are constant returns to scale, $(1-\alpha-\beta) = 0$, and per capita output will only grow if there is technological progress. With diminishing returns to scale, $\alpha + \beta < 1$, perhaps in some sense a Malthusian situation, then technological progress has to be sufficient to outweigh the diminishing returns. This version of the neoclassical model particularly focuses our attention on technological progress as a source of rising living standards.

A final modification to the model with constant returns to scale will include land as a separate factor of production, Z. We can write

$$\frac{Y}{L} = f(1, \frac{K}{L}, \frac{Z}{L}, t) \quad (21)$$

which form of the production function yields an expression analagous to equation (17)

$$\frac{\Delta y}{y} = \alpha'\frac{\Delta k}{k} + \gamma'\frac{\Delta z}{z} + r'^{*} \qquad (22)$$

where the small case letters represent per capita variables and γ' is the elasticity of output with respect to land. Equation (22) distinguishes as sources of growth of output per worker rises in the ratio of other factors to labour and technological progress. Equation (17) becomes for the revised form of the production function

$$\frac{\Delta Y}{Y} = \alpha'\frac{\Delta K}{K} + \beta'\frac{\Delta L}{L} + \gamma'\frac{\Delta Z}{Z} + r'^{*} \qquad (17a)$$

Table 4 gives results from the application of equations (17a) and (22) to the eighteenth century.

Table 4. A neoclassical parable of eighteenth century economic growth.

	$\alpha'^{b} \times \Delta K/K$	$\beta'^{b} \times \Delta L/L$	$\gamma'^{b} \times \Delta Z/Z$	r'^{*c}	$\Delta Y/Y^{a}$
1740-80	0.35 x 1.0	0.45 x 0.7	0.20 x 0.4	0.25	1.0
1780-1800	0.35 x 2.0	0.45 x 1.0	0.20 x 0.4	0.77	2.0
1780-1800	0.35 x 2.0	0.45 x 1.6[d]	0.20 x 0.4	0.50	2.0
	$\alpha' \times \Delta k/k$		$\gamma' \times \Delta z/z$	r^{*}	$\Delta y/y^{e}$
1740-80	0.35 x 0.3		0.20 x -0.3	0.25	0.3
1780-1800	0.35 x 1.0		0.20 x -0.6	0.77	1.0
1780-1800	0.35 x 0.4[d]		0.20 x -1.2[d]	0.50	0.4[d]

a. Using equation (17a), neoclassical equilibrium condition $\Delta Y/Y = \Delta K/K$ and data of Tables 1 and 2.

b. α', β' and γ' are based on factor shares of 1780-1800 in Table 2.

c. Values inferred by substituting in equation (17a).

d. Making allowance for possible growth of labour inputs per capita.

e. Using equation (22) and values obtained in the earlier part of the table.

These numbers should be regarded as illustrative rather than definitive, in view of the frailty of the data. This is an important point to bear in mind as the residual will be very sensitive to measurement errors. This is illustrated by comparison of rows 2 and 3 of Table 4. The rate of growth of labour inputs was probably considerably more rapid than population growth by the end of the century (Freudenberger and Cummins 1976: 6) but by how much is unclear. Row 3 for illustrative purposes makes uses of Abramovitz and David's estimates for the U.S. in the early nineteenth century (1973: 254).

We can use the estimates from row 3 of Table 4 to investigate the counterfactual equilibrium growth rates of income at the end of the century for a reduction of population growth to zero or an increase to 2.0% per annum. For the revised production function equation (19) will become

$$\left(\frac{\Delta Y}{Y}\right)_{eq.} = \frac{\beta' n + \gamma' \Delta Z/Z + r'^{*}}{1-\alpha'} \qquad (19a)$$

Using (19a), for population growth at zero output growth becomes 1.31%. for 2% population growth output growth becomes 2.69%. It follows then that these assumptions generate a falling rate of growth of income per head as population growth rises but much more slowly than the Harrod-Domar type model would have suggested.

The model would also predict a once for all favourable impact on income per head from the rise in the savings rate which it was argued above occurred in the eighteenth century and a once for all adverse effect from the rise in population growth. The different results as compared with the Harrod-Domar type model derive essentially from allowing v to be endogenously rather than exogenously determined.

The model we have just used is clearly a 'parable'; its assumptions are manifestly unrealistic just as were those of the Harrod-Domar type model. The neoclassical model's message appears to be straightforward in qualitative terms; by the end of the century Britain had moved to a position where technological progress was exerting the major force in raising incomes per head. This is apparently a rather different point of view from that of the Harrod-Domar type model.

At this point it again seems appropriate to comment on the use of this model from the perspective of the arguments developed in Section II. Once again it is a model whose validity has been assumed rather than tested and once again the detailed results are highly vulnerable to data problems, as was instanced by the different values obtained for the residual. In such circumstances it clearly requires a leap of faith to identify the residual as technological progress; however, the implied behaviour of the capital to output ratio is consistent with Deane and Cole's qualitative discussion (1969: Ch. 8).

Once again the model is constructed on the basis of exogeneously given rates of growth of technological progress and factors of production other than capital, which itself is accumulated with an exogenously given constant savings rate, and the use of the model should again be thought of as an ex-post accounting exercise. Even supposing the proximate 'sources of growth' are measured correctly the model does not claim to answer such questions as what determined the rate of technological progress or the rate of capital accumulation and hence addresses a relatively limited kind of question.

The comparison of the results of using the two models has revealed the importance of assumptions to the answers given to apparently quite straightforward questions. This emphasises the importance of making models and the assumptions on which they are based explicit, a point raised in Section II.

Actually the two ways of organising the story may not be quite so contradictory as appears at first sight. First of all they both see growth occurring with a constant capital to output ratio and a falling labour to output ratio. The falling labour to output ratio in the Harrod-Domar type model was concealed in our treatment but in fact represents technological progress. Thus both models point to rising income per head resulting from a rising capital to labour ratio and technological progress. Secondly, if we accept this common insight, we might go on to criticise both models for making an arbitrary distinction between capital accumulation and technological progress by choosing to argue that their contributions to growth were not additive and separable. For example, we might argue that in a more disaggregated model what we would find happening would be investment in new types and vintages of capital which embodied innovations. Alternatively we might prefer a model which saw rises in the capital to labour ratio and technological progress as joint products of a search for new investment outlets.

Examination of the two macro accounting models has thus revealed some insights into possible sources of rising incomes per head in the eighteenth century - in particular improved technology and a rising capital to labour ratio - and has illustrated the importance of assumptions about exogeneity and endogeneity of variables. This suggests a direction for further study, namely using richer models which allow more variables to be endogenous, for example, by allowing the rate of growth of factors of production or technological progress to be determined endogenously. Then we might well come up with different answers to the counterfactuals about population growth, for instance.

As a start we can briefly examine another macro model which provides for a two way relationship between population growth and income per head. This model is one of a 'low level equilibrium' or 'Malthusian Trap'. It holds that population growth is a function of the level of income per head; specifically it is postulated that population growth increases as income per head rises until at a certain income level the rate of population growth becomes constant.

$$\frac{\Delta L}{L} = n(y) = n' \quad \text{where} \quad y \geqslant y' \qquad (23)$$

This assumption is reflected in the shape of the L/L curve in all three panels of figure 3.

Secondly population growth is an independent variable affecting the rate of growth of output. For simplicity we can retain equation (19) of the neoclassical model as a statement of the equilibrium rate of growth of output whilst dealing with panels (i) and (ii) of figure 3. In so doing we will assume that as population growth increases the rate of output growth rises but by a smaller amount, that is $(\beta/1-\alpha) < 1$.

Thirdly as an identity the rate of growth of income per head equals the rate of growth of income minus the rate of growth of population

$$\frac{\Delta y}{y} = \frac{\Delta Y}{Y} - \frac{\Delta L}{L} \qquad (24)$$

We can examine the interactions of these three relationships in panels (i) and (ii) of figure 3 with the aid of equation (20) which gave us the necessary condition for income per head to grow. Equation (20) implies that for incomes per head to grow

$$\frac{r^* + \beta n}{1-\alpha} > n \qquad (25)$$

For our Malthusian model this implies that

$$\frac{r^* + \beta n(y)}{1-\alpha} > n(y) \qquad (26)$$

or for incomes greater than y'

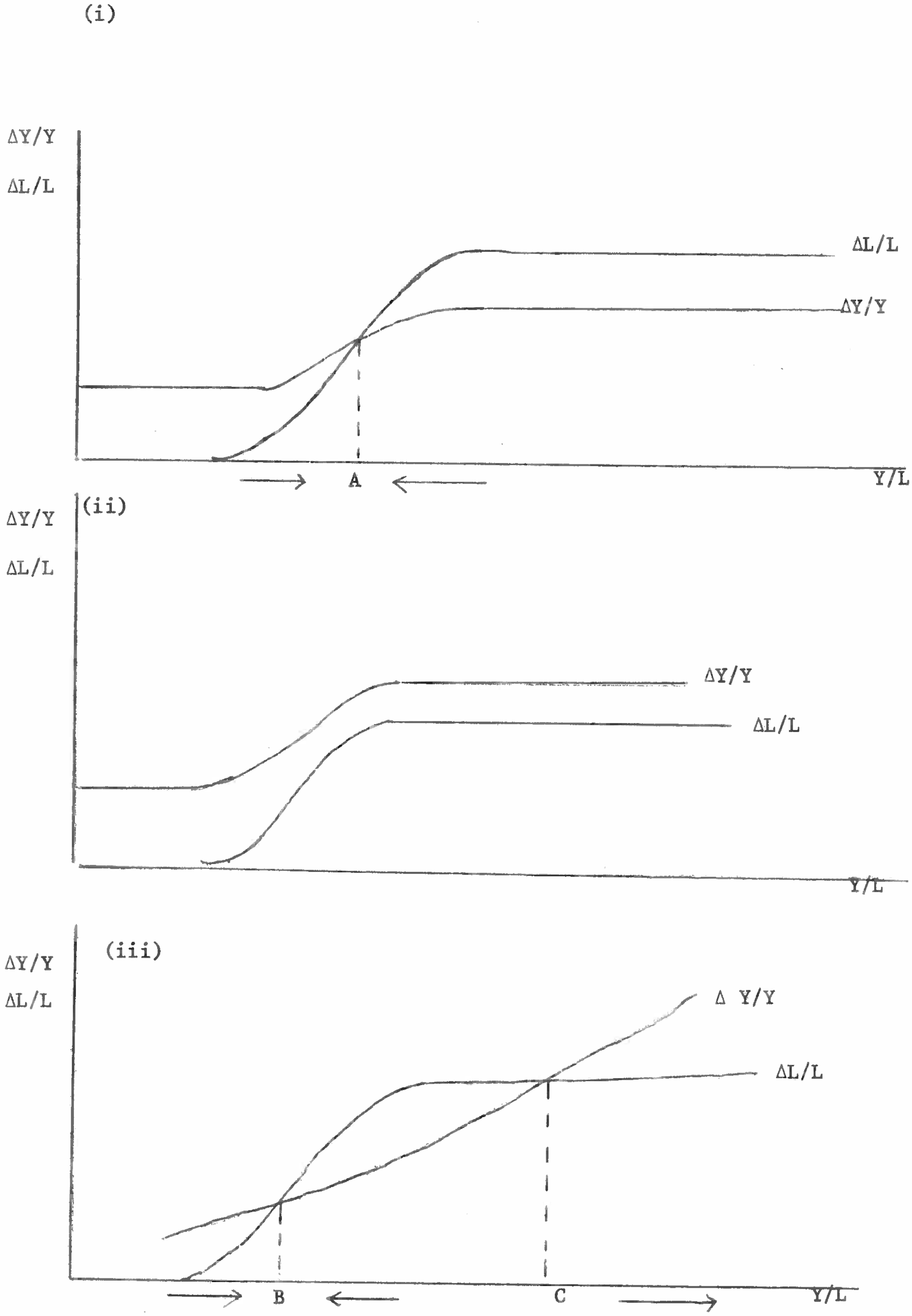
$$\frac{r^* + \beta n'}{1-\alpha} > n' \qquad (27)$$

Since in the absence of technological progress population growth is associated with decreasing incomes per head, the important message of equations (26) and (27) is that for sustained growth of income per head technological progress has to be sufficient to outweigh the greater population growth induced by higher incomes per head. Ceteris paribus, this will be more likely the higher is r^* and the lower is n.

If we turn to figure 3, panel (ii) depicts a situation where the growth of incomes is indeed sufficient to outweigh the induced rises in the population growth rate at all income levels. In panel (i), however, this condition is only satisfied to the left of point A, whereas to the right of point A prosperity induces a population growth rate which exceeds the rate of income growth. Bearing in mind the identity (24) it is easy to see what is happening in panel (i). To the right of A population growth exceeds income growth and hence income per head must be falling, whilst to the left of point A the opposite is true. Income per head then always tends to the low level A; the economy is caught in a 'Malthusian Trap'.

If we were to use this model to analyse eighteenth century Britain, it appears that panel (ii) would fit the British experience more nearly than panel (i). Many of the facts of the progress of the economy can indeed be organised in this framework. As incomes per head rose through the eighteenth century, Tables 1 and 2 suggest population growth rose so that by mid century the rate of growth of incomes per head remained positive but at a somewhat lower rate than previously. Ultimately population growth stabilised at a fairly constant rate in the early nineteenth century. However, Table 4 might suggest that sometime in the late eighteenth century the $\Delta Y/Y$ curve shifted upwards ensuring the avoidance of the 'Malthusian Trap'.

Figure 3. The Malthusian Trap.



We might inquite a little further into how the economy avoided the 'Malthusian Trap'. We have already discussed the proximate sources of growth in connection with the neoclassical model, where it seemed that technological progress was indeed a force for growth of incomes per head. The determinants of changes in the population growth rate are changes in birth rate and death rate and it might be hypothesised that the level of income per head would operate to raise the birth rate and reduce the death rate in an economy like Britain of the eighteenth century. As income per head rose, for example, earlier marriage might prevail thus raising the birth rate; in addition rising incomes could lead to better nutritional standards and hence lower the death rate. Both these forces have been thought to have been operational in Britain (Habakkuk 1971: 35-48, McKeown, Brown and Record 1972). However, for the eighteenth century it appears likely that neither the birth rate nor the death rate was changed markedly by these mechanisms. It seems unlikely that marriage age changed enough to have much impact on population growth (Crafts and Ireland 1976) and much of the last part of the century saw pressure on nutritional standards from steadily rising food prices (Habakkuk 1971: 33). In any case population growth was much lower than the rapid rates common in today's developing countries as the death rate remained at a highish level.

It should be noted that some authors would deny the existence of a relationship such as (23) and would prefer to regard population growth as exogenous (Chambers 1972:1-90). We cannot examine this debate here; our purpose is merely to point out that, as a comparison of the neoclassical and 'Malthusian Trap' models implies, it will make quite a difference to any interpretation of eighteenth century economic growth whether population growth is assumed exogenous or not. For example, contrast a vision of the effect of the industrial revolution on living standards as that of rescuing the economy from the adverse consequences of accelerated population growth with one which supposed that the population growth itself was largely a result of the impact of the industrialisation process on income growth. The counterfactual situations envisaged, (what would have happened to living standards if there had been no industrial revolution), are substantially different (Gould 1969: 201).

The 'Malthusian Trap' of panel (i) of figure 3 is but one example of a general way of looking at the problem of underdevelopment which is to argue that poor countries can get trapped in a 'vicious circle' of underdevelopment. There are many variants of this argument, but a fairly typical one would go as follows: low income levels imply low savings rates which imply low rates of capital accumulation and productivity growth which imply low growth of incomes inadequate to outweigh rapid population growth and hence income levels remain low. Panel (iii) of figure 3 represents this kind of situation in a 'Malthusian Trap' framework, where as before equation (23) underlies the $\Delta L/L$ curve. The shape of the $\Delta Y/Y$ curve is consistent with an assumption that the equilibrium growth rate of output is positively related to the savings rate which itself is positively related to the level of income per head. It is thus a non neoclassical argument. Panel (iii) exhibits a stable equilibrium point B, exactly analagous to point A in panel (i). It also exhibits a point C beyond which point incomes again rise faster than population. The economy's problem is to get to point C or beyond and avoid being caught in a trap at B. Anything which shifts the $\Delta Y/Y$ curve up, (for example, a higher savings rate), and/or the $\Delta L/L$ curve down will tend to make the task of getting to C easier. As has been suggested above eighteenth century Britain, at least post 1750, was probably in a situation more like panel (ii) than (iii) with a considerable capacity for both savings and technological progress and a fairly low population growth rate, and thus avoided this vicious circle.

Recalling the expression developed in equation (17) for the ex-post sources of growth, it would now seem appropriate to consider expansion of our models to take account of the determinants of the rate of capital accumulation and technological progress. The treatment will be suggestive rather than formal at this stage we move beyond the realm of elementary growth models and indeed, as far as technological progress is concerned, into an area where existing economic theory is arguably especially deficient.

Our models thus far have treated the net investment rate as exogenous and have not attempted to account for the (putative) rise in its value during the eighteenth century. This appears to coincide with the approach of many economic historians and virtually all discussions until Ashton (1948). It is not congruent with mainstream economic theory, however, which would envisage in the short run much investment expenditure as 'induced' with a relatively small share as 'autonomous' and in the long run sees entrepreneurs trying to adjust the capital stock to an optimal size. The main determinants of the desired capital stock would normally be regarded as the level of output and relative factor prices and investment would generally be seen as some function of recent changes in output (the 'modified accelerator') and possibly the rate of interest.

Ashton stressed falls in the latter as an important stimulant of investment in the eighteenth century, a hypothesis which is not testable in the absence of data on investment expenditure, but which has met much scepticism (Dickson 1967: 452-3). The 'modified accelerator' hypothesis of investment induced by changes in output is also untestable, of course.

However, as noted earlier, there seems to be widespread agreement that Britain in the early eighteenth century had a capacity to save considerably greater than the amount actually devoted to investment. It thus appears likely that the availability of attractive investment outlets, in Keynesian terms a high marginal efficiency of investment, was the major force operating to raise the net investment rate. If so, then it could be expected that growth of incomes and output and the development of opportunities to invest in innovations made during the course of the century would be important in raising the marginal efficiency of investment.

Again it is important to note the corollaries of thinking in terms of endogenous capital formation, rather than to enter a debate over the nature of the investment function. The important points are firstly that it opens the way for the existence of a two-way relationship between the rate of growth of the capital stock and the rate of growth of income, i.e. it suggests the likelihood of dynamic interactions between the two, with increased income leading to a larger demand for capital whilst a greater capital supply makes for greater output and income, and investment expenditure raises effective demand. Secondly, it also provides the possibility of forces which raise the level of effective demand, for example the growth of exports or even population, having indirect repercussions on capital accumulation.

Whilst most elementary growth models, including the ones outlined above, regard technological progress as exogenous, recent literature on the industrial revolution generally prefers to see innovation as endogenous to the process of eighteenth century growth. Perhaps the most telling reason for this is that "This is not a story of sophisticated inventions breaking through some technological barrier, and so creating the conditions for expansion. Developments that were technically so simple can only be responses to social and economic conditions' (Lilley 1973: 195). It may well be that the assumption of exogenous technological progress seriously restricts insights into our issues of the roles of population growth and capital accumulation in the growth of the eighteenth century economy.

For our present purposes we shall regard social conditions as exogenous; we will merely note that a frequent argument has been made to the effect that events of preceding centuries predetermined that Britain in the eighteenth century was capable of a very vigorous response by entrepreneurs both to profit opportunities and problem solving (Landes 1969: Ch. 1-3, Wilson 1965). Taking this as given our focus will be on economic conditions which might be conducive to innovation.

A very common proposition in the literature is the general idea that innovation is a response to a bottleneck situation, ('necessity is the mother of invention'). From an economist's point of view one way of formulating this notion would be to argue that innovation arises from disequilibrium situations, for example where techniques are in operation which once were profitable but now are no longer so.

This both suggests a starting point and a further possible criticism of our discussion of the three models described, namely that those models were constructed as equilibrium models and only their behaviour in equilibrium was considered. For the neoclassical model the equilibrium condition, which had the characteristic that $\Delta Y/Y = \Delta K/K$, was

$$\left(\frac{\Delta Y}{Y}\right)_{eq.} = \frac{\beta n + r^*}{1-\alpha} \qquad (19)$$

Adjustment to a disequilibrium situation was achieved via changes in the capital to output ratio, a process described in the context of figure 2. Since no other determinant of the rate of growth was endogenous no other adjustment mechanism was possible in this model.

If, however, we now suppose technological progress to be endogenous, then a change in r^* could potentially restore equilibrium. Thus, for example, it might be envisaged that a disequilibrium situation created by the capital stock growing faster than income would be resolved by an induced rise in r^*, rather than a rise in v, such that $\Delta Y/Y_{eq}$ rose to match the growth of the capital stock. The model might be made behavioural by arguing that the initial tendency for capital to grow faster than output would tend to lower the rate of profit and that this would lead entrepreneurs to intensify efforts to innovate. For a development of this kind of hypothesis see Robinson (1956: 101-76).

This kind of notion has found favour with several prominent economic historians for eighteenth century Britain and is probably the most widely offered macroeconomic explanation given for innovative behaviour. The particular point often made is that the growth of output and the capital stock in the first half of the eighteenth century was tending to outrun the growth of the labour supply and natural resources, (notably wood), and that the resultant changes in relative prices were a very powerful incentive to innovation (Crouzet 1966: 168, Landes 1969: Ch. 2). However, it should be noted that such predictions are not easy to derive from conventional economic theory (David 1975: 34). Moreover, some writers, although acknowledging the profit motive, give considerable weight to the independent role of science and point out that in the eighteenth century many inventions were made whose economic use was long delayed (Musson 1972: 52-3) and conversely that many wants and potentially profitable situations went unfulfilled (Rosenberg 1974: 97).

On reflection one might indeed suppose that eighteenth century innovations emerged from a trial and error search process in which both economic inducement and scientific knowledge were involved. If so, this implies a view of technological progress as having both an 'autonomous' and an 'induced' component. However, as with the debate over the endogeneity of population growth it is not our purpose here to resolve the issues as to whether capital accumulation or technological progress are better modelled as exogenous or endogenous but once again to point out that the position taken will very significantly affect one's account of eighteenth century growth. Thus we find Cole (1973: 348) arguing that population growth ultimately stimulated the growth of incomes per head by raising demand and inducing both capital accumulation and technological progress. Alternatively Landes (1969: 115) has claimed that the tightness of the labour situation in the early part of the century was instrumental in generating the labour saving innovations and factory based technology of the later parts of the century. These hypotheses differ markedly both from each other and in the counterfactual situations they envisage as compared with those derived, say, from the standard Harrod-Domar or neoclassical models.

Naturally our review of macro growth models has not yielded a definitive view of eighteenth century growth. What we have found at this stage are several models, either formal or informal, which are consistent with at least some of the facts or alternatively into whose framework much of the story can be organised and which offer some insights into how the growth process may have operated. We have also demonstrated that interpreting eighteenth century growth and answering questions concerning the impact of population growth, the rate of savings etc. on economic growth relies on theory. Particularly important are assumptions about the exogeneity or key variables, or, in other words what interactions are permitted between the variables of equation (17).

IV. Agriculture and Industry

In Section I it was seen that the eighteenth century saw an increasingly rapid structural change in the economy featuring a decline in the relative share of agriculture and a rise in the relative share of industry in economic activity. Accordingly it might well be argued that the aggregative one sector growth models rev iewed in Section III were seriously restricted in their insights by their inability to deal with the interactions between sectors from which the overall growth process envolved. In this Section we will consider an expanded, but still very highly aggregative, model of growth in which two sectors 'agriculture' and 'industry' are assumed. The discussion will be in the framework of a famous genre of models going back to Lewis (1954).

Interactions between the industrial and agricultural sectors are frequently seen in terms of a catalogue of roles agriculture can play in economic development. These would generally include (Thornton 1973)

(i) the release of labour to the industrial sector,

(ii) the supply of food to meet the demand of a growing and increasingly non-agricultural population and rising incomes,

(iii) the supply of savings for investment in the industrial sector,

(iv) the provision of a market for industrial goods.

Although the emphasis of lists such as this is ostensibly on agriculture's role in transferring resources, the successful implementation of this transfer, of course, requires that industry has the capability to employ the released factors of production.

The first two proposed roles for agriculture, the release of labour and supply of food, can be illuminated by reference to a 'dual economy' model, similar to that proposed by Dixit (1969). In this model agriculture (denoted by subscripts 2) is assumed to produce an output 'food' which is a consumption good, industry (denoted by subscripts 1) is assumed to produce an output 'goods' which can be either an investment or a consumption good.

Consider first of all an economy in which the industrial sector does not yet exist and where all activity is confined to agriculture, sector 2. Growth of output in this economy is described by equation (28).

$$\frac{\Delta Y_2}{Y_2} = b_2 + \beta_2 \frac{\Delta L_2}{L_2} \qquad (28)$$

This equation says no capital is involved in agricultural production, and allows for both a fixed factor of production, land and diminishing returns to labour, $(0 < \beta_2 < 1)$, on account of it, and also technological progress at the rate b_2.

Suppose that the economy is characterised by a constant rate of growth of both population and labour supply = n. Using (28) it is easy to see that the rate of growth of output is

$$\frac{\Delta Y_2}{Y_2} = b_2 + \beta_2 n \qquad (29)$$

and that the rate of growth of output per head is

$$\frac{\Delta Y_2}{Y_2} - n = b_2 + \beta_2 n - n \qquad (30)$$

$$= b_2 - (1 - \beta_2)n \qquad (31)$$

For output per head to be rising this implies

$$b_2 - (1 - \beta_2)n > 0 \tag{32}$$

In other words technological progress more than offsets diminishing returns to labour.

Suppose further that per capita demand for food is constant. Then the rate of growth of the demand for food will be at the rate of growth of population and will equal n. What rate of growth of the labour force, $\Delta L_2/L_2$, will give an output growth rate of n sufficient to meet this demand? Using (28) we have

$$\frac{\Delta L_2}{L_2} = \frac{n - b_2}{\beta_2} \tag{33}$$

The implications of equation (33) are very important. Notice if $(\frac{n - b_2}{\beta_2}) < n$, this implies that the food requirements of the increasing can be met by a rate of increase of the labour force in agriculture lower than the rate of increase of the labour force in the economy as a whole, that is by a reduced share of the labour force. The economy is then said to be 'viable' and labour would then potentially be available for other uses, for example in an incipient industrial sector. There will only be 'viability' if (32) is satisfied. Therefore 'viability' will require $b_2 > 0$, that is the existence of technological progress which diminishes labour requirements per unit of output, in order to offset the existence of diminishing returns to labour in agriculture $(0 < \beta_2 < 1)$.

We can now introduce the industrial sector to the model, albeit for the time being in a passive role. Suppose that all labour potentially made available to industry can be absorbed in that sector. Then we have

$$\frac{\Delta L}{L} \equiv \frac{\theta \Delta L_1}{L_1} + (1 - \theta) \frac{\Delta L_2}{L_2} = n \qquad (34)$$

which simply says that the rate of growth of the labour force as a whole is a weighted average of the rates of growth of the industrial and agricultural labour forces. This implies using (33) that in the 'viable' economy

$$\frac{\Delta L_1}{L_1} = \frac{n - (1 - \theta)\ (n - b_2/\beta_2)}{\theta} \qquad (35)$$

where θ is the proportion of the labour force in industry. Given 'viability' we know that the rate of growth of the labour force in industry exceeds the rate of growth of the labour force as a whole. Using (35) it is easy to see that $\Delta L_1/L_1 \rightarrow \infty$ as $\theta \rightarrow 0$ and $\rightarrow n$ as $\theta \rightarrow 1$.

Our condition for a decline in the share of agriculture in the labour force is that $(n - b_2/\beta_2) < n$, which requires technological progress and reduced labour input per unit of agricultural output. Evidently, <u>ceteris paribus</u>, 'viability' will be easier to achieve the lower is the rate of population growth and the more rapid is technological progress in agriculture. However, it should be noted that for absolute numbers in agricultural employment to fall a much more stringent condition must be fulfilled. Inspection of equation (33) reveals that for $\Delta L_2/L_2 < 0$ we require $b_2 > n$. In other words technological progress in agriculture must reduce labour requirements in agriculture faster than population growth raises them by increasing the demand for food. So we might suppose from this kind of model that quite often a decline in the proportion of the labour force in agriculture would take place whilst absolute numbers in that sector rose.

This supposition is strengthened if the specification of a constant per capita demand for food is dropped in favour of allowing income to exert a positive effect on food demand. Unfortunately use of this more realistic demand for food equation considerably complicates the algebra of the model but we can note the general result that allowing the income elasticity of demand for food to be positive but less than 1 tends to make employment in agriculture larger and the decline of the share of the labour force in agriculture slower but not to alter the basic condition for 'viability' (Dixit 1969: 40-1).

Let us look more closely at the industrial sector's ability to absorb the labour potentially released from agriculture. If it is assumed that industrial output can be produced with variable factor proportions and there are no effective demand problems, that is neoclassical conditions obtain, there is no problem and production conditions for industry will be represented by an equation such as (17). The labour supply released from agriculture becomes an exogenously given labour supply to industry and the rate of growth of industrial output will be as described by equation (19). In other words the industrial sector can adjust to whatever labour supply is available.

If it is assumed that production conditions in industry are characterised by fixed coefficients of production, that is Harrod-Domar type assumptions, the ability of industry to employ the surplus labour released from agriculture is unclear. With a fixed capital to output ratio in industry, evidently a higher rate of release of labour from agriculture will require a higher savings rate for the transfer to industry to be successfully effected.

Testing the applicability of this 'dual economy' model to the British economy of the eighteenth century is not possible because information on outputs and inputs in agriculture is not available. Once again though a substantial part of the story of the economy's progress can be organised to fit in with the model. It is generally agreed that the share of the labour force in agriculture fell but that absolute numbers in agriculture rose and that the increased demand for food from population growth and rising incomes was met almost entirely by growth of domestic agricultural output (Mingay 1969). The economy appears to have been 'viable'. Moreover there is qualitative evidence of considerable technological progress in agriculture throughout the eighteenth century (Chambers and Mingay 1966: Ch. 3). For the early nineteenth century where there is more information available we find indeed that technological progress in agriculture appears to be associated with a decline in labour per unit of agricultural output but not with an absolute fall in either rural population or agricultural employment. Deane and Cole report a rise of forty per cent in agricultural output output together with a twenty five per cent rise in the agricultural labour force between 1801 and 1851 (1967: 143, 152).

In accounting for the 'viability' of the economy a major stress would have to be placed on the lowish rate of population growth. With a plausible value for β_2, of, say, 0.5 the implication would be that b_2

for Britain would only have to be > 0 pre 1740, > 0.35 1740-80 and > 0.5 after 1780 for 'viability'. In accounting for the ability of the eighteenth century economy to absorb labour in increased employment in industry important factors would be Britain's savings abilities, a high marginal efficiency of investment, and the likelihood that the rate of growth of the potential labour force was probably not more than about 3% a year, substituting plausible numbers from Tables 1 and 2 into equation (35). So seemingly it could be argued that the first two roles for agriculture were successfully played during the eighteenth century.

However, some limitations of the above 'parable' should be noted. First, there are strong grounds for arguing that in the second half of the century the supply of agricultural goods could not keep up with demand, whereas for the first half of the century the opposite was true (Crafts 1976). The important point to note is that in the second half of the century agricultural prices were rising and the terms of trade for industry declined, by the end of the century markedly so. It would seem that some of the increased demand for food was choked off by rising prices. Secondly, the specification of the agricultural production function may yield some misleading insights as undoubtedly for eighteenth century Britain capital was an independent factor of some importance in the production process. Thirdly, this version of the story has not said anything about the third and fourth roles for agriculture, nor has it profferred any explanation for technological progress in agriculture.

We can consider heuristically agriculture's role as a supplier of savings as follows. From the earlier discussion of Section III it is obvious that a higher savings rate in agriculture whose fruits are transferred for investment in industry will augment the rate of growth of the capital stock, and hence the demand for labour in that sector, in a Harrod-Domar situation, in neoclassical disequilibrium, but not in neoclassical equilibrium.

For eighteenth century Britain the extent to which there was a net flow of savings from agriculture to industry is 'much debated' (Crouzet 1972:54). There was considerable capital formation in agriculture; Pollard has estimated that in 1770 agriculture accounted for about 30% of investment outlets (1965: 362). This is somewhat less than agriculture's share in national output of about 40% at this time. The implication is that, if savings rates from agricultural income were no lower than those prevailing elsewhere in the economy, there would have been a net outflow, but unless savings rates in agriculture were substantially higher than in the rest of the economy, it would not have been very large. The existence of country banks as channels for the transfer of funds and some direct investment by landlords outside of industry has been widely noted (Crouzet 1972: 54-6).

Agriculture's role in sustaining the level of effective demand for industrial goods also needs to be discussed. On the assumption that manufactures were a normal good, it will be obvious that rises in output per head in agriculture will generate increases in the demand for manufactures. Thus it would appear that 'viability' should in the long run ensure adequate food supplies, release labour and provide for the development of a market for industrial goods.

Prima facie, it would also seem obvious that 'good harvests' should be good for growth and development in the short term. It has often been remarked that Britain had a spell of particularly good harvests in the first half of the eighteenth century and it is intuitively tempting therefore to presume that this good fortune may have been a stimulus to the industrialisation process. However, this last propostion has been much disputed, especially with regard to the impact of a 'good harvest' on the level of effective demand in the short term. See, among others, Ashton (1959), Deane and Cole (1969): Ch. 2, Gould (1962), Parry-Lewis (1965)and Whitehead (1970). The problem arises because it is generally presumed that a 'good harvest' would imply for farmers as a whole a move along a short run demand curve in a range in which demand was price inelastic, such that revenue for agriculturalists fell.

The argument can be followed through in a formulation provided by Parry-Lewis (1965: 44-7), for the analysis of a situation of a good harvest in year t following a bad harvest year in $t-1$ in which some food was imported. In both years all home production is consumed at home. Then in year t consumers have the following change in the amount they have available to spend on industrial goods;

$$p_{t-1} (h_{t-1} + i_{t-1}) - p_t h_t \qquad (36)$$

where p is the price of agricultural output, h is home output and i is imported food. Farmers have the (probably negative) change in their potential spending on industrial goods

$$p_t h_t - p_{t-1} h_{t-1} \tag{37}$$

Consumers' spending on goods will then rise by

$$c(p_{t-1} h_{t-1} - p_t h_t) + c(p_{t-1} i_{t-1}) \tag{38}$$

and farmers' spending on goods by

$$c'(p_t h_t - p_{t-1} h_{t-1}) \tag{39}$$

where $0 < c, c' \leqslant 1$.

The total change in spending on industrial goods can then be written as

$$c(p_{t-1} h_{t-1} - p_t h_t) + cp_{t-1} i_{t-1} - c'(p_{t-1} h_{t-1}) - p_t h_t) \tag{40}$$

or

$$cp_{t-1} i_{t-1} - (c' - c)(p_{t-1} h_{t-1} - p_t h_t) \tag{41}$$

Let us suppose, incommon with the literature, that $(p_{t-1} h_{t-1} - p_t h_t) > 0$. Then, if there are no imports in year t-1, expenditure on industrial goods will rise in year t if the (gaining) consumers' propensity to spend on industrial goods, c, exceeds that of farmers, c'. For the eighteenth century economy we have no evidence on the expenditure patterns of different groups but we do know savings rates in general were low and it seems unlikely that there would be much difference between c and c' and hence little impact on demand for manufactures. A similar conclusion was reached by Gould (1962) who took account of a number of offsetting complications to the above argument. However, in the case where there had been a bad harvest and imports in the preceding year, in this model there is a gain to consumers represented by the first term of (41) and it appears highly likely that aggregate expenditure on goods would rise. For Britain during the period of good harvests there were few years with any significant amount of agricultural imports and hence this point seems to be of little historical importance.

Although the explicit treatment of the demand and savings implications of the agricultural sector's performance are interesting, it might be argued that they do not vitiate the insights from the 'dual economy' model. However, that model does treat technological progress as exogenously given to the agricultural sector and this may be a more serious weakness.

In particular many economic historians have implicitly viewed technological progress in agriculture as arising from interactions between agriculture and industry. For example, Deane (1965: 46) has stressed the rising agricultural prices of the later part of the century, which were presumably a result of the growth of industrial output and incomes in part at least, as a major stimulus to innovation in agriculture. Thus it could be that 'viability' was induced by the strength of the growth of the industrial sector. The extent to which agricultural innovation was induced by rising agricultural prices is controversial and no direct evidence exists, except that the rate of enclosure seems to have been somewhat responsive to higher agricultural prices (Crafts 1977). Indeed other authors have argued that falling prices exerted a positive stimulus (Grigg 1966: 189, Jones 1965) and Chambers and Mingay say both periods of rising and falling prices encouraged innovation (1966: 131).

Again it is not our purpose to resolve a controversy, merely to point out that whilst the notion of 'viability' would not change, the counterfactuals hypothesised for agricultural-industrial interactions in the eighteenth century do differ considerably for the parables with and without induced innovation.

V. The external sector and economic growth

In the last Section the 'viability' of the economy was apparently a prerequisite (necessary condition) for industrialisation. However, it may be premature to accept such a hypothesis. Indeed Gerschenkron has maintained that there are no prerequisites for economic development, but rather that there are 'substitutes for prerequisites', that is more than one way of achieving the objective (1962: Ch. 2). For example, an obvious possibility is that, if the tacit assumption of a closed economy were dropped, then the external sector might fulfil some of the roles prescribed for agriculture. In that context it is pertinent to note that Britain became a net food importer in the 1770's and that for cotton textiles, often seen as a key sector in the industrialisation process, not only was raw cotton wholly imported but by the 1790's about 40% of output was being exported (Deane and Cole 1969: 185).

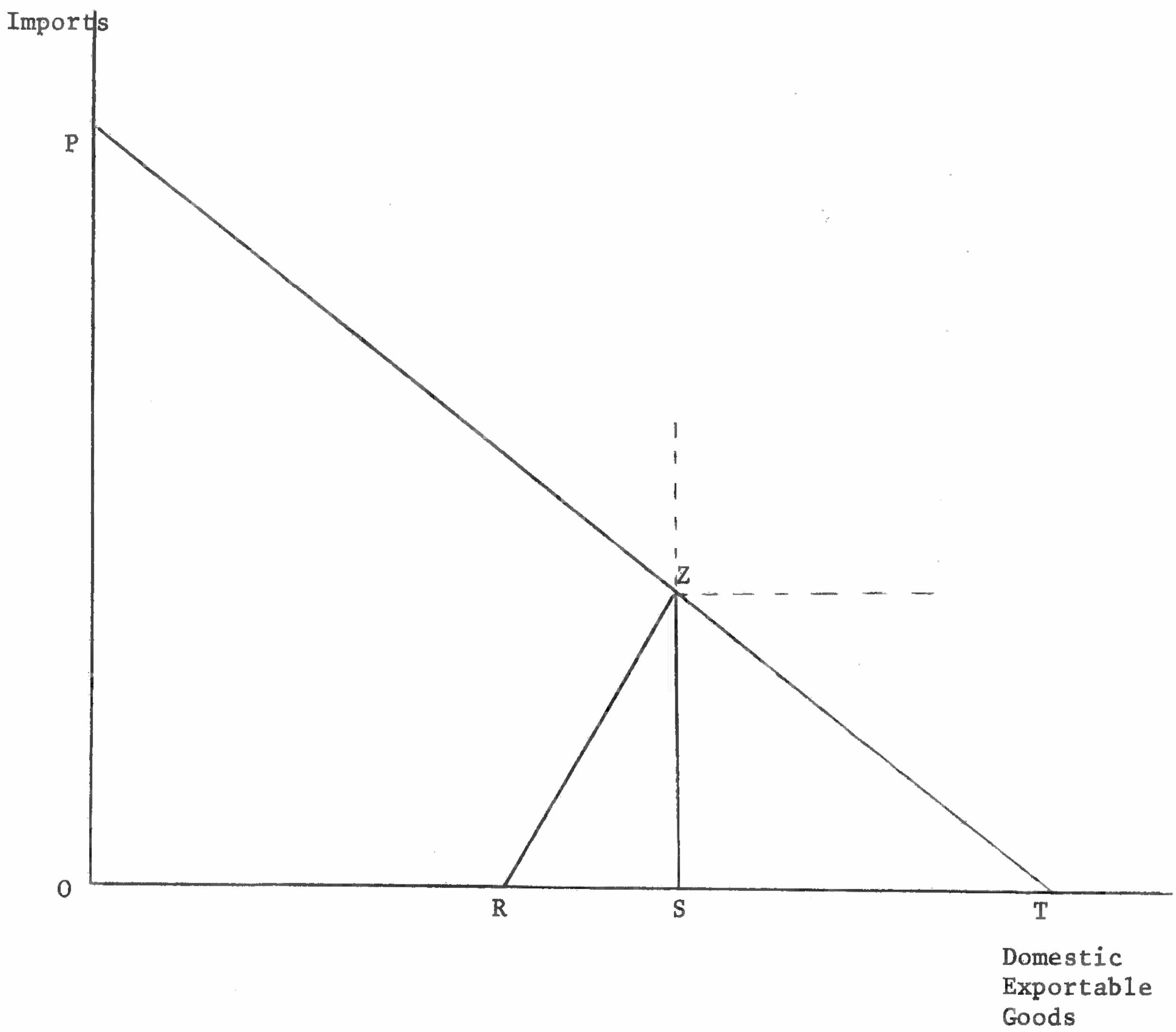
The following discussion is confined to the dynamic relationships between trade and growth and the, perhaps more familiar, static gains from specialisation along lines of comparative advantage will be ignored. It should be noted, however, that during our period Britain generally pursued high tariff and restrictive practice trading policies rather than the free trade regime of the second half of the nineteenth century (Davis 1966).

Evidently the increase in productive potential associated with economic growth may have important implications for external trade in general and for the 'terms of trade' in particular. For the time being we can think of the 'terms of trade' rather loosely as being p_x/p_m, where p_x is an index of the price of exports and p_m is an index of the price of imports. Consider a country where over time there is an increase in production of its domestically produced exportable goods, such that the supply curve of these exportables to the world market is shifting to the right. The question then is whether prices of exports have to fall in order to clear the market in the face of this increase in supply and if so by how much? Clearly this depends upon demand conditions, in particular on whether the demand curve for these exportables is shifting to the right and on their price elasticity of demand. It is possible, of course, that the expansion of output of the exportable might even lead to 'immiserising growth', the concept introduced and defined by Bhagwati as a case where 'Economic expansion increases output which, however, might lead to a sufficient deterioration in the terms of trade to offset the beneficial effect of expansion and reduce the real income of the growing country' (1958: 201).

The significance of the impact of growth on the terms of trade becomes more obvious when we turn to the potential contribution of trade to growth. Suppose for the time being that the role of the foreign sector is to allow a necessary input good to be imported and that output has both a fixed capital coefficient and a fixed import coefficient. Then, for any given rate of growth of output to be achieved, imports have to grow at least as fast and there is a 'required capacity to import'. But imports have to be paid for implying a need to generate either foreign loans or exports sufficient to achieve this required capacity to import. This may create a difficulty for, if a potentially immiserising situation exists, there may in effect be an export revenue maximum. In the absence of foreign loans, if the export revenue maximum is below the 'required capacity to import' for a given rate of growth desired by investors, an 'exchange gap' may be said to exist and in effect, to present a bottleneck frustrating investors' efforts to raise the growth rate.

This argument can be illustrated by the use of diagrams adapted from one drawn by Findlay (1973: 189) and labelled here as figures 4 and 5.

Figure 4. The absence of an 'exchange gap'.



In figure 4 the economy produces OT units of the domestic exportable, which is both a capital and a consumption good, OR units of which are consumed, RS units of which are invested and ST units of which are exported.

To increase output over time requires increases in both capital and imports in fixed proportions because of the assumption that both the import coefficient and capital coefficients of output are fixed. The ray through R indicates the amount of imports required to go with a given amount of investment. Thus for the RS units of investment taking place SZ units of imports are needed. The SZ units of imports need to be paid for by exports. The slope of the line PT represents the (constant) terms of trade and indicates that to pay for SZ units of imports ST units of exports are needed, which is in fact the amount being exported. The economy is then in balance, as it were, with RS units of investment matched by SZ units of imports paid for by ST of exports and leaving OR units of consumption. There is no 'exchange gap'.

Figure 5. The existence of an 'exchange gap'.

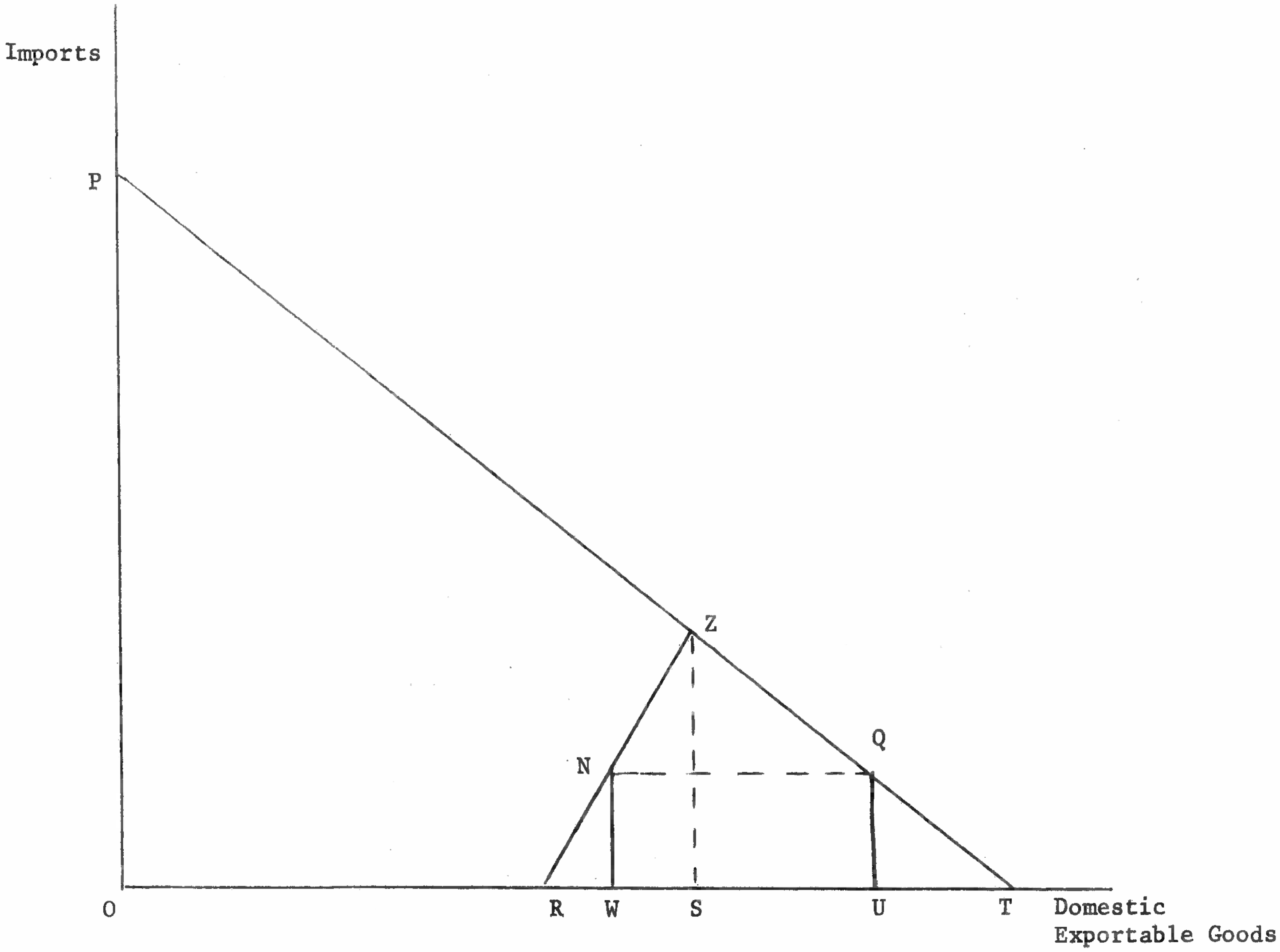


Figure 5 is constructed similarly and again for simplicity has the line PT whose slope is the constant terms of trade. Again OT units of output are produced. The difference lies in the existence of an import maximum represented in the diagram by QU = NW units of imports. At the given terms of trade this is paid for by UT units of exports. What is being assumed but not shown in the diagram is that attempts to import more by exporting more than UT units of exports would be defeated by a change in the terms of trade, (a pivoting of PT), such that the amount of imports paid for would not rise above QU units.

Given that QU = NW units of imports is the maximum obtainable, from RZ we see that only RW units of investment will be worthwhile and that investing more than RW units is pointless because of a lack of the necessary imports to go with the capital formation. Thus there is an 'exchange gap' between desired investment RS which would require SZ units if imports and the QU maximum. In the circumstances it would be sensible to consume instead of exporting and investing and raise consumption from OR to OR + WU units. Of course, in a Harrod-Domar type model the lowered savings rate will also lower the growth rate. It has often been argued that something like this situation applies to today's developing countries (Linder 1967).

If we approach the eighteenth century with this framework in mind it would seem that the 'exchange gap' was not a problem in general and that growth was not seriously constrained by an inadequate capacity to import, at least after 1750. During this period the volume of imports grew faster than national income, at perhaps a little more than 1% a year from 1740-80 and perhaps 4% a year for 1780-1800. In this latter period Britain was able to expand export volume very rapidly whilst experiencing only a small decline in the terms of trade (Deane and Cole 1967: 321) and the middle years of the century saw improvements in the terms of trade. Moreover, given the technical progress taking place in export industries such as textiles, it is apparent that these imports were obtained with relatively small increases in the factors of production devoted to exports. Prior to 1745, however, there was a period of perhaps two decades when the expansion of exports did not lead to increased imports volume as the terms of trade deteriorated.

Organising the story in this way naturally draws attention to the market conditions which permitted this favourable expansion. On the demand side it is noteworthy that exports were mostly of manufactures with relatively high income and price elasticities of demand and that Britain was trading with a number of markets, especially in the New World in which the demand curve for British goods was shifting rapidly to the right (Davis 1962). This may well be a contrast with conditions faced by many primary producing developing countries in the twentieth century. The implication is that the eighteenth century saw both the supply curve of British exports and the demand curve for them shifting to the right.

A rather different account of interactions between trade and growth can be told by changing a few assumptions to allow for effects arising from an increased demand for exports. This version of events would allow for a role for trade in stimulating or even initiating growth rather than merely sustaining the process. In particular the argument would hypothesise important induced effects of expanding export markets in stimulating employment, investment and innovation at home, thus promoting a response in terms of increased supply. The importance of these 'spread effects' is stressed by Davis (1962: 290), Hobsbawm (1968: 32) and Williams (1944:52) among others, whilst Deane and Cole (1967: 85) and Hartwell (1971:197) argue that the increases in exports are a consequence of autonomous changes in domestic conditions in Britain.

Again these stories differ in terms of their implied counterfactuals. As the 'exchange gap' model suggests, however, even in the Deane and Cole case where export expansion is seen as coming from growth at home, the favourability of external demand conditions in preventing large declines in the terms of trade is noteworthy. The question at issue is rather whether one prefers a model in which external demand conditions are permissive or one in which they provide the dynamic. Since as we noted above both the supply and demand curves for British exports were shifting to the right over time both models would have *prima facie* plausibility.

VI. Concluding remarks.

Obviously this brief introduction to the eighteenth century does not pretend to be a comprehensive examination either of the economy or of the possibilities of a macro analysis of it. Rather it is hoped that it has served to whet the reader's appetite for the succeeding detailed chapters, to stimulate an interest in the application of economics to historical problems and to create more awareness of the role of assumptions in economic history.

Footnotes

(1) Even this 'general statement' relies on a number of strong assumptions, as the experienced reader will be aware. In particular, it implicitly assumes constant factor shares and Harrod neutral technological progress. It could well be possible to construct another parable based on a production function not exhibiting a unitary elasticity of substitution in which technological progress was biassed; such a parable has indeed been put forward for 19th century U.S. economic growth by Abramovitz and David (1973) who suggest an elasticity of substitution less than 1 and Harrod labour saving technological progress as the correct explanation for the combination apparently observed there of a rising capital to labour ratio and a rising share of profits in national income. For eighteenth century Britain the income shares data is, of course, highly untrustworthy but it seems that a hypothesis of constant shares, pretty much repeated in the nineteenth century (Deane and Cole 1969: 152, 282), is not refuted and that the 'stylised facts' of constant shares and neutrality of technological progress are a feasible interpretation.

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