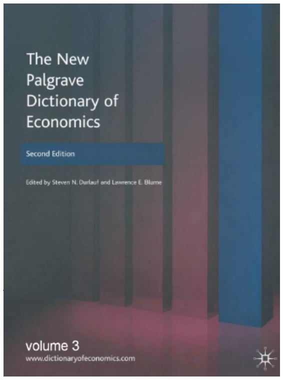

Harrod, Roy Forbes (1900–1978)

Roy Harrod was born in February 1900 and died in 1978. His father, Henry Dawes Harrod, was a businessman and author of two historical monographs. His mother, Frances (née Forbes-Robertson) was a novelist, and sister of the notable Shakespearean actor-manager, Sir Johnson Forbes-Robertson. Henry Harrod's business failed in 1907, but Roy won a scholarship to St Paul's School in 1911 and a King's Scholarship to Westminster in 1913. He became Head of his House, and in 1918 won a scholarship in history to New College, Oxford, his father's college. He enlisted in September 1918 and was commissioned in the Royal Field Artillery, but the war ended before his training was completed.

He went up to Oxford in early 1919 and first read Literae Humaniores (Classical Literature, Ancient History and Philosophy). He might well have devoted his career to academic philosophy, and he valued his publications in that subject more highly than his seminal contributions to economics. He has remarked that significant economic problems have only attracted the attention of profound thinkers for about 200 years, and interest in them might well disappear in another 200. In contrast, deep thought has been devoted to the great philosophical problems (such as the validity of inductive methods of thought) for more than 2,000 years and new contributions will be read for so long as civilized life remains. But his philosophy tutor at New College, H.W.B. Joseph, deterred him from devoting his life to that subject, by reacting extremely negatively to his essays. Harrod has left an account of a seminar on Einstein's theory of relativity in Oxford in 1922 where Joseph drew attention to a few terminological problems and believed this had undermined the theory. Einstein's theory of relativity survived, but Harrod was persuaded not to pursue a career in academic philosophy. In later years he published in the distinguished philosophical journal, *Mind*, and his *Foundations of Inductive Logic* (1956a) has received serious critical attention from philosophers as distinguished as A.J. Ayer (1970), but his main scholarly work was not to be in philosophy.

He followed his first class honours in Literae Humaniores in 1922 with a first class in modern history just one year later, and in 1923 Christ Church, Oxford, elected him to a Tutorial Fellowship (confusingly described as a studentship in that college) to teach the novel subject, economics, which was to be part of Oxford's new Honour School of Politics, Philosophy and Economics.

Harrod was allowed two terms away from Oxford so that he could learn enough economics to teach it, and it was suggested that he might spend this time in Europe, but he first went to Cambridge where he attended a wide range of lectures and wrote weekly essays on money and international trade for John Maynard Keynes. He was equally fortunate when he returned to Oxford, for while he was critically discussing the economics essays of Christ [illegible]dergraduates he was himself writing weekly microeconomic essays for the Drummond Professor of Political Economy, Francis Ysidro Edgeworth.

In addition to his new academic work Harrod took a notable part in the administration of his college (where he was Senior Censor in 1929–31, the most responsible office a student of Christ Church can be called upon to discharge), and also the university where he was elected to Oxford's governing body (the Hebdomadal Council) in 1929 before he was 30. In the university and in Christ Church, he fought powerful campaigns on behalf of Professor Lindemann (subsequently Lord Cherwell) who held Oxford's Chair of Experimental Philosophy (Physics), and became principal scientific adviser to Winston Churchill's wartime government and a member of his post-war cabinet.

By 1930 his economics had developed to the point where he was able to publish his first important and original contribution, 'Notes on Supply', in which he was the first 20th-century economist to derive the marginal revenue curve. This should have appeared in 1928 to produce a claim for international priority, but Keynes, the editor of the *Economic Journal*, sent the article to Frank Ramsey, who first believed there were difficulties with the argument. He subsequently appreciated that his objections rested on a misunderstanding, but Harrod's new contribution was less startling in 1930 than it would have been in 1928. He followed this initial contribution to the imperfect competition literature with an important article, 'Doctrines of Imperfect Competition' (1934), in which he summarized the essential elements of the new theories of Edward Chamberlin and Joan Robinson.

During the 1930s Harrod frequently stayed with Keynes and he was increasingly drawn into the group of brilliant young economists which included Richard Kahn and Joan Robinson, who were helping him develop the new theories which culminated in *The General Theory of Employment, Interest and Money*. Harrod had written a number of important and influential articles in the press advocating new reflationary policies in the early 1930s, and these together with his extension of Kahn's employment multiplier to international trade in his *International*

Economics (1933b) prompted Joseph A. Schumpeter to write in 1946 in his obituary article on Keynes, 'Mr Harrod may have been moving independently toward a goal not far from that of Keynes, though he unselfishly joined the latter's standard after it had been raised'.

Shortly after the *General Theory* appeared, Harrod published *The Trade Cycle* (1936a) in which he developed some of the dynamic implications of the new theory of effective demand. The conditions where output would grow were a central theme in Adam Smith's *The Nature and Causes of the Wealth of Nations*, and it had been much analysed in the great 19th-century contributions of Malthus, Ricardo, Mill and Marx, but the long-term dynamic implications of immediate changes to particular economic variables received virtually no attention in the neoclassical work that followed the marginal revolution. In the *General Theory* Keynes mostly went no further than to work through completely the immediate effects *on a formerly stationary economy* of a variety of disturbances such as an excess of the saving which would occur at full employment over the investment businessmen considered it prudent to undertake. Harrod went a vital step further and showed what could be expected to occur if saving was *permanently high* in relation to *the long-term opportunity to invest*. In 1939 he followed *The Trade Cycle* with 'An Essay in Dynamic Theory' (1939c), and after the war he developed his growth theory further in the book, *Towards a Dynamic Economics* (1948a). Important articles followed including a 'Second Essay in Dynamic Theory' (1960a), and 'Are Monetary and Fiscal Policies Enough?' (1964a). It is almost certainly because of Harrod's rediscovery of growth theory in the 1930s and his notable contributions to it that Assar Lindbeck, the Chairman of the Nobel Prize Committee, chose to state that he was among those who would have been awarded a Nobel Prize in economics if he had lived a little longer. The nature of Harrod's original contribution and the gradual evolution of his theory from 1939 to 1964 are set out in the second part of this article. The detailed technical characteristics of Harrod's growth model are the subject of Eltis (1987).

In the Second World War Harrod's friendship with Lindemann and his increasing distinction as an economist led to an invitation to join the Statistical Department of the Admiralty (S Branch) which Churchill set up when he again became First Lord in 1939. This moved to Downing Street when Churchill became Prime Minister in 1940, but Harrod did not have a particular talent for detailed statistical work and he developed an increasing interest in the international financial institutions, the International Monetary Fund and the World Bank, which would need to be set up as soon as the war was won, and from 1942 onwards he pursued this work in Christ Church. In the immediate post-war years he took a strong interest in national politics, and stood for Parliament unsuccessfully as a Liberal in the general election of 1945 and for a time he was a member of that party's Shadow Cabinet. He had served on Labour Party committees before the war, and in the 1950s with Churchill's support he unsuccessfully sought adoption as a Conservative parliamentary candidate: his economic advice was warmly welcomed by Harold Macmillan, Conservative Prime Minister in 1957–63. Harrod received the honour of knighthood in 1959 in recognition of his public standing and his notable academic achievements in the pre-war and post-war decades.

He had succeeded Keynes as editor of the *Economic Journal* in 1945, and in partnership with Austin Robinson (who looked after the book reviews) he sustained its reputation and quality until his retirement from the editorship in 1966.

His own post-war academic work included important contributions in three areas. In addition to the continuing development and refinement of his pre-war work on dynamic theory, he published extensively on the theory of the firm and on international monetary theory which had been his particular concern during the war.

The Oxford Economists' Research Group had begun to meet prominent British industrialists before the war. A group of Oxford economists which generally included Harrod invited individual industrialists to dine in Oxford, and after dinner they were questioned extensively on the considerations which actually influenced their decisions. This led to the publication of a number of much cited articles and the book, *Oxford Studies in the Price Mechanism* (Wilson and Andrews, 1951) to which Harrod himself did not contribute. Propositions which emanated from these dinners included the notion that businessmen took little account of the rate of interest in their investment decisions, and that they did not seek to profit maximize, but priced instead by adding a margin they considered satisfactory to their average or 'full' costs of production. In his important articles, 'Price and Cost in Entrepreneurs' Policy' (1939b) and 'Theories of Imperfect Competition Revised' (1952a), Harrod set out a theoretical account of how firms price in which industrialists follow something like these procedures. Their object is especially to achieve a high market share, and by setting prices low enough to deter new entry they actually succeed in maximizing their long-run profits and avoid the excess capacity that Chamberlin and Joan Robinson had considered an inevitable consequence of monopolistic or imperfect competition. This attempt to reconcile the 'rules of thumb' that the businessmen revealed with the propositions of traditional theory was more highly regarded outside Oxford than some of the books and articles in the new tradition.

His work on the world's international monetary problems occupied a good deal of his time and attention in the post-war decades. Keynes himself had considered the breakdown in international monetary relations a crucial element in the collapse of effective demand in so many countries in the 1930s, and he devoted much of the last years of his life to the creation of new institutions which would avoid a repetition of these disasters. Harrod believed he was continuing this vital work when he devoted much thought and energy to these questions. He arrived at the conclusion that there was bound to be some inflation in a world which was successfully pursuing Keynesian policies, and that the liquidity base of the world's financial system was bound to become inadequate if the price of gold failed to rise with other prices. He believed that underlying world liquidity which rested on gold in the last resort must be allowed to rise in line with the international demand for money. He therefore came to focus on the price of gold, and in his book, *Reforming the World's Money* (1965), he proposed that a substantial increase in the price of gold would be needed if subsequent international monetary crises were to be avoided. Harry Johnson (1970) has summarized his contribution to this debate.

Harrod took a great interest in actual developments in the United Kingdom economy, and published seven books and collections of articles in the first two post-war decades which were directly concerned with the policies Britain should follow. There was in addition an immense range of articles in the academic journals, the bank reviews and the press on these questions, not to mention monthly stockbrokers' letters for Phillips and Drew. Harrod argued strongly and powerfully that nothing was to be gained by running the economy below full employment, which meant an unemployment rate of less than two per cent in the 1950s and the 1960s. In the late 1950s he was deeply concerned that the removal of import controls would render it increasingly difficult for Britain to pursue such Keynesian policies, and he was a vigorous opponent of European Common Market entry. He attached more significance than some distinguished Keynesians to holding down inflation but he published statistics in *Towards a New Economic Policy* (1967a) to show that in Britain this had tended to be faster when the economy was in recession than when output was allowed to expand. He argued therefore that deflationary policies could play no useful role in policies to control the rate of cost inflation, which he considered the essential element in inflation in Britain. Policy swung sharply away from this Keynesian tradition in the last years of his life, and he wrote a final letter to *The Times* on 21 July 1976 in which he praised the economics of Tony Benn and Peter Shore for their opposition to the Labour government's public expenditure cuts, for, 'To cut public spending when there is an undesirably high rate of unemployment is crazy'.

His advocacy of import controls and his adverse reaction to deflationary policies at all times might suggest that he was an economist of the Left, but his willingness to support each of the British political parties at various times underlines how his approach to economic and social problems cannot be typecast. The lines of policy he supported always followed directly from his understanding of the significance of the major interrelationships, and it was his belief that Keynesian theory (which he had so notably helped to refine and develop) provided the appropriate tools for the analysis of Britain's economic problems that led him towards the expansionist policies he so consistently advocated. But further theoretical and empirical relationships which he believed were equally well founded led him to advocate a series of social policies to which very right-wing labels can be attached.

Just before the 1959 election his article, 'Why I Shall Vote Conservative', in *The Sunday Times*, put forward the startlingly unfashionable argument that only the Conservatives would allow more money to go to the better off who had most to contribute to the future of Britain. Harrod's strong belief in the importance of the *quality* of the country's population stock (which, he held, mattered no less than the physical capital stock) lay behind this article. Harrod thought the quality of the population would be bound to deteriorate if the middle classes continued to have fewer children than the poor. He was a strong believer in the inheritance of every kind of ability, and a provocative conversational conclusion he drew was that in an ideal world one-third of Christ Church's much sought-after undergraduate places should be sold to the rich. Their children often had insufficient academic ability to perform well in examinations, but they had inherited abilities of other kinds which would take them to the highest positions, so they should go to Oxford first. Harrod's reasoning on the inheritance of ability and its implications is set out in detail in the Memorandum he submitted to the Royal Commission on Population in 1944. There he suggested that a difficulty in finding servants was one reason why the middle classes had fewer children. Among his suggestions to remedy this state of affairs was that Diplomas in Domestic Service should be established, and that it should become common practice for servants to have latch-keys and the same rights as their mistresses to enjoy social lives with no questions asked. His Memorandum reads strangely nowadays when it is widely regarded as unacceptable that any practical conclusions may be drawn from the proposition that human abilities are inherited. Harrod never hesitated to carry his arguments to their limits, and he always went where his reasoning took him, irrespective of the predictable reactions of others.

The unselfconsciousness of both his academic and his public writing comes out especially in his two biographical volumes, the official life of Keynes (commissioned by the executors) which he published in 1951 and *The Prof* (1959a), his personal sketch of Lord Cherwell. As well as providing magnificent accounts of their subjects from the standpoint of one who had known them intimately (and who profoundly understood the economic problems Keynes wrestled with), these books contain extensive autobiographical passages which will enable later generations to know more of Harrod than any biographer can begin to convey.

He ceased to lecture in Oxford in 1967 upon reaching the statutory retirement age of 67, but as a Visiting

Professor he continued to teach in several distinguished North American Universities. He died in his Norfolk home in 1978 eleven years after his Oxford work came to an end.

Harrod's revival of growth theory and his contribution to Keynesian macroeconomics

Harrod was intimately involved in the origins and development of Keynesian economics. As the galley proofs of the *General Theory* emerged from the printers from June 1935 onwards, copies were sent to Harrod, to Kahn and to Joan Robinson and with their assistance, Keynes rewrote extensively for final publication. Harrod helped to clarify the relationship between Keynes's new theory of the rate of interest and the then ruling neoclassical theory where this depended upon the intersection of *ex ante* saving and investment schedules. In the course of their correspondence, Harrod showed Keynes how well he understood the essence of the *General Theory* by setting out its novelty and its principal elements in ten lines on 30 August 1935:

Your view, as I understand it is broadly this:-

Volume of investment determined by	marginal efficiency of capital schedule; rate of interest
Rate of investment determined by	liquidity preference schedule; quantity of money
Volume of employment determined by	volume of investment; multiplier
Value of multiplier determined by	propensity to save

Keynes responded, 'I absolve you completely of misunderstanding my theory. It could not be stated better than on the first page of your letter.'

Almost immediately after the appearance of the *General Theory*, Harrod published *The Trade Cycle* (1936a) which contained for the first time in the Keynesian literature the concept of an economy growing at a steady rate. Keynes wrote of it to Joan Robinson on 25 March 1937, 'I think he has got hold of some good and important ideas. But, if I am right, there is one fatal mistake', and to Harrod himself on March 31, 'I think that your theory in the form in which you finally enunciate it is not correct, being fatally affected by a logical slip in the argument.' Harrod replied devastatingly on April 6th, 'There is no slip ... The fact is that you in your criticism are still thinking of once over changes and that is what I regard as a static problem. My technique relates to steady growth.' Harrod's slip was in fact the first step towards the reinstatement of growth theory into mainstream economic analysis.

Harrod convinced Keynes, who on 12 April congratulated him for 'having invented so interesting a theory', but with the reservation, 'I should doubt whether any reader who has not talked or corresponded with you could be aware that the whole of the last half of the book was intended to be in relation to a moving base of steady progress.' Keynes added that it was vital that Harrod carry his ideas further and restate them more comprehensibly.

Harrod made important progress in the next 15 months, and on 3 August 1938 he sent Keynes a preliminary draft of the article, 'An Essay in Dynamic Theory', and wrote in his accompanying letter,

> my re-statement of the dynamic theory ... is, I think, a great improvement on my book ... I have been throwing out hints in a number of places of the possibility of formulating a simple law of growth and I want to substantiate the claim. It is largely based on the ideas of the general theory of employment; but I think it gets us a step forward.

A lengthy correspondence then developed between Harrod and Keynes in which the two most original elements in Harrod's contribution which later excited much interest and controversy in the economics profession were extensively discussed.

Harrod's principal innovation was the invention of a *moving equilibrium growth path* for the economy, and he described this as the 'warranted' line of growth. Harrod had perceived before he wrote *The Trade Cycle* that there was a fundamental contradiction between the assumptions prevalent in the microeconomic theory of the firm and industry, to which he had made notable contributions, and the new Keynesian macroeconomics. In the theory of the firm, long-term investment was zero, for firms had no motivation to undertake further investment once they were in long-period equilibrium. But the new Keynesian macroeconomics required that there be net investment by firms or the government whenever there was any net saving in the macroeconomy. A theory compatible with both macro and microeconomic equilibrium therefore required that firms invest all the time, so that they can continually absorb total net saving. Harrod's formulation of the warranted rate of growth, his novel discovery, was an attempt to set out this necessary equilibrium growth path that industrial and commercial investment decisions must all the time follow in order to achieve a complete economic equilibrium.

Harrod's moving equilibrium or warranted growth path required that saving (of s per cent of the national income) be continually absorbed into investment, so he asked the question: at what rate of growth will firms all the time choose to invest the s per cent of the national income, which equilibrium growth requires? To answer this question, he made use of the acceleration principle or 'the relation', as he called it, that firms need say C_r units of additional capital to produce an extra unit of output. It follows from these premises that the warranted rate of growth of output will be s/C_r per cent per annum. Since each rise in output by 1 unit entails that C_r extra units be invested, a rise in output by s/C_r per cent of the national income will call for an equilibrium investment of C_r times this, which is precisely s per cent of the national income, the ratio of *ex ante* saving in the national income. In Harrod's examples at this time, he suggested a typical s of 10 per cent of the national income and a C_r of 4, to produce a warranted rate of growth of 2.5 per cent.

This idea that if there is continual saving, then equilibrium entails a continual geometric growth in production came as a considerable surprise to Keynes and the other members of the 'circus'. As Harrod had already explained in April 1937,

> The static system provides an analysis of what happens where there is no increase [in output] which entails (as in Joan Robinson's long-period analysis) that saving = 0. Now I was on the lookout for a steady rate of advance, in which the rates of increase would be mutually consistent.

But Harrod's second discovery had equally radical implications. Suppose the actual growth of output is marginally above the equilibrium or warranted rate of growth. In Harrod's numerical example with s 10 per cent and C_r 4, it can be supposed that output actually grows 0.1 per cent faster than the warranted rate, that is by 2.6 per cent instead of 2.5 per cent. Then with 2.6 per cent output growth, the acceleration principle or relation will entail that 4 times 2.6 per cent be added to the capital stock, so that *ex ante* investment is 10.4 per cent of the national income. With *ex ante* saving limited to 10.0 per cent, the 0.1 per cent excess of actual growth over warranted growth then produces an excess in *ex ante* investment over *ex ante* saving of 0.4 per cent of the national income. Any excess in *ex ante* investment over *ex ante* saving will be associated with extra expansion of the national income according to the economics of the *General Theory.* Thus, if the actual rate of growth exceeds the warranted rate of s/C_r per cent, the tendency will be for actual growth to rise and rise, for as soon as actual growth rises from 2.6 to say 3 per cent, required investment will rise further to 4 times 3 per cent which equals 12 per cent and so exceed the 10 per cent savings ratio by a still greater margin. Conversely, when actual growth comes out at a rate just short of the warranted 2.5 per cent, *ex ante* investment will be below the 10 per cent savings ratio, which will cause the rate of growth to decline. This second discovery, which became known as Harrod's knife-edge, was therefore that any rate of growth in excess of the equilibrium or warranted path he had discovered would set off a continual acceleration of growth, while any shortfall would set off deceleration. He wrote to Keynes of this discovery on 7 September 1938:

> If in static theory producers produce too little, they will be well satisfied with the price they get and feel happy; but this is not taken to be the *right* amount of output; they will be stimulated to produce more. The equilibrium output is taken to be that which *just* satisfies them and induces them to go on as before. Similarly the warranted rate [of growth] is that which just satisfies them and leaves them going on as before. The difference between the warranted rate and the old equilibrium (i.e. the difference between dynamic and static theory) is, in my view, that if they produce above the warranted rate, they will be more than satisfied and be stimulated, and conversely, while in the case of equilibrium in static conditions the opposite happens. The 'field' round the [static] equilibrium contains centripetal, that round the warranted centrifugal forces.

It took Keynes time to absorb Harrod's startling discovery. On 19 September he proposed a counter-example in which C_r was merely one-tenth, while s was also one-tenth. With this counter-example, a deviation of output by a small amount from the warranted path, say by δx, which would raise planned investment above the level at which it would otherwise be by $C_r\delta x$ would merely raise this by 0.10 δx, which would equal the rise in planned saving of $s\delta x$, which would also come to 0.10 δx, so there would be no tendency towards an explosive growth in effective demand. This would grow explosively if C_r was one-ninth (in which case planned investment would rise by 0.11 δx and saving by only 0.10 δx) but the further growth of output would be damped if C_r was merely one-eleventh, so, Keynes insisted, 'neutral, stable or unstable equilibrium' are equally likely.

Harrod protested on 22 September, 'it is absurd to suppose extra capital required [C_r] only $\frac{1}{10}$ of annual output, when the capital required in association with the pre-existent level of incomes in England today is 4 or 5 times annual output'. The probability that C_r would exceed s so that *ex ante* investment would rise by more than *ex ante* saving in order to produce instability was therefore overwhelming.

But several qualifications emerged. In comparing the increase in *ex ante* investment to the increase in *ex ante* saving following a small deviation of output from the warranted rate:

1. The relevant marginal capital coefficient (C_r) which determines how much planned investment will rise is the net new requirement of *induced* investment. In so far as investment decisions are autonomous of short-term fluctuations in output, the relevant C_r will be lower than the economy's overall capital output ratio.
2. The relevant coefficient which determines the increase in planned saving is the *marginal* and not the average propensity to save. Planned saving will rise more where output deviates upward from the warranted rate, the greater is the marginal propensity to save in relation to the average propensity.

The circumstances that could produce a stable upward deviation of growth from the warranted rate and the avoidance of Harrod's knife-edge are therefore a very high marginal propensity to save in combination with a situation where most investment is autonomous so that the induced investment coefficient, C_r, is considerably less than 1. In 'An Essay in Dynamic Theory', Harrod covered this possibility with the caveat, 'when long-range capital outlay is taken into account ... the attainment of a neutral or stable equilibrium of advance may not be altogether improbable in certain phases of the cycle'. The possibility he had in mind here is that in the early stages of a cyclical recovery there may be so much excess industrial capacity that C_r will be quite low for a time, and therefore quite possibly lower than the marginal propensity to save. But in general any deviation of growth from the warranted line of advance would raise *ex ante* investment by a greater margin than *ex ante* saving with the result that the rate of growth would deviate further.

In addition to establishing the existence of the warranted line of advance and its instability, Harrod had to define the equilibrium investment behaviour by businesses which would actually lead to expansion at the requisite rate. In his 1939 article he omitted to offer any behavioural rule but simply asserted that the warranted rate was 'that rate of growth which, if it occurs, will leave all parties satisfied that they have produced neither more nor less than the right amount'. That is no more than a description of equilibrium growth, and much the same can be said of his definition of the warranted rate in *Towards a Dynamic Economics* (1948a) as 'that over-all rate of advance which, if executed, will leave entrepreneurs in a state of mind in which they are prepared to carry on a similar advance'. It was only in the article 'Supplement on Dynamic Theory' (1952b) that Harrod arrived at a behavioural assumption that matched his algebraic formulation of the warranted rate:

> Let the representative entrepreneur on each occasion of giving an order repeat the amount contained in his order for the last equivalent period, adding thereto an order for an amount by which he judges his existing stock to be deficient, if he judges it to be deficient, or subtracting therefrom the amount by which he judges his stock to be redundant, if he does so judge it.

With that assumption an economy which once achieves growth at the warranted rate will sustain it, while any upward or downward deviations will lead to still greater deviations wherever C_r exceeds the marginal propensity to save.

But it emerged by 1964, when Harrod published 'Are Monetary and Fiscal Policies Enough?', that even that assumption fails to define growth at the warranted rate, for it must also be assumed that the representative entrepreneur will expand at a rate of precisely s/C_r when he judges his capital to be neither deficient nor redundant. This requires an expectation by the representative entrepreneur that his market will grow at a rate of precisely s/C_r. Hence the full requirement for growth along Harrod's warranted equilibrium path is that entrepreneurs expect growth at this rate and expand and continue to expand at that rate so long as their capital stock continues to grow in line with their market so that it is neither deficient nor redundant. They will of course increase their rate of expansion if their capital should prove deficient, and curtail it if part of their stock becomes redundant.

The warranted rate of growth and its instability were Harrod's great innovations. From 1939 onwards he contrasted this equilibrium rate with the natural rate of growth, 'the rate of advance which the increase of population and technological improvements allow', which was entirely independent of the warranted rate. Harrod defined the rate of technical progress more precisely in 1948 as the increase in labour productivity 'which, at a constant rate of interest, does not disturb the value of the capital coefficient'. This then entered the language of economics as Harrod-neutral technical progress, which, together with growth in the labour force, determines the natural rate of growth, that is, the rate at which output can actually be increased in the long run. This raised few theoretical problems in 1939, and there was nothing novel in the proposition that long-term growth must depend on the rate of increase of the labour force and technical progress. Keynes himself had said as much several years earlier in 'Economic Possibilities for our Grandchildren' (1930). But the contrast between this natural rate and Harrod's innovatory warranted rate offered entirely new insights.

If the warranted rate exceeds the feasible natural rate, the achievement of equilibrium growth must be impractical because the economy cannot continue to grow faster than the natural rate. It must deviate downwards from the warranted rate towards the natural rate far more than it deviates upwards with the result that 'we must expect the economy to be prevailingly depressed'. If the natural rate is greater, output will tend to deviate upwards towards the natural rate with the result that the economy should enjoy 'a recurrent tendency towards boom conditions'.

Keynes's own reaction to the dichotomy between the warranted and natural rates was characteristically (his letter to Harrod on 26 September 1938) that the warranted rate always exceeded the natural:

> In actual conditions ... I suspect the difficulty is, not that a rate in excess of the warranted is unstable, but that the warranted rate itself is so high that with private risk-taking no one dares to attain it ...
>
> I doubt if, in fact, the warranted rate – let alone an unstable excess beyond the warranted – has ever been reached in USA and UK since the war, except perhaps in 1920 in UK and 1928 in USA. With a stationary population, peace and unequal incomes, the warranted rate sets a pace which a private risk-taking economy cannot normally reach and can never maintain.

That is characteristic Keynes, but Harrod had persuaded him to express his familiar analysis in the language of his new theory of growth. In the immediate post-war decades when full employment and creeping inflation prevailed, it was widely argued that the natural rate had come to exceed the warranted. The richness of Harrod's model is demonstrated by its ability to illuminate both kinds of situation.

Evsey Domar's growth model which has a good deal in common with Harrod's was published seven years after 'An Essay in Dynamic Theory', and a considerable literature emerged in the next 15 years on the stability conditions and other important features of what came to be known as the Harrod–Domar growth model. This is elegantly summarized by Frank Hahn and Robin Matthews in their celebrated 1964 survey article.

The development of neoclassical growth theory in the 1950s led to an increasing realization that the warranted and natural growth rates could be equated by an appropriate rate of interest. If the warranted rate was excessive so that over-saving led to slump conditions, a lower interest rate which raised C_r sufficiently would bring it down to the natural rate. Conversely the inflationary pressures that resulted from an insufficient warranted rate would be eliminated if higher interest rates reduced C_r sufficiently. If the real rate of interest and C_r responded in this helpful way, s/C_r, the warranted rate could always be brought into equality with the natural rate.

Harrod's response included his 'Second Essay in Dynamic Theory' (1960a), a title which underlines its significance. He proposed that there was an optimum real rate of interest r_n which would maximize utility, with a value of G_p/e, G_p being the economy's long-term rate of growth of labour productivity and e the elasticity of the total utility derived from real per capita incomes with respect to increases in these. If a one per cent increase in real per capita incomes raises per capita utility 0.5 per cent, e will be 0.5, and r_n the optimum rate of interest which maximizes utility will be $G_p/0.5$, viz. twice the rate of growth of labour productivity. If the marginal utility of income does not fall at all as real per capita incomes rise, per capita utility will grow one per cent when incomes rise one per cent so that e is unity, and r_n equals G_p. The more steeply the marginal utility of incomes fall, the more e will fall below unity, and the more the optimum real rate of interest, G_p/e, will exceed the rate of growth of labour productivity.

If a society actually seeks to establish the optimum rate of interest determined in this kind of way, the value of C_r will depend upon this optimum rate of interest, so it will not also be possible to use the rate of interest to equate the natural and warranted rates of growth in the manner the neoclassical growth models of, for instance, Robert Solow (1956) and Trevor Swan (1956) propose. There will therefore still be difficulties because the warranted rate of growth with real interest rates at their optimum level will not in general be equal to the natural rate. Therefore, as Harrod suggested in the final articles he published in 1960 and 1964, governments will have to run persistent budget deficits or surpluses if they are to avoid the difficulties inherent in discrepancies between the natural and the warranted rates of growth.

So Harrod remained a convinced Keynesian who continued to believe that a long-term imbalance between saving, the main determinant of the warranted rate, and investment opportunity would call for persistent government intervention. When that approach to economic policy again becomes fashionable, economists may learn a good deal from Harrod's later articles which have not yet received the same attention from the economics profession as his seminal work in the 1930s and the 1940s.

WALTER ELTIS

Selected works

The 'Bibliography of the Works of Sir Roy Harrod', in *Induction, Growth and Trade: Essays in Honour of Sir Roy Harrod*, ed. W.A. Eltis, M.FG. Scott and J.N. Wolfe, Oxford: Oxford University Press, 1970, includes all the articles he published in books, journals and magazines from 1928 to 1969, and some of his most influential newspaper articles. The present list of selected works is confined to his books and academic articles in books and journals.

1930a. Notes on supply. *Economic Journal* 40, 232–41.

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