ECONOMIC DEVELOPMENT AND INTERNATIONAL TRADE[1]

By HARRY G. JOHNSON*

Economic growth gives rise to many problems of international economic adjustment. This lecture is concerned with the formal analysis of one group of such problems, the effects of economic growth of various kinds on the growing country's demand for imports and dependence on international trade. The analysis may be treated in either of two ways: as an analysis of the nature of the equilibrium adjustment which growth requires of the international economy; and as a preliminary to analysis of the monetary problems which arise if the mechanism of international adjustment prevents or inhibits the attainment of the required new international equilibrium. The

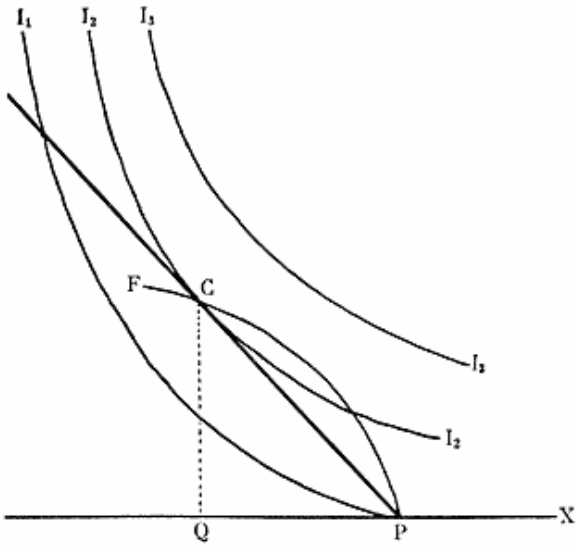

Fig. 1 a.

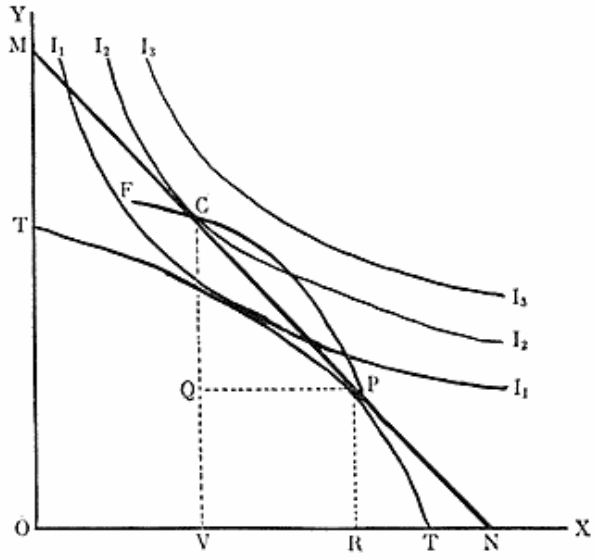

Fig. 1 b.

1. The substance of two lectures delivered at the University of Copenhagen, April 28th and 29th, 1959.

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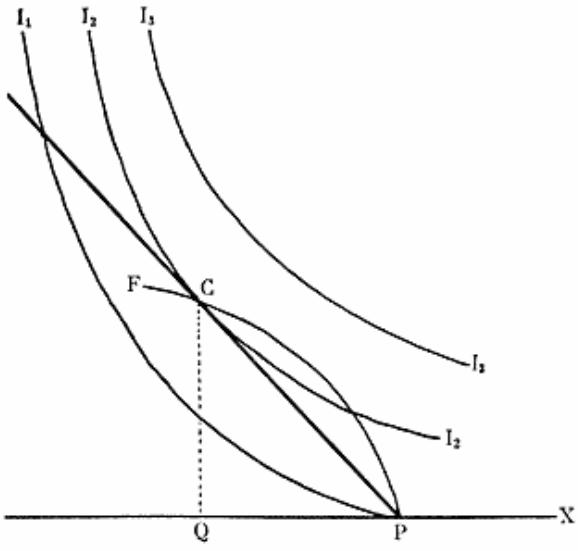

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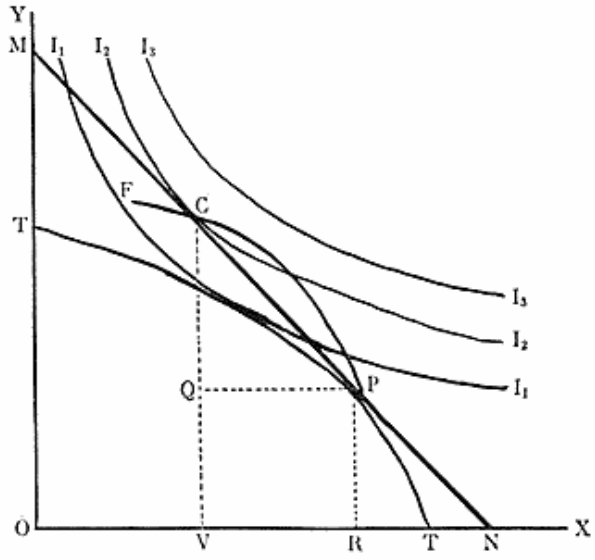

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argument employs the standard two-country two-factor model, assuming constant returns to scale in production and perfectly competitive conditions. When we come to analyse the effects of specific types of economic growth, the model will be "concretized" by making assumptions about the nature of the countries and the demand and supply conditions of the goods they produce.

To begin with, let us recapitulate the general nature of the equilibrium established in international trade. Two cases may be distinguished, corresponding to complete and incomplete specialization of the country in production: these are represented in Figs. 1a and 1b. In both Figs. quantities of commodities X and Y are measured along the axes, and I_1, I_2, I_3 represent community indifference curves. The domestic production possibilities are represented by the fixed quantity OP in the complete specialization case, and by the transformation curve TT in the incomplete specialization case: the terms of trade open to the country on the world market are represented by the slope of the line PC. In equilibrium, the terms-of-trade line is tangent to a community indifference curve at C; and also, in the incomplete specialization case, to the transformation curve at P; the country produces the quantities represented by P (OP of X in case *a*, OR of X and PR of Y in case *b*) and consumes the quantities represented by C (OQ of X and CQ of Y in case *a*, OV of X and CV of Y in case *b*), exporting PQ of X to pay for imports of QC of Y. The value of the country's national product (national income), measured in terms of import goods, is represented by OM in each case; and the level of satisfaction enjoyed is I_2, as compared with the level I_1 that would be enjoyed if there were no international trade.

The foregoing account assumes that the country faces given terms of trade. In general, the terms of trade will not be given but will be variable and determined by the interaction in the market of the country's own willingness to trade, as determined by its preference system and production capacity (case *a*) or transformation curve (case *b*), and the willingness of the foreign country to trade, as determined by the same factors abroad. The foreign country's willingness to trade can be represented by an offer curve (PF in Figs. 1a and 1b) showing the quantities of Y the foreign country would export in return for imports of various quantities of X, the price at which each exchange would occur being shown by the ratio of the quantities of X and Y exchanged. In case *a*, the foreign offer curve has a fixed origin at the point corresponding to the domestic country's productive capacity, and international trade equilibrium is determined by the condition that the point at which an indifference curve is tangent to the (variable) terms of trade line must lie on the foreign offer curve: in case *b*, the origin of the foreign offer curve shifts along the transformation curve, as domestic production alters; and international trade equilibrium requires, in addition to the condition

just stated, that the terms-of-trade line be tangent to the transformation curve at the point from which the offer curve originates. With the insertion of the foreign offer curve PF, the "trade triangle" CPQ in Figs. 1a and 1b represents the equilibrium of international trade when the terms of trade are variable.

The effect of economic growth is to shift the production point P outwards along OX in case *a*, and the transformation curve TT outwards in case *b*. The analysis of the effects of growth can be pursued in two alternative ways:

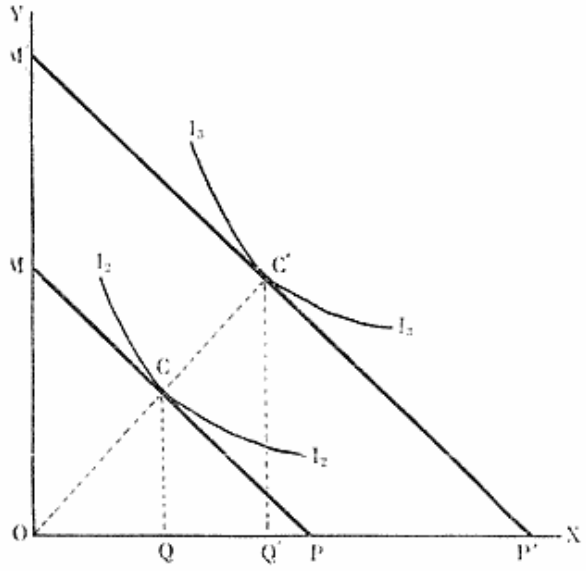

Fig. 2 a.

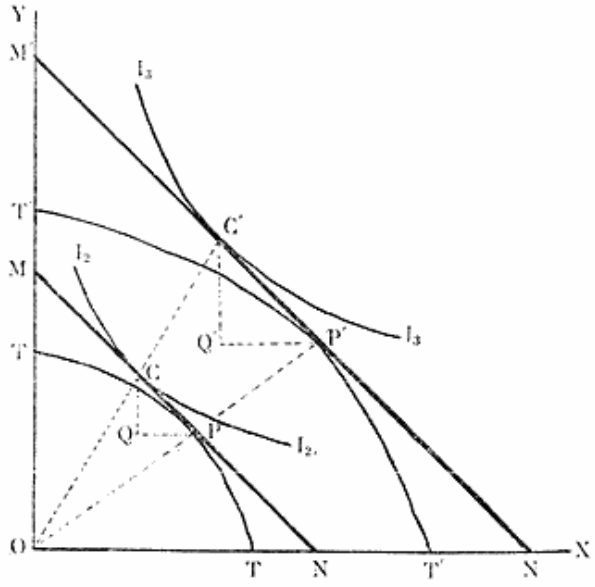

Fig. 2 b.

by assuming a given foreign offer curve and analysing the new international trade equilibrium that will result from growth, or by considering the effect of growth on the domestic country's demand for imports at the initial terms of trade. The latter is the approach adopted here, both because it enables the isolation of the effects of the growth of the economy and the development of concepts for the analysis of these effects, concepts which are directly applicable to economies whose terms of trade are fixed by the world market, and because, if the foreign offer curve is unchanged, the direction of change of the terms and volume of trade can be predicted from the effect of growth on the country's demand for imports at constant prices.

The general nature of the effect that economic growth would have on the growing country's demand for imports if growth occurred with unchanged terms of trade is illustrated in Figs. 2a and 2b. In each case, the production point shifts from P to P′, national income (product) measured in terms of imports from OM to OM′, the consumption point from C to C′, and the level of satisfaction enjoyed from I_2 to I_3. Imports demanded increase from CQ to C′Q′, and exports supplied from QP to Q′P′.

The question of economic interest is whether growth will increase the demand for imports more than proportionally to the increase in the value of the national product, in the same proportion as, or less than proportionally to the increase in the value of the national product. From the growing country's point of view, the question is whether growth makes the country relatively less self-sufficient, no more or less dependent on trade, or relatively more self-sufficient. From the point of view of the foreign country, the question is whether the market for its exports expands more than proportionally to, at the same rate as, or less than proportionally to the growth of this country. The three possibilities can be conceptualized in terms of three types of growth: pro-trade-biased growth, which increases the country's demand for imports and supply of exports more than proportionally to output; "neutral" or unbiased growth, which increases the country's demand for imports and supply of exports in proportion to output; and anti-trade-biased growth, which increases the country's demand for imports and supply of exports less than proportionally to output. Figs. 2a and 2b represent a particular type of unbiased growth, in which production and consumption of each of the two goods, and therefore exports and imports, expand proportionally with income – as shown by the fact that M'M, C'C, and P'P all meet in the origin. In addition to the three general types of growth, two extreme cases can be distinguished: ultra-pro-trade-biased growth, in which more than the whole increase in national income is devoted to the purchase of imports so that the demand for home-produced goods actually falls and the country becomes absolutely less self-sufficient; and ultra-anti-trade-biased growth, in which more than the whole increase in national income is devoted to the purchase of home-produced goods, so that the demand for imports actually falls and the country becomes absolutely more self-sufficient.

In the case of complete specialization, the type of growth is determined by the behaviour of the consumption of importables as the national product rises. Formally, it can be related to the "output-elasticity of demand for importables" – the proportional change in quantity of importables demanded, divided by the proportional change in national output which causes the change in import demand: growth is pro-trade biased, neutral, or anti-trade biased according as this elasticity exceeds, equals, or falls short of one, ultra-anti-trade biased if the elasticity is negative and ultra-pro-trade biased if the elasticity exceeds the original ratio of national income to imports (an alternative way of expressing a negative output-elasticity of demand for exportables). The ranges of shift of the consumption point corresponding to the five possible types of growth are illustrated in Fig. 3a.

If growth is due to some other cause than population change, income per head will rise, and the type of growth will depend on the average income-elasticity of demand for imports: if imports are luxury goods, growth will be

pro-trade-biased, if they are necessary goods growth will be anti-trade-biased; if imports are inferior goods growth will be ultra-anti-trade-biased and if exports are inferior goods growth will be ultra-pro-trade-biased. If, on the other hand, growth is due to population increase alone, it may be presumed that income per head will fall, so that in aggregate demand luxury goods will behave like necessities and conversely; the net effect of growth on demand will depend on the relations between population size and income per head, and between income per head and consumption per head of the good consumed, and a luxury good may even appear inferior in aggregate consumption. To simplify the following argument, and also because it seems

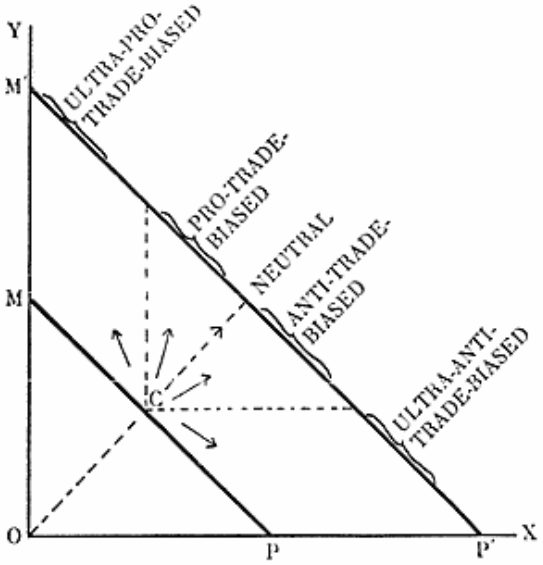

Fig. 3 a.

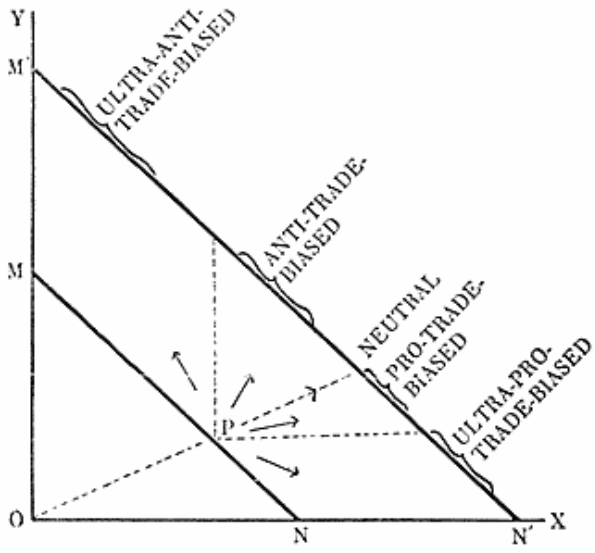

Fig. 3 b.

reasonable to do so, cases of ultra-bias in the consumption shift will henceforth be ignored.

In the case of incomplete specialization, the effect of growth on the demand for imports depends on the combined behaviour of consumption and production. For analytical purposes it is convenient to consider separately the effects on the country's self-sufficiency of the consumption and production shifts associated with growth, before considering their combined effect. The consumption shift has already been analysed (the term "demand for importables" rather than "demand for imports" has been used deliberately to permit the argument to be extended to the case in which some importable goods are produced at home). The production shift can similarly be classified into five types, which can be formally described in terms of an "output-elasticity of supply of importables". If this elasticity exceeds one, so that domestic production of importables increases more than proportionally to national income and the country's production pattern becomes more self-

sufficient, growth is anti-trade-biased; if the elasticity is negative, so that domestic production of importables falls, growth is ultra-pro-trade-biased; and so on. The ranges of shift of the production point corresponding to these types are shown in Fig. 3b. The determinants of the production shift will be discussed later; it would be possible, but is not worth while, to develop an analysis of output-elasticity of supply in terms of luxury, necessary and inferior production paralleling the analysis of output-elasticity of demand in terms of luxury, necessary and inferior consumption already presented.

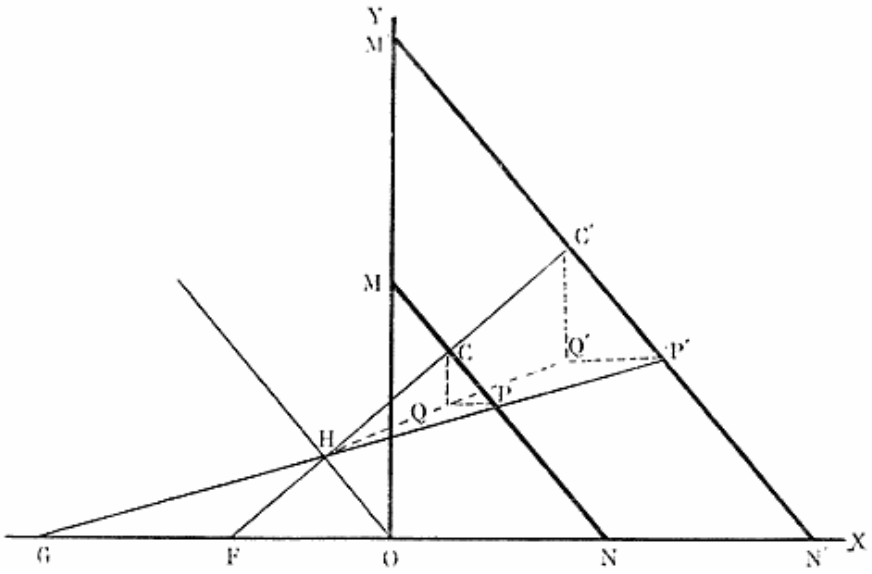

Fig. 4.

The effect of growth on the demand for imports is the combined result of its effects on consumption demand and domestic supply; and the addition of the effects of the consumption and production shifts is complicated. If both shifts are biased in the same direction, or one is neutral, the combined effect is clearly pro-trade-biased or anti-trade-biased. If, however, the two shifts are biased in opposite directions, the net effect cannot be simply assessed. Because consumption of imports initially exceeds domestic production of them, biases of the same degree (as measured by the deviation from unit output-elasticity) but in opposite directions will not cancel out; instead, the bias on the consumption side will dominate unless the production shift is sufficiently more biased than the consumption shift. In other words, the degrees of bias must be compared. But where there is ultra-bias in the production shift and the possibility of contrary ultra-bias in the consumption shift is ruled out, some simplification is possible: ultra-anti-trade-bias in the production shift is sufficient to make the effect of growth ultra-anti-trade-biased, and ultra-pro-trade-bias in the production shift is sufficient to prevent growth being ultra-anti-trade-biased on balance.

The relation between the output-elasticities of consumption and produc-

tion of importables, the production and consumption biases, and the overall bias of growth can be shown geometrically in terms of Fig. 4, which reproduces Fig. 2b but for clarity omits the transformation and difference curves. The proportional changes in aggregate output, consumption of importables and production of importables are respectively:

$$\frac{MM'}{OM} = \frac{NN'}{ON}, \frac{CC'}{FC} = \frac{NN'}{FN}, \text{ and } \frac{PP'}{GP} = \frac{NN'}{GN}.$$

Hence the output-elasticity of consumption of importables is $\frac{CC'}{FC} \div \frac{MM'}{OM} = \frac{ON}{FN}$, and the output-elasticity of production of importables is $\frac{PP'}{GP} \div \frac{MM'}{OM} = \frac{ON}{GN}$. The proportional change in demand for imports is $\frac{CC'}{HC} = \frac{PP'}{HP} = \frac{QQ'}{HQ}$, and the output-elasticity of demand for imports is $\frac{CC'}{HC} \div \frac{NN'}{ON}$. The magnitude of the latter, and hence the overall bias of growth, can be determined simply by comparing the slopes of OH and MN. If OH and MN are parallel, as in Fig. 4, $\frac{C'C}{HC} = \frac{NN'}{ON}$, the output-elasticity of demand for imports is unity and growth is neutral; if OH lies to the right of a line through O parallel to MN, $\frac{C'C}{HC} > \frac{NN'}{ON}$, the elasticity exceeds unity, and growth is pro-trade-biased; conversely, if OH lies to the left of the line through O parallel to MN, the elasticity is less than unity and growth is anti-trade-biased. By extension, if C'C and P'P meet in H at an obtuse angle growth is ultra-pro-trade-biased, while if H lies to the right of MN growth is ultra-anti-trade-biased. The bias of the consumption shift can be measured by the excess of the output-elasticity of consumption of importables over unity, and of the production shift by the excess of unity over the output-elasticity of production of importables (so that pro-trade bias is positive and anti-trade-bias negative in each case). On these definitions the consumption bias is represented in Fig. 4 by $-\frac{FO}{FN}$ and the production bias by $\frac{GO}{GN}$; $\frac{GO}{GN}$ is larger than $\frac{FO}{FN}$, thus demonstrating the point previously stated that where the biases are opposed the production bias must be larger than the consumption bias if the latter is not to predominate.

Ultra-pro-trade-biased growth and ultra-anti-trade-biased growth have been described as extreme cases, in terms of their effects on the growing country's self-sufficiency or dependence on trade. Before proceding to discuss the likely effects on trade of growth due to particular causes, it seems appropriate to notice an alternative conception of extreme types of growth,

a conception in terms of economic welfare which really belongs at a later stage of the argument but which it is convenient to introduce at this stage.

Let us assume that only the one country is growing, and consider the nature of the new international trade equilibrium that will result from its increased production, and the economic welfare that will be derived from it. Normally, at least so far as the argument up to this stage has taken us, we might expect that growth would increase the country's demand for imports, thereby worsening its equilibrium terms of trade and so imposing a loss of economic welfare as a partial offset to the gain in welfare associated with a higher level of production. This suggests two possible extreme cases. The first is the case in which the growing country's demand for imports falls instead of rises, so that its terms of trade improve and the benefit from increased production is augmented by a gain on the terms of trade; this case will occur when growth is ultra-anti-trade-biased, possible causes of which will appear in subsequent analysis. The other extreme is the case in which

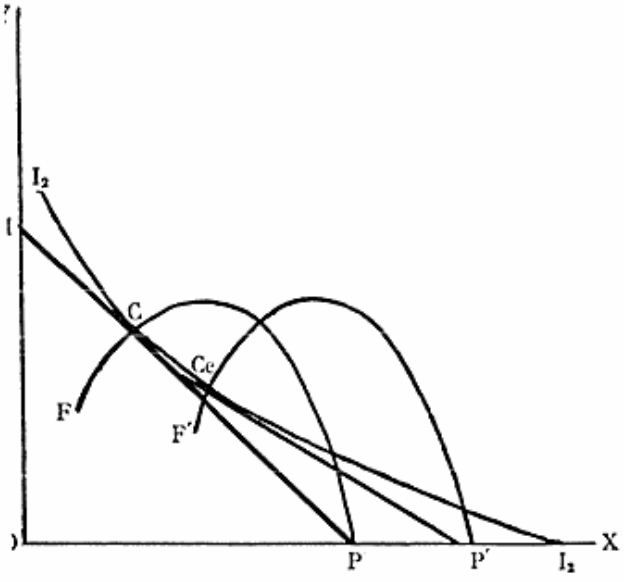

Fig. 5 a.

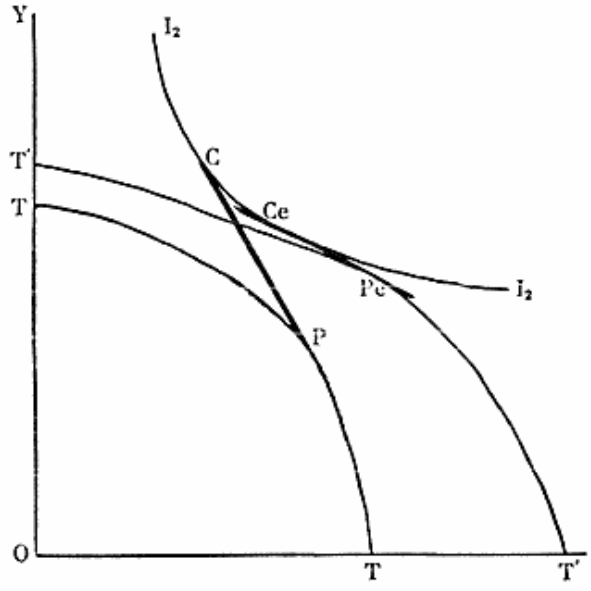

Fig. 5 b.

the terms of trade turn unfavourable to such an extent that the welfare loss from this cause more than offsets the gain from increased production, so that the country's growth leaves it worse off on balance. This is the case which Jagdish Bhagwati has described as "immiserizing growth";[1] it is probably a *curiosum*, but worth analysing.

The simplest way of doing so is to illustrate the possibility of growth which leads to no welfare gain; this possibility is depicted in Figs. 5a and 5b,

1. Jagdish Bhagwati, "Immiserizing Growth: A Geometrical Note", *The Review of Economic Studies*, Vol. XXV (3) No. 68 (June 1958), pp. 201-05.

for the two cases of complete and incomplete specialization. In both Figs, C_e on the pre-growth indifference curve I_2 is the consumption point when growth has occurred and the terms of trade moved against the country sufficiently to preserve international trade equilibrium; in Fig. 5b, P_e is the new equilibrium production point on the new transformation curve.

In the complete specialization case, zero-gain growth obviously requires that foreign demand for the country's exports be inelastic. With a higher price of imports and the same level of indifference, consumption of importables and therefore imports demanded must fall. For this to correspond to full international equilibrium, the foreigner must accordingly reduce the quantity of imports supplied when their price rises, or, what is the same thing, spend less of his goods on this country's exports when the price of the latter falls. This necessary condition for zero-gain growth in the complete specialization case is illustrated in Fig. 5a, where PF and P'F' represent the (given)foreign offer curve drawn through the pre-growth and post-growth production points. In the incomplete specialization case, consumption of importables must also fall; but the demand for imports does not necessarily fall, since domestic production of importables may fall by more than consumption of them. Thus, zero-gain growth in this case requires *either* that the foreign demand for the country's exports be inelastic *or* that the country's growth be ultra-pro-trade-biased.

To return to the main line of the argument, the concepts of neutral, pro-trade-biased, anti-trade-biased, and ultra-pro and ultra-anti-trade-biased growth, together with the distinction between the consumption, the production, and the overall effect of growth, must now be applied to analysing the effects of different types of growth. Following convention, we shall be concerned with three types of economic growth – technical progress, population increase, and capital accumulation – which are assumed to be analytically separable. And we shall consider their effects in two types of economy, one which exports manufactured goods in exchange for foodstuffs – a "manufacturing country" – and one which exports foodstuffs in exchange for manufactured goods – an "agricultural country". Both countries are assumed to be only partially specialized – this is the more interesting case, and can readily be adapted to the case of complete specialization.

To make the analysis more concrete, it is assumed that food is labour-intensive in production and a necessary good in consumption, while manufactures are capital-intensive in production and a luxury good in consumption. Further, it is assumed that capital is better off than labour, so that the average and marginal propensities to consume manufactures are higher for capital than for labour, and the average and marginal propensities to consume food are higher for labour than for capital.

In considering the effects of growth, it is convenient to distinguish bet-

ween technical progress, which alters the production functions of the economy, and population increase and capital accumulation, which increase the quantity of a productive factor without altering the production function. The effects of factor accumulation are the simplest to deal with, and will therefore be discussed first. For reasons which will become clear in the course of the argument, it is necessary to consider the production effects before the consumption effects.

The production effect of factor accumulation, for the simple model we are using, is given by a rather simple proposition sometimes described as "the

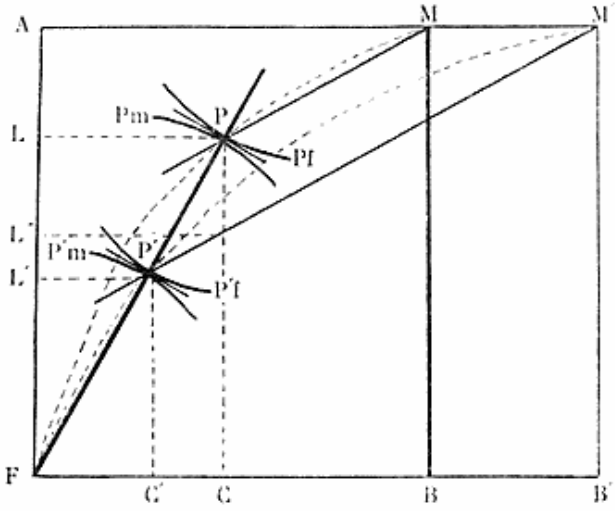

Fig. 6.

Rybczynski theorem";[1] if the terms of trade are constant, and one factor accumulates, there will be an absolute reduction in the production of the good which uses that factor less intensively, and the production of the good using that factor more intensively will increase by more than the value of the total increase in output. The proof of this proposition starts from the fact that, to keep the relative prices of the goods constant, it is necessary to keep factor prices constant, because an increase in the relative price of a factor will increase the relative cost of the good which uses that factor more intensively. To keep factor prices constant, it is necessary to keep the ratio of one factor to the other in each industry constant, since it is this ratio which determines the relative marginal productivities and therefore the relative prices of the factors.

How is this to be done when the amount of one factor increases? Suppose there is an increase in the quantity of capital: then if labour and capital to-

1. T. M. Rybczynski, "Factor Endowment and Relative Commodity Prices", *Economica*, N.S. Vol. XXII, No. 88 (Nov. 1955) pp. 336-41. The writer first encountered the argument in a paper read by W. M. Corden in November 1954.

gether are shifted out of the labour-intensive into the capital-intensive industry, labour will be released from the labour-intensive industry in greater quantities than are required to operate the released capital in the capital-intensive industry; and the surplus will be available to operate the additional capital.

This point can be illustrated by means of the production box-diagram, as in Fig. 6. In the diagram AF represents the initial endowment of labour, and AM the initial endowment of capital; production indifference curves for food are drawn in the box with F as origin, and for manufactures with M as origin; the points of tangency of indifference curves from the two origins, which constitute efficient allocations of resources between the two industries, form the contract curve FPM. Suppose that P is the pre-growth production point, the economy producing P_f food by using FL of labour and FC of capital in agriculture, and P_m of manufactures by using LA of labour and BC of capital in manufacturing; the labour: capital ratios in food and manufactures respectively are shown by the slopes of FP and MP, and the exchange ratio between labour and capital is given by the slope of the common tangent to P_f and P_m at P.

Now suppose that capital increases to AM′, shifting the origin of the manufactures production indifference curves to M′ and altering the contract curve to FP′M′. At P′, the point on the new contract curve with the same labour: capital ratio in each industry and therefore the same exchange ratio between factors as at P, production of food P'_f is lower than at P. The reduction of food production from P_f to P'_f releases LL′ of labour and CC′ of capital from agriculture; only L′L″ of the labour released is required to cooperate with CC′ capital in manufactures, leaving LL″ free to operate the additional capital MM′.

It follows from the foregoing argument that capital accumulation will reduce agricultural production and increase manufacturing production at constant terms of trade. Capital accumulation in the manufacturing country will therefore have an ultra-pro-trade-biased production effect; whereas capital accumulation in the agricultural country will have an ultra-anti-trade-biased production effect. Conversely, population growth will reduce manufacturing output and increase agricultural output; thus the production effect of population growth will be ultra-anti-trade-biased in the manufacturing country and ultra-pro-trade-biased in the agricultural country.

It also follows from the previous argument that, at constant terms of trade (and so long as the country remains incompletely specialized), all of the increase in output goes as income to the factor which is accumulating. On our assumption of differing marginal and average propensities to consume the good, capital accumulation will increase the average proportion of income spent on manufactures, and population growth will increase the average pro-

portion of income spent on food. Hence the consumption effect of capital accumulation will be anti-trade-biased in the manufacturing country and pro-trade-biased in the agricultural country, while the consumption effect of population growth will be the reverse in the two countries. As explained earlier, an ultra-anti-trade-biased production effect will dominate the consumption effect while an ultra-pro-trade-biased production effect will rule out an ultra-anti-trade-biased total effect. Hence capital accumulation in the agricultural country and population growth in the manufacturing country will be ultra-anti-trade-biased, while the opposite type of factor accumulation in each country may be anything from ultra-pro-trade-biased to anti-trade-biased, but will not be ultra-anti-trade-biased.

Let us now turn to the effects of technical progress. This is a complex problem, because such progress may not only go on at different rates as between industries, but may also affect factors of production differentially in the industry in which it occurs, as well as in the economy as a whole. A technique for dealing with biased technical progress, which permits the whole problem to be dealt with in a relatively simple fashion, has only just been published by two American graduate students.[1] The following argument employs a somewhat modified version of their technique. As before, we begin with the production effect.

Let us begin with the simplest case of technical progress, "neutral" technical progress, defined as progress which reduces the quantities of the two factors required to produce a given quantity of output in the same proportion. Neutral technical progress has the initial effect of increasing the output of the industry in which it occurs, and lowering its cost of production at the initial factor prices. We are interested in the effect on production at constant relative prices and costs of the goods. In order to restore the initial relative prices, factors must shift from the other industry into this one: as they do so, the price of the factor used relatively intensively in this industry rises, and the price of the factor used relatively intensively in the other industry falls, so altering the relative costs of the goods and restoring the initial price ratio. Thus neutral technical progress in an industry leads to expansion of the output of that industry at the expense of the other, at given terms of trade; in other words, neutral progress is ultra-biased. It follow that neutral progress in manufacturing has an ultra-pro-trade-biased production effect in the manufacturing country, and an ultra-anti-trade-biased production effect in the agricultural country; while the effects of neutral progress in agriculture are exactly the reverse.

Now consider technical progress which is biased, in the sense that it alters

1. R. Findlay and H. Grubert, "Factor Intensity, Technological Progress, and the Terms of Trade", *Oxford Economic Papers*, (New Series), Vol. II, No. 1 (February 1959).

the optimum ratio of one factor to the other employed at the initial factor prices in the industry in which progress occurs. Such progress may be described as saving the factor whose optimum ratio to the other is reduced.[1] Biased progress has a dual initial effect: it lowers the cost of production in the industry, and it releases a quantity of the factor it saves. Its effects are therefore the same as those of a neutral technical change,[2] combined with an increase in the supply of the factor which is saved by the biased progress.

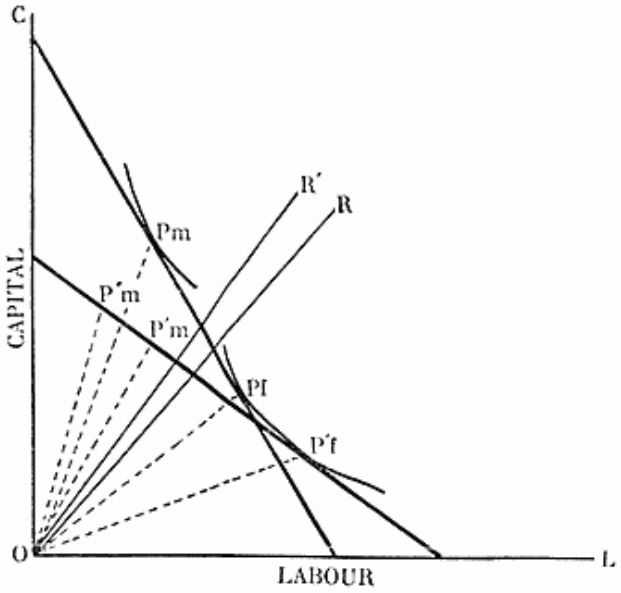

Fig. 7.

Again we are interested in the effect on production at constant commodity prices. As in the case of neutral technical progress, the reduction in cost requires a shift of factors into the industry where the progress has occurred. As in the case of factor accumulation, the factor released by progress must be absorbed by an expansion of production of the good which uses the factor relatively intensively, at the expense of production of the other good.

It follows that if technical progress saves the factor which is used relatively intensively in the industry where the progress occurs, both factors operate in the same direction, and the production effect will be even more ultra-biased than if progress were neutral. But if progress saves the factor used relatively intensively in the other industry, the two effects – cost-reducing

1. The bias is defined in terms of the effect of progress on the optimum factor ratio, rather than in terms of the relative reductions in quantities of factors required per unit of output, because progress may increase the quantity of one factor required per unit of output.
2. Neutral technical progress (increased output in the industry) if the cost-saving effect outweighs the bias effect so that less of both factors is required per unit of output than before, neutral technical regress (reduced output in the industry) if more of the other factor is required per unit of output than before.

and factor-saving – work in opposite directions, and the production effect may vary from one to the other extreme of ultra-bias, depending on the balance of cost-reducing and factor-saving effects.

The argument can be illustrated by reference to Fig. 7, which is reproduced (with emendations) from Findlay and Grubert. Capital is measured on the vertical axis, labour on the horizontal. The country's factor-endowment ratio is OR. The line through P_m and P_f represents the pre-progress factor price ratio, tangent to a manufacturing production indifference curve at P_m and an agricultural production indifference curve at P_f, these curves representing quantities of equal cost and value at the inital price ratio. OP_m and OP_f are the optimum factor-ratios in the two industries; and the allocation of production between the industries must be such that the two ratios, each weighted by the proportion of the labour force in the industry where the ratio is used, average out to the endowment ratio OR.

This diagram, incidentally, can be used to establish the Rybczynski theorem. Suppose that capital is accumulated, increasing the endowment ratio to OR′; for OP_m and OP_f to average out to the higher level OR′, the weight of OP_m must increase and that of OP_f decrease. That is, a larger proportion of the unchanged labour force must be employed in the capital-intensive manufacturing industry, and a smaller amount of labour in the labour-intensive food industry. Since capital: labour ratios are constant, production must vary with the amount of labour employed, falling in the labour-intensive industry.

To return to the effects of technical progress, suppose that there is technical progress in manufacturing, which shifts the production indifference curve for manufactures towards the origin O. At the initial factor prices, the cost of the quantity of manufactures represented by this indifference curve would now be less than the cost of the quantity of foodstuffs represented by the (unchanged) production indifference curve for agriculture. To keep the costs of the quantities of the goods equal, and so maintain the initial price ratio, factor prices must alter in favour of capital and against labour, to the factor-price ratio given by the new common tangent to the two production indifference curves, P'_m P'_f. As factor prices alter, labour will be substituted for capital in both industries.

The new capital: labour ratio in foodstuffs OP'_f is necessarily lower than the original one, owing to the substitution of cheaper labour for more expensive capital. If progress in manufacturing is capital-saving, neutral, or only slightly labour saving, the capital:labour ratio in manufactures will also be lover than originally, as illustrated by P'_m. With a lower equilibrium capital:labour ratio in both industries, resources must have shifted out of the labour-intensive industry (foodstuffs) into the capital-intensive industry (manufactures) to maintain the overall average endowment ratio OR. Thus

progress of these three types in manufacturing will be ultra-biased towards production of manufactures.

But if progress is sufficiently strongly labour-saving to offset the substitution effect of cheaper labour, the new capital:labour ratio in manufactures will be higher than the original. And with a higher capital:labour ratio in the one industry and a lower ratio in the other, the overall endowment ratio might have been maintained by a shift of resources in either direction (and to any extent) between the industries. Thus in this case the effect of technical progress in manufacturing may lie anywhere between the extremes of ultra-bias towards production of manufactures, and ultra-bias towards production of foodstuffs.

What about the consumption effect of technical progress? The restoration of the initial relative cost ratio involves lowering the relative price of the factor used less intensively in the industry where progress has occurred, and raising the price of the other. Thus more than the whole of the increase in national income due to progress goes to that factor which is used intensively in the industry in which the progress has occurred. In consequence, the proportion of expenditure out of national income on the good for which this factor's average and marginal propensity to consume is relatively high rises. It is even possible that total expenditure on the good preferred by the factor from which income is redistributed will fall; it will do so if the reduction in consumption due to straight income redistribution exceeds the increase in consumption due to the net increase in national income which accrues to the favoured factor. But it seems permissible to exclude this possibility of ultra-biased consumption effects through income-redistribution as an exceptional one. On this basis, it follows that progress in manufacturing, which reduces the income of labour and the proportional demand for food, will have an anti-trade biased consumption effect in the manufacturing country and a pro-trade biased consumption effect in the agricultural country; while the consumption effects of progress in agriculture will be the reverse.

Remembering that cases of ultra-anti-trade-biased and ultra-pro-trade-biased consumption effects have been excluded by assumption, the conclusions about the total effects of technical progress to which the foregoing analysis leads can be summarized as follows:

(a) The following types of progress will be ultra-anti-trade biased:
  (i) neutral technical progress in agriculture in the manufacturing country
  (ii) neutral technical progress in manufacturing in the agricultural country

(iii) capital-saving technical progress in manufacturing in the agricultural country
(iv) labour-saving technical progress in agriculture in the manufacturing country.

(b) The following types of progress will be ultra-pro-trade-biased to anti-trade-biased, but not ultra-anti-trade-biased:
(i) neutral technical progress in manufacturing in the manufacturing country
(ii) neutral technical progress in agriculture in the agricultural country
(iii) capital-saving technical progress in manufacturing in the manufacturing country
(iv) labour-saving technical progress in agriculture in the agricultural country.

(c) The following types of progress can be biased in any way whatever from ultra-pro-trade-biased to ultra-anti-trade-biased:
(i) capital-saving technical progress in manufacturing in either country
(ii) labour-saving technical progress in agriculture in either country.

TABLE

THE EFFECTS OF ECONOMIC GROWTH

Type of Growth	Manufacturing Country			Agricultural Country		
	Production Effect	Consumption Effect	Total Effect	Production Effect	Consumption Effect	Total Effect
Capital accumulation	UP	A	UP to A	UA	P	UA
Population Growth	UA	P	UA	UP	A	UP to A
Neutral technical progress						
(a) manufacturing	UP	A	UP to A	UA	P	UA
(b) agriculture	UA	P	UA	UP	A	UP to A
Capital-saving technical progress						
(a) manufacturing	UP	A	UP to A	UA	P	UA
(b) agriculture	UA to UP	P	UA to UP	UP to UA	A	UP to UA
Labour-saving technical progress						
(a) manufacturing	UP to UA	A	UP to UA	UA to UP	P	UA to UP
(b) agriculture	UA	P	UA	UP	A	UP to A

A: anti-trade-biased
P: pro-trade-biased
UA: ultra-anti-trade-biased
UP: ultra-pro-trade-biased

In brief, progress which is neutral or saves the factor used relatively intensively in the industry in which it occurs will be ultra-anti-trade-biased if it occurs in a country's import-competing industry, and ultra-pro-trade-biased to anti-trade-biased but *not* ultra-anti-trade-biased if it occurs in a country's export industry; progress which saves the factor used relatively intensively in the other industry than that in which the progress occurs may have any effect whatsoever.

The production, consumption, and total effects of growth of the various types analysed in the argument so far on the growing country's demand for imports and supply of exports are summarized in the accompanying Table. The results in many cases are rather indefinite. It should perhaps be remarked that the chief reason why this is so lies in our original assumption that each factor prefers to consume the product in which it is employed intensively so that progress in that product, by redistributing income towards that factor, increase the relative demand for the product. If each factor preferred the product in which it was used less intensively, the consumption and production effects of progress would work in the same direction in many cases, giving unambiguous results. This may be confirmed by scrutiny of the summary Table: if factors' preferences for goods were the opposite of those assumed, the effects of growth of the types discussed would be *either* ultra-anti-trade-biased, *or* pro-trade-biased to ultra-pro-trade-biased, except in cases of capital-saving progress in agriculture and labour-saving progress in manufactures.

There are two further possible results of technical progress, suggested by Fig. 7, which should be mentioned, though it does not seem worth while to develop them in full. The first is that technical progress in one industry may reduce costs there so much that the country specializes completely on that product. In Fig. 7, the production indifference curve shifts so far towards the origin that either no common tangent exists, or the common tangent implies factor ratios inconsistent with the endowment ratio and non-negative production. This case is simply the extreme example of an ultra-biased production effect.

The second possibility arises when progress is so saving of the factor used intensively in the industry in which it occurs as to make the optimum ratio of that factor to the other at the initial factor prices lower than the endowment ratio in both industries. In this case, the saved factor cannot be absorbed (at the initial factor price ratio) by a shift of factors between industries; its relative price must fall, so that the consumption effect of progress is biased against the industry in which it occurs. The production effect of this kind of progress will entail complete specialization on the good in which progress occurs, at the initial commodity prices, provided that it can be assumed that with the original technology, the relative factor-intensities of the

two industries would be the same at any factor price ratio. This assumption ensures that, as the price of the saved factor falls, the relative cost of producing the product in which progress has occurred, using the pre-progress technique, will fall. Thus it will never pay to produce the other product.[1] But since the reduction in the price of the saved factor will reduce the cost of producing this product with the old technique more than it will reduce the cost of producing it with the new technique, it is possible that, before the optimum factor-intensity with the new technique is raised to the endowment ratio, the old and new techniques become cost-indifferent. In this case, specialization will be accompanied by the use of that mixture of old and new techniques which demands factors in the average proportion of the country's endowment ratio.

The next step is to analyse the effects of growth in the two countries together, that is, of the growth of the world economy. If growth of the same type is going on in the two countries, conclusions about the movement of the terms of trade between them (i.e. between manufactures and food) can be drawn directly from the Table in many cases. For example, capital accumulation and neutral or capital-saving technical progress in manufactures turn the terms of trade in favour of the agricultural country, population growth and neutral or labour-saving technical progress in food turns the terms of trade in favour of the manufacturing country. But capital-saving progress in agriculture and labour-saving progress in food may turn the terms of trade either way.

In the general case, with population increasing, capital accumulating, and technical progress being applied in both countries, the movement of the terms of trade will depend on the bias and the rate of growth in each country. This dependence can be expressed in the following formula:

$$R_{pm} = \frac{\varepsilon_a R_a - \varepsilon_m R_m}{\eta_a + \eta_b - 1}$$

1. If factor-intensities with the old technique can reverse as the price of the saved factor falls, it is possible for there to exist a common tangent to the new production indifference curve for the industry where progress has occurred and the production indifference curve for the other industry such that (a) the optimum factor ratios lie on opposite sides of the endowment ratio, (b) the cost of production with the new technique is lower than with the old, in the industry where progress has occurred. In this case the country remains incompletely specialized at the initial commodity prices, this being made possible by a reversal of relative factor intensities in the two industries; the production effect here may be anywhere between the extremes of bias. The writer is indebted to Messrs. Findlay and Grubert for pointing out in correspondence the importance of condition (b), and so permitting the correction of an error in the original formulation of the argument.

where R_{pm} is the rate of increase (decrease if negative) of the relative price of manufactures, R_a is the rate of growth of output in the agricultural country and ε_a its output-elasticity of demand for imports, R_m and ε_m are the rate of growth and output-elasticity of demand for imports of the manufacturing country, η_a and η_b are the two countries' price-elasticities of demand for imports, and $\eta_a + \eta_b - 1$ is the "elasticity factor" which determines the proportion of the initial value of trade by which a country's trade balance would improve if the price of its export good fell. The sense of the formula is that $\varepsilon_a R_a$ and $\varepsilon_m R_m$ are the rates of increase in the countries' demands for each other's goods; if these are unequal, equilibrium must be maintained by a relative price change whose magnitude will vary inversely with the elasticity factor.

Consideration of the effects of growth on the terms of trade suggests a concept of "balanced growth" – growth of the two countries at rates which keep the terms of trade between them constant. Balance in this sense requires $\varepsilon_a R_a = \varepsilon_m R_m$; obviously, it is impossible if the output-elasticities of demand have opposite signs, the growth of one country being ultra-anti-trade-biased. In any case, the concept is of very limited usefulness, since "balance" does not imply equal rates of growth of total output, let alone output per head. All that is implied by growth not being "balanced" in this sense is that one of the countries is benefitting not only by the growth of its own output but by an improvement in its terms of trade, while the benefit the other derives from the growth of its output is reduced by a worsening of its terms of trade; it is even possible, as has been shown earlier, for a country to be worse off as the result of growth. If complete specialization is assumed, so that bias depends on consumption only, "balanced growth" implies slower growth in the agricultural country unless growth is due to population increase.

In conclusion, some remarks on the extension of the analysis beyond the confines of the two-country two-good two-factor model seem called for. In the first place, recognition of a third factor, land, used predominantly in agriculture, introduces the classical problem of diminishing returns. If returns diminish strongly enough, the conclusions concerning the effects of population growth may be reversed – if there is no outlet on the land, the growing population may be forced into manufacturing. Second, allowance for a multiplicity of products introduces a variety of complications: rising income may lead to demands for foreign products formerly considered not worth their cost as compared with domestic substitutes; technical progress may be random, leading to sudden reversals of comparative advantage – for example, giving a capital-rich country a comparative advantage in producing a formerly labour-intensive product; and capital accumulation or po-

pulation increase may alter a country's comparative advantage in particular goods – so that, for example, it may shift from labour-intensive to capital-intensive products in both manufacturing and agriculture. Thirdly, recognition of intermediate products which may be traded, and of the network of intersectoral transactions, greatly complicates the simple connection assumed in the foregoing between domestic demand for and supply of final goods, and the volume of international trade. Fourthly, allowing for the presence of many countries means that the movement of the terms of trade between manufactures and agricultural products depends on the nature and rate of growth in all countries together. One consequence of this is as follows: in the two-country model, "general" growth of one country will tend to increase its demand for imports, so that if the other country does not grow or grows only slowly it will benefit from a favourable movement of its terms of trade; but if there are two groups of countries, the effect of world growth on a particular country depends not only on the relative rates of growth of the two groups, but also on its individual rate of growth as compared with the growth rates of others in its group. A country may lose by a low rate of growth because the rapid growth of others in its group turns the terms of trade against it.