

# **Traverse Analysis: Progenitors and Pioneers**

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## **ABSTRACT**

Traverse analysis has two progenitors (David Ricardo, Karl Marx) and five pioneers: Michal Kalecki, Adolph Lowe, Joan Robinson, J.R. Hicks, and John Hicks. Defined as the dynamic disequilibrium adjustment-path that connects an initial with a different terminal state of economic growth, the traverse comes in four “flavours”. There are neoclassical (J.R. Hicks), neo-Austrian (John Hicks), observed (Ricardo, Marx, Kalecki, Robinson), and instrumental (Lowe) traverses. These terms are explained and the seven seminal contributions are summarised and commented upon in this paper.

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## Introduction

Nobel laureate economist Robert Solow once quipped: “The traverse is the easiest part of skiing but the most difficult part of economics”. Later, Joseph Halevi and Peter Kriesler (1992, p 225) complained that “The traverse is at the same time one of the most important concepts in economic theory, and also one of the most neglected.” This paper outlines briefly the history of economic thought between 1821 and 1973 concerning this difficult, important and neglected theoretical construct.

Traverse analysis has two progenitors (David Ricardo, Karl Marx) and five pioneers: Michal Kalecki, Adolph Lowe, Joan Robinson, J.R. Hicks, and John Hicks. Defined as the dynamic disequilibrium adjustment-path that connects an initial with a different terminal state of economic growth, the traverse comes in four “flavours”. There are neoclassical (J.R. Hicks), neo-Austrian (John Hicks), observed (Ricardo, Marx, Kalecki, Robinson), and instrumental (Lowe) traverses. These terms are explained and the seven seminal contributions are summarised and commented upon in this paper.

Ricardo and Marx are first identified as the original progenitors of the traverse concept. Next, the work of those pioneers who did most to convince the economics discipline of its importance for dynamic analysis is discussed, viz. the contributions of Kalecki, Lowe, Robinson, J.R. Hicks, and John Hicks<sup>1</sup>. Finally, this excursion into the history of economic thought is used to isolate four separate definitions of the traverse: the neo-Austrian, neoclassical, instrumental, and observed traverses, of which the last is argued to be the most relevant. As an afterthought, it is conjectured that there may exist a vast trove of misrecognised traverse analyses, a “hidden literature” treating this dynamic disequilibrium process in a translucent, implied or even opaque, fashion. If this conjecture proves accurate, there is much scope for historians of economic thought to carry out research into the way economists have handled what we now recognise as traverse processes.

## Two Progenitors

In 1821 Ricardo (1817) analysed the dynamic process of machines-labour substitution in Chapter 31 – On Machinery, which he added to the third edition of his *Principles of Political Economy and Taxation*. This was a recantation of Ricardo's previous belief that the process benefited all classes of society. "I am convinced", he wrote in the new chapter, "that the substitution of machinery for human labour, is often very injurious to the interests of the class of labourers" (p 388). Ricardo's traverse analysis showed that his previous belief remained true, but *only* as a long-term proposition. In the short to medium term, he demonstrated, the working class would have to endure *transitional* unemployment as machinery displaced labour.

In 1885 an "embryonic consideration" of traverse phenomena appeared in Volume II of *Capital* by Marx (1885). Halevi & Kriesler (1998) note that Marx analysed "... the nature of the flows between the capital goods producing sectors and the consumption goods producing sectors ... In order to avoid disproportionality crises, Marx showed that certain conditions must be fulfilled by these flows. However, he also concluded that the satisfaction of these conditions was extremely unlikely in a capitalist economy ... this prepared the space for the analysis by Lowe and Hicks of the structural traverse ..." (p 1). With their neo-Marxian credentials and mutual respect, it can be said that Kalecki and Robinson also occupied this prepared space.

On their respective publication dates, Ricardo's chapter and Marx's volume each created a furore among economists. Gregory Claeys & Prue Kerr (1981) mention that "McCulloch was particularly angry, and wrote to Ricardo 'the Chapter on Machinery ... is a very material deduction from the value of the work' ... He had been convinced previously to change his own views by Ricardo's initial arguments for the benefits of machinery." (p 254, n1). As early as 1886 there were attacks on Volume II of *Capital* by Wilhelm Lexis and Achille Loria.

## David Ricardo

Ricardo's historical-time traverse analysis pivots on two *fulcra*. The first is his distinction between a £15,000 gross and a £2,000 net produce of a business enterprise, the £13,000 difference being the

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<sup>1</sup> According to John Hicks (1975, p 365), he disowned his original identity (as the neoclassical economist, "J.R. Hicks") by publishing Hicks (1969), *A Theory of Economic History*. See also Hicks (1979).

capitalist's "wage fund". The second is the power of saving = investment from an increasing net produce (i.e. classical "commodity surplus") to add to the circulating capital of the enterprise (p 388).

A capitalist we will suppose employs a capital of the value of 20,000*l.* and that he carries on the joint business of a farmer, and a manufacturer of necessaries. We will further suppose, that 7000*l.* of this capital is invested in fixed capital, viz. in buildings, implements, &c. &c. and that the remaining 13,000*l.* is employed as circulating capital in the support of labour. Let us suppose, too, that profits are 10 per cent., and consequently that the capitalist's capital is every year put into its original state of efficiency, and yields a profit of 2000*l.*

Then, in the *opening* year of Ricardo's traverse, this capitalist diverts half his workforce to construct a £7,500 machine, so that only £7,500 worth of circulating capital is reproduced that year, of which £2,000 flows to him as his usual surplus. In the *following* year, therefore, his wage fund will be only £5,500 worth of wage-goods with which to offer employment. So he fires all the machine-builders and more than one-quarter of those who lately were producing "corn" and (other) "necessaries", i.e. wage-goods.

By utilising the highly-productive new machine, this drastically-reduced workforce thereafter annually turns out a gross produce of £7,500-plus, and the capitalist is content to receive at least his usual profit of £2,000, after replacing the £5,500-plus wage fund of circulating capital. In addition, the unit costs of production of these wage-goods – hence also their prices – will have fallen due to mechanisation of the production process for corn and necessaries.

Ricardo then generalises this labour-saving impact to the entire economy (p 390).

In this case, then, although the net produce will not be diminished in value, although its power of purchasing commodities may be greatly increased, the gross produce will have fallen from a value of 15,000*l.* to a value of 7500*l.*, and as the power of supporting a population, and employing labour, depends always on the gross produce of a nation, and not on its net produce, there will necessarily be a diminution in the demand for labour, population will become redundant, and the situation of the labouring classes will be that of distress and poverty.

After a few more years of transitional adjustment along the traverse-path, however, this situation will be ameliorated (and perhaps even corrected) because

... with the same wants he [the capitalist] would have increased means of saving, – increased facility of transferring revenue into capital. But with every increase of capital he would employ more labourers; and, therefore, a portion of the people thrown out of work in the first instance, would be subsequently employed; and if the increased production, in consequence of the employment of the machine, was so great as to afford, in the shape of net produce, as great a quantity of food and necessaries as existed before in the form of gross produce, there would be the same ability to employ the whole population, and, therefore, there would not necessarily be any redundancy of people.

As for the *duration* of this traverse, Ricardo said that “These savings, it must be remembered are annual, and must *soon* create a fund, much greater than the gross revenue, originally lost by the discovery of the machine, when the demand for labour will be as great as before ...” (p 396, italics added). Thus, the economy may successfully negotiate the traverse and “soon” return to its former stationary state.

This historic first-ever traverse analysis has all the right hallmarks. An initial dynamic equilibrium (a stationary state, in this case) is disturbed by a parameter-change. This sparks off a transitional disequilibrium adjustment-path which lasts for some years before a final state of dynamic equilibrium (also a stationary state) is successfully attained.

“On Machinery” was written less than five years after Britain’s parliament had despatched 12,000 soldiers to quell the machine-breaking activities of Luddite textile workers opposing the introduction of mechanical weaving looms. And in France, the original *saboteurs* had been casting their wooden clogs into the mechanisms of the new Jacquard looms. Given this political climate, it was courageous of Ricardo to publish his traverse analysis and to conclude “That the opinion entertained by the labouring class, that the employment of machinery is frequently detrimental to their interests, is not founded on prejudice and error, but is conformable to the correct principles of political economy.” (p 392). No subsequent study of the traverse has succeeded in undermining this firm conclusion.

## Karl Marx

Published in 1885, Volume II of *Capital* introduced the simple and expanded reproduction schemas of Marx (1885), which correspond to the classical stationary and steady states, respectively. In Part III – The Reproduction and Circulation of the Aggregate Social Capital, Marx addresses the problem of a lack of effective demand, which occurs whenever unemployment rises and the price of wage-goods falls. His model analyses real product flows between a capital-goods sector (Department I) and a consumption-goods sector (Department II), each using constant and variable capital to generate surplus value. Marx considers the conditions necessary for each sector to absorb its accumulation requirements, both from its own production and from that of the other sector, without any co-ordination imposed *except* that derived from the market.

The basic point of his model is to examine the conditions under which a capitalist economy can *grow* (expanded reproduction), without enduring crises of overproduction in either sector. Marx shows that the conditions necessary for such balanced growth are extremely restrictive and improbable, with the result being that overproduction *within* sectors is likely to generate structural imbalances in the flows *between* sectors.

According to Halevi & Kriesler (1998), the problem stems from the *dual* role of workers, as consumers of the output of the wage-goods sector *and* as a cost of production to both sectors, so that wages and profits are inversely related. This relationship, Marx believes, lies at the heart of capitalism and it provides an important obstacle to balanced growth, as it necessitates an increase in workers' powers of consumption that is antagonistic to capitalist class interests. As a result, the problem of unbalanced intersectoral flows will spread to the whole economy, resulting in a fall in investment, which will cause an increase in unemployment. Marx (pp 614-5) states that

[As] things actually are, the replacement of the capitals invested in production depends to a large extent on the consumption capacity of the non-productive classes; while the consumption capacity of workers is restricted partly by the laws governing wages and partly by the fact that they are employed only as long as they can be employed at a profit for the capitalist class. The ultimate reason for all real crises always remains the poverty and restricted consumption of the masses, in the face of the drive of capitalist production to develop the productive forces as if only the absolute consumption capacity of society set a limit to them.

It is here, when the initial crises caused by a skewed sectoral structure spread to become a general “underconsumption” problem, that the link between disproportionalities and effective demand comes into its own. In other words, the Marxian reproduction schemas do not show the actual conditions of capitalist economies; rather, Marx uses them to investigate the conditions under which such economies could grow without crises, in much the same way as in the Harrod-Domar growth model.

Having done this, the next stage might appropriately have been an analysis of what happens *outside* the steady state. Instead, Marx truncated his analysis precisely where Hicks, Robinson, Lowe, and Kalecki started theirs. Given the difficulty of growth without structural problems, the next step could have been a traverse analysis, to see how the capitalist economy will *respond* to these crises of disproportionality and underconsumption. Instead, Volume III abandons the sectoral approach of the reproduction schemas and so the opportunity was lost, according to Halevi & Kriesler.

### **Five Pioneers**

The 1929-34 Great Depression inspired, *inter alia*, John Maynard Keynes’s *Treatise on Money* (1930), Robinson’s *Economics of Imperfect Competition* (1933) and Keynes’s *General Theory* (1936), plus comparable demonstrations of the effective demand principle by Kalecki (1933) and Myrdal (1939, first published 1931). This massive “shock” or “disturbance” also was the “impulse” or “perturbation” that stimulated a fresh approach to the problem of structural traverse by Kalecki (early 1930s), who was followed by Lowe (1950s decade), Robinson (mid-1950s), J.R. Hicks (mid-1960s), and John Hicks (early 1970s). Their pioneering contributions are outlined below.

#### Michal Kalecki

Early in the 1930s decade, Kalecki published the first of a long series of macroeconomic models of endogenous cycles, distribution and growth, in which all three outcomes are driven by one strategic variable: the investment aggregate. Investment has no less than four separate effects within uncontrolled pure capitalist economies, viz. it increases productive capacity, raises aggregate demand, incorporates technical progress, and its trend-plus-fluctuations drive cycles, distribution and growth.

Steindl (1981, p 125) has rationalised Kalecki's impressive *oeuvre* into three underlying "versions". Courvisanos (1996, p 14) explains that

Version I dates from an original Polish monograph (Kalecki, 1933) with two abbreviated English journal articles (Kalecki, 1935; 1937). This version has an undamped endogenous business cycle, criticised mathematically by Frisch and Holme (1935). Version II dates from Kalecki (1943) and was revised in 1954. This version maintains a linear equation. It has a damped business cycle which eventually requires a random shock to oscillate ... in the manner of a pendulum (Goodwin, 1964, p 421). Version III from Kalecki (1968) also has a linear damped business cycle, but allows for greater fluctuations as it concentrates on the profitability of new capital stock. In this way, it incorporates technical progress with a trend above cyclical oscillations.

Courvisanos (p 51) goes on to explain how "Kalecki never formally embraced the concept of the traverse in any of his work, but in three respects it is implicit in Kalecki's ... investment theories." The first aspect of his implicit traverse is the *production lag* which, in all versions, is a parameter of the investment function representing time elapsed between the decision to invest and the consequent deliveries of newly-produced capital goods. It makes its first appearance in Kalecki (1933) and figures in both subsequent versions

The second aspect of the implicit traverse concerns the long-period *path of economic growth*, which Kalecki (also Lowe and Robinson, see below) always viewed as no more than a slowly-changing component of the chain or sequence of short-period situations. Kalecki uses a short-period or sequential approach to permit specificity of capital goods, making the new vintages more productive than the old, thus capturing higher profit rates for the former.

The third aspect of the implicit traverse is the *shiftability of capital goods*, which Kalecki (1969, first published 1963) introduced to permit investment to increase without having to expand the capital-goods sector more rapidly than the economy's total productive capacity. Two shiftability factors can ameliorate this situation, however: changing the way some equipment is used (e.g. turning plant used for manufacturing consumer durables towards the production of machinery) and raising machinery imports (by cutting back on consumer-goods imports and/or increasing exports of such goods).



Kalecki had no need for an *explicit* traverse concept because, for him, the economy effectively was *always* in traverse! He knew that the fully-adjusted stationary state, steady state and regularly cycling time-paths, although important theoretical constructs, are almost never observed in any real-world economy. This Kaleckian viewpoint implies that fresh traverses continually modify earlier, uncompleted, traverses. If only for taxonomic purposes, however, a formal definition of Kalecki's implicit "observed traverse" is required, and this is provided below, after the work of his four fellow pioneers has been outlined.

### Adolph Lowe

Throughout the 1950s decade, Lowe developed his analysis of traverse processes by building upon the structural economics and business cycles work of the Kiel Institute of World Economics, which he had directed from 1926 to 1931. The relevant papers are Lowe (1951, 1952, 1954, 1955, 1959). This line of development culminated in *The Path of Economic Growth* (Lowe, 1976), which contains the fullest statement of his unique and highly original "instrumental traverse" concept, a melding of positive with normative economics that has significant policy-relevance.

Lowe's positive view of the *observed* path of economic growth (p 10) is identical with that of Kalecki and Robinson.

... what in retrospect appears as a secular process is, in fact, an abstraction derived from a sequence of short-term movements, the latter being the only "real" processes. We have long been accustomed to this kind of reasoning in statistical trend analysis. It is time to realize that it applies with equal force to the theoretical treatment of growth.

He expands on this in a footnote (p 10, n11), which is worth quoting *verbatim* and in full.

I have stated this position originally in the Introduction to my paper on "Structural Analysis of Real Capital Formation," in *Capital Formation and Economic Growth*, Princeton, 1955, pp. 581-634, especially Section 4. In the meantime, I received the valuable support of Michal Kalecki in his *Selected Essays on the Dynamics of the Capitalist Economy*, Cambridge (England), 1971, p. 165: "In fact, the long-run trend is but a slowly changing component of a chain of short-period situations; it has no independent entity ..." The significance of these short-term processes for a theory of economic growth has been implicitly recognized in Joan Robinson, *The Accumulation of Capital*, London, 1956, Book III, and in Hicks, *loc. cit.*, Ch. XVI, in which he discusses the intermediate processes

required to achieve a change in the rate of growth under the heading of “traverse” – a suggestive term which we shall adopt. See also John Hicks, *Capital and Time*, Oxford, 1973, Chs. VII-XII.

Lowe accepts the “circular and horizontal” schemas of simple and expanded reproduction, but he divides Marx’s Department I (capital-goods) into Department Ia (machine-tools) and Department Ib (all other capital equipment). Department II (consumption-goods) produces wage-goods with the aid of capital equipment purchased from Department Ib. The machine-tools sector is of strategic importance, having the singular ability to initiate and sustain a circular production process of its own. His preferred analogy, which likens the machine-tools of an industrial economy to the “seedcorn” sustaining circular reproduction within an agricultural economy, sits well with this thesis.

In Lowe (1965), he reminisces that a study of bread production had shown “... seed-wheat as an input is capable of producing two types of outputs: bread-wheat as a potential consumer good and seed-wheat as its own replacement good”. There followed an intuitive leap which solved the seeming paradox of infinite regress in the replacement of fixed capital, one which Austrian economists had papered over by positing original inputs of labour and land only. Searching for a special capital good that was capable of producing other capital goods, as well as reproducing itself, Lowe found “... not one such mechanical instrument, but a comprehensive group which is defined as machine tools ... They play the same strategic role as seed-wheat plays in agriculture.” (pp 269-70).

Following the lead of his former Kiel Institute student, Fritz Burchardt (1931-2), Lowe also incorporates the “linear and vertical” schema of Böhm-Bawerk’s Austrian “stages of production” into his treatment of industrial structure. This means that his theoretical models also keep track of (a) the absorption within Department I of raw materials plus semi-finished capital goods and (b) the flows of finished capital-goods from Department Ib to Department II.

Sectoring of the industrial structure along its Marxian horizontally-integrated “width” dimension is complemented by adding an Austrian vertically-integrated “depth” dimension, to highlight the significance of working capital embodied in work-in-progress. Furthermore, while the Marxian analysis relates essentially to flows, Lowe explicitly includes their associated stock variables, which become especially significant when capital accumulation and other changes are to be analysed. As

with Marx, the starting point of his analysis is the stationary state of zero growth. His model makes explicit the relevant stock-flow interactions involved in these changes and the adjustment processes (i.e. traverses) which they generate in restoring the stationary conditions.

It was in Lowe (1952) that his viewpoint began to move towards *normative* economics. Society should not necessarily accept a given structure of production and endure the inevitable traverses, but might democratically decide to control them. The division of net investment between the three sectors affects the overall growth rate. Then the “productivity of investment” (reciprocal of the marginal capital-output ratio) determines employment and output by interacting with the volume of investment allocated to both parts of Department I. Lowe’s structural analysis inspired the similar corn-tractors models of economic planning by Mahalanobis (1953, 1955), Dobb (1955, 1960), Sen (1960), Raj & Sen (1961), Naqvi (1963), Mathur (1965), and Ishikawa (1967).

Too heavy a concentration of investment in the strategic machine-tool sector, rather than raising corn production after a short time-lag, can actually delay the increase in consumption unnecessarily. Making fewer tractors will certainly release resources for building extra machine-tools, but corn production cannot be increased without more tractors. A balance must be struck, so that Department Ia does not squeeze out Department Ib. Lowe also points out that the machine-tool sector is dependent on a balanced supply of intermediate inputs, which could slow its rate of growth for some time. Imports to supplement the domestic output of intermediate goods could, however, relieve such working-capital bottlenecks, at least for a time.

Eventually, in Lowe (1959), he gave precise expression to the possibility of an *instrumental analysis* of the traverse. By contrast with the deductive procedure of positive economic analysis – arguing “forward” from behavioural premises to terminal states – instrumental analysis resembles induction by searching “backward” for the determinants of given states. Except that the terminal states and processes are given by stipulation, rather than observation. He argues that the “invisible hand” of unfettered individualism cannot generate socially-optimal states unaided. Even if it could, it is only the *homo oeconomicus* assumption that decrees maximisation of the flow of consumer goods, or of the terminal capital stock (turnpike theory), to be the optimum that society always should aim for.

Therefore, Lowe calls for the deliberate “social engineering” of successful traverses to goal-states which have been selected in a democratic manner. Perhaps homeostatic processes assuring a traditional standard of living may be what the people really want from their economy? But, whatever society decides, it is the task of instrumental controls to achieve these aims with the help of deliberate measures of economic policy – a contrived system taking the place of a self-regulating one. These “carrot and stick” control measures should be designed to complement, not override, the behavioural-motivational patterns of economic agents.

### Joan Robinson

In the mid-1950s, Robinson (1956, pp 61-176) analysed “Accumulation in the Long Run” in Book II of *The Accumulation of Capital*. Therein, she describes the traverse as “The Process of Transition” (pp 140, 153, 168) between two “golden ages”, i.e. steady states of constant full-employment growth. She distinguishes between a *change* in historical time within the same economy and a *comparison* in logical time between different economies. The transition process belongs to the former category, and comparative dynamics to the latter.

Her first traverse analysis initially *compares* two economies (Alaph and Beth) offering the same money wage. Beth has higher profit margins and money prices (hence a lower real wage) due to, say, “monopolistic rings”. Alaph has the smaller investment (and the larger consumption) sector because “... we have caught them at a moment in their respective histories when the amount of employment is the same in both” (p 77). Hence its rates of capital accumulation, output growth and profit are all lower than in Beth. Two key assumptions are that both economies can draw on “unlimited supplies of labour”, as in the Lewis (1954) development model, and that there is a single fixed technique of production.

Robinson next supposes a *change* within the more competitive of these two economies: “... the Alaph entrepreneurs begin to form themselves into rings and raise prices” (p 77). She shows that this must lower demand (hence also employment) in the C-sector, then eventually in the I-sector, which supplies it with capital goods. A likely outcome is “... the ratio of accumulation to the stock of capital is now the same in Alaph as it was in Beth, but this ratio has become established by a

reduction in the stock of capital (and in the labour force) so that it now bears the low, Beth, ratio to the low, Alaph, level of accumulation” (p 78). On a brighter note, Robinson also refers to the possibility that “... if competition broke out in Beth, and gradually raised real wages there to the original Alaph level, a burst of extra accumulation (and immigration of labour) would establish the stock of capital at the high, Alaph, ratio to the high, Beth, rate of accumulation” (p 78).

Thereafter, she progressively drops the two key assumptions and analyses *changes* (within the same economy) that spark off traverses, starting from situations of labour surplus, which lowers the money wage (p 78); labour scarcity, which raises the money wage (p 80); and also “... (1) the rate of technical progress alters unexpectedly; (2) the competitive mechanism becomes clogged; (3) accumulation tends to vary relatively to the rate of increase of productivity; (4) technical progress fails to be spread evenly throughout the system” (p 89).

Following an interlude (pp 101-38) of *comparisons* (between different economies) concerning choice of technique, degree of mechanisation and measurement of capital<sup>2</sup>, Robinson (p 139) returns to traverse analysis with this observation: “A change in the position of the mechanisation frontier in one economy is quite another story. It is an event taking place in time. It involves a change in the rate of profit and a revision of expectations.”

This time she examines the effects of a labour shortage raising (p 140 *et seq*), and a labour surplus lowering (p 153 *et seq*), the “real-capital ratio”, which is “The ratio of capital measured in terms of labour time to the amount of labour currently employed when it is working at normal capacity ... for this corresponds most closely to the conception of capital as a technical factor of production” (pp 122-3).

As a necessary preliminary, Robinson (pp 139-40) makes several “Special Assumptions”, which are designed

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<sup>2</sup> Together with Robinson’s (1953-4) article on the neoclassical production function, this interlude – which introduced the “Ruth Cohen Curiosum” (p 109) – ignited the long-running Cambridge controversies over capital theory, fully documented by Geoffrey Harcourt (1972, 1975).

... to make it possible to analyse the transition from one technique to another as though it took place without any disturbance to tranquillity. The argument, for this reason, is somewhat fanciful, but setting it out in this way enables us to see the workings of the mechanism, which are hard to follow in the hurly-burly of short-period disequilibrium in which it actually operates.<sup>3</sup>

After discussing shifts in the mechanisation frontier, she completes Book II by analysing those traverses set off by accumulation with neutral (pp 159-163) and biased (pp 164-72) technical progress – innovations that are both “capital-saving” and “capital-using”.

Although Robinson views Book II as “... the central part of the work” (p ix), the remainder of her *magnum opus* contains many more traverse analyses, in Books III – The Short Period through Book VIII – International Trade. She describes the long-period golden age as representing “... a mythical state of affairs not likely to obtain in any actual economy” (p 99) and goes on (p 181) to state that

In reality to-day is a break in time. Yesterday lies in the past, and has ceased to be relevant to what happens to-day, except in so far as experience of it colours expectations about what will happen next. To-morrow lies in the future and cannot be known. The short-period situation in existence to-day is like a geological fault; past and future developments are out of alignment. Only in the imagined conditions of a golden age do the strata run horizontally from yesterday to to-morrow without a break at to-day.

So, like Keynes, Kalecki and Lowe before her, Robinson reinforces the primacy of the Marshallian short period. Though not usually thought of in these terms, *The Accumulation of Capital* appears to be the most concentrated collection of traverse analyses in the history of economic thought. To Joan Robinson also, the uncontrolled pure capitalist economy was “always in traverse”.

### J.R. Hicks

In the mid-1960s, Hicks (1965, pp 183-197) introduced a “new” method of dynamic economic analysis in Part 2 – Growth Equilibrium of his seminal work, *Capital and Growth*. The final chapter of Part 2 is Chapter 16 – Traverse.

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<sup>3</sup> “We may speak of an economy in a state of *tranquillity* when it develops in a smooth regular manner without internal contradictions or external shocks, so that expectations based upon past experience are very confidently held, and are in fact constantly fulfilled and therefore renewed as time goes by.” (Robinson, 1956, p 59)

Part 1 – Methods of Dynamic Economics is designed “... to explain my own former work, even to myself”, in that Hicks (p 28) devotes nine of its 11 chapters to his three earlier dynamic methods: the Static method of *A Theory of Wages* (1932), the Temporary Equilibrium method of the dynamic parts of *Value and Capital* (1939) and the Fixprice method of *A Contribution to the Theory of the Trade Cycle* (1950). Part 3 – Optimum Growth presents a dynamic reconstruction of static welfare theory, based on his fourth, or Growth Equilibrium, method. Finally, Part 4 – After Growth Theory uses this “new” method to criticise Keynesian monetary theory and the neoclassical production function. The method, however, was already quite old.

The *annus mirabilis* of equilibrium growth theory was 1956, when the steady-state growth models of Joan Robinson, Robert Solow and Trevor Swan were first published. These economists themselves stood on the shoulders of Roy Harrod (1939) and Evsey Domar (1946), of course. Hicks (p vi) candidly admits that “... the earlier stages of the new developments (at the hands of Joan Robinson and Kaldor at the English Cambridge, of Samuelson and Solow at the American) rather passed me by.”

In *Capital and Growth*, Hicks (p 184) introduces his own concept of the dynamic disequilibrium adjustment path into mainstream economics and bestows the name “Traverse” upon it.

Suppose that we have an economy which has in the past been in equilibrium in one set of conditions; and then, at time 0, a new set of conditions is imposed; is it possible (or how is it possible) for the economy to get into the new equilibrium, which is appropriate to the new conditions? We do not greatly diminish the generality of our study of disequilibrium if we regard it in this way, as a Traverse from one path to another. And there is some advantage to be gained from greater specification of the initial position from which the Traverse takes off (that is what the point really is). Chiefly, it enables us to split up the kinds of adjustment that have to be made, so as to take different kinds separately.

Hicks (pp 184-185) first disposes of the Harrodian “knife-edge” problem. “If an economy has been in growth equilibrium at a particular growth rate, and is required to adjust to a different growth rate (maintaining full employment of labour), it cannot do so unless the propensity to save is varied, or the capital-output ratio is varied” – in response to an appropriate change in the rate of profit. After acknowledging the primacy of Kaldor’s (1957) flexible-saving solution, Hicks admits Solow’s

(1956) flexible-technology solution as a secondary influence. “Indeed, if *anything* emerges to change the overall propensity to save out of income, along any channel, the Harrod difficulty can be got over. And (of course) if the change in the growth rate affects the capital-output ratio in the right direction, that also will help.” So, a new equilibrium growth path *can* be defined. But the real question is: Can it be reached? Will the economy be able to “traverse from” its initial steady state and “converge upon” its final steady state of growth?

Throughout Part 2 – Growth Equilibrium, Hicks develops his two-sector model of a farm-factory economy which employs labour and “tractors” to produce “corn” and tractors, with technical coefficients of production that are *fixed* for each *sector*. However, the *overall* capital-labour ratio (K/L tractors/worker) is *variable* and obviously the variation will depend on the economy’s sectoral output composition.

In that model ... the equilibrium ratio of ‘tractors’ to labour depends upon the rate of growth; with given technique it depends upon the rate of growth only. Thus if, at time 0, the economy is in equilibrium with a growth rate  $g_0$ , it will have to have a capital-labour ratio that corresponds. Now if the rate of growth is changed (either upwards or downwards) and the technique is unchanged, the equilibrium tractor-labour ratio will be changed; so that the actual tractor-labour ratio, at time 0, will not be that which is appropriate to the new equilibrium.

Hicks then performs his historic First Traverse Analysis (FTA), which examines “... four cases: according as  $g$  rises or falls, and according as  $m >$  or  $< 1$ ” (p 186). Now  $g$  is the economy’s growth rate and  $m$  the *ratio* of its two fixed sectoral capital-labour ratios. This variable is the economy’s overall “relative degree of mechanisation”;  $m$  is a pure number that is formed by taking the tractor-labour ratio of the farm sector and dividing it by the tractor-labour ratio of the factory sector. So, if  $m > 1$  the corn sector must be more “mechanised” than the tractor sector.

Hicks next proceeds to prove algebraically that “It can in fact be shown that whether  $g$  rises or falls, there is a full-employment path to equilibrium, *provided that*  $m > 1$ . But if  $m < 1$  (if the factory is more mechanized than the farm) such a full-employment path does not exist” (p 186). This is his famous Capital Intensity Theorem, although it was not Hicks who discovered it. Ronald Findlay



(1963, p 6) first proved that the full-employment “state of bliss” in Joan Robinson’s (1956) *The Accumulation of Capital* could only be attained upon satisfaction of the Capital Intensity Theorem.

Hicks offers no opinion on how many years the economy might have to remain in traverse but, in his logical-time model, that is not the point. He simply is following the standard neoclassical methodology of deriving the “conditions” under which an equilibrium point or path will exhibit certain “properties”. Necessary and/or sufficient conditions for the four classic properties of existence, uniqueness, stability, and optimality already had been proved by others.<sup>4</sup> What Hicks successfully derives is a new condition ( $m > 1$ ) for a fifth property, one which might be termed the “traversibility” or “convergence” of an intertemporal Walrasian general equilibrium system.

This new (specifically dynamic) property of convergence or traversibility could be defined as: The ability of an economy to traverse from one equilibrium growth path to any other, while preserving equilibrium in the labour market – though not necessarily in the capital market. It is related to the stability property, which guarantees that temporary or accidental departures from the equilibrium path will not persist. Traversibility or convergence, however, guarantees that a structural change (such as faster workforce growth) will not prevent the economy from attaining the fresh dynamic equilibrium path which it entails.

Hicks had followed the “Cambridge controversies in the theory of capital”<sup>5</sup> closely. He knew that Cambridge, England had proved there is no such thing as a stock of “aggregate capital” that can be plugged into a neoclassical production function, in order to determine a marginal productivity of “capital”, equal to the economy-wide rate of profit (pp 190-1).

I do not believe (as I think that some economists believe) that the fixity of technique, under which we have been working, is the vital point. The big change occurs before we come to that – at the point where we abandon the single capital good. (It is not, or should not be, possible to deal with change of technique, except for comparative equilibrium purposes, before we have abandoned the single capital good ...)

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<sup>4</sup> Most notably by Walras in 1874 and by Malinvaud, Arrow, Debreu, and others during the 1950s.

<sup>5</sup> *Vide* Harcourt (1972)

In 1965, Hicks was still enough of a neoclassical to feel dissatisfied with the economy's capital stock being out of equilibrium (albeit converging upon it) along his traverse path. Hicks wanted "... idleness of capital ... to be kept as low as possible" (p 194), to complement the full-employment traversibility or convergence property he had already proved with his Capital Intensity Theorem.

So, Hicks spends the remainder of Chapter 16 – Traverse proposing two sources of "flexibility" that should keep this irritating "idleness of capital" to a bare minimum. He first introduces flexibility of production around some "normal" degree of capacity utilisation of his (formerly fixed-output) tractors, then opines (pp 194-5)

All this (as I think the reader will agree) does sound like sense – much more like sense than was the case with the 'simple' model with which we began this chapter. But (I expect he will be burning to ask) what about prices? ... Surely, however, we must say something about prices if we are to tell anything like a full story.

Therefore, he recommends a Flexprice policy on the part of business managers during the traverse. Hicks points out that "... the urgency in question is urgency in the breaking of bottlenecks. Flexibility along the Traverse is of major importance; an economy which insists upon making its transitions on a Fixprice basis is doing so with 'one hand tied behind its back'" (p 196). In his peroration, Hicks (p 197) reminds his readers that

It is a condition for the establishment of the new equilibrium that the right prices should be found – for without the establishment of the right prices the right techniques will not be selected. If it is not just a matter of the maintenance of the old prices, but of the finding of new prices, this (in turn) cannot be an easy matter. If unsuitable prices are adopted, and adhered to for long, unsuitable techniques will be adopted; the problem of getting into equilibrium will be further complicated, and the approach to equilibrium will be retarded.

He finishes the chapter, significantly, with the observation: "No wonder that there is a problem of business management!"

The Hicksian traverse differs greatly from those of his fellow pioneers and progenitors. For instance, it runs its course in logical (not historical) time and the world is assumed to be "ergodic". This means an equilibrium must exist "out there", the economy's only task being to locate a fresh dynamic path

and “manage” its way most efficiently towards this terminal steady state of growth. As noted above, what Hicks seemed to be working towards was a new “convergence” or “traversibility” property for neoclassical general equilibrium systems – one which would supplement the existence, uniqueness, stability, and optimality properties that already had been proved by other economists.

### John Hicks

Early in the 1970s decade, John Hicks (1970, 1973) introduced his “neo-Austrian” method of dynamic economic analysis, based on the vertically-integrated linear production metaphor. It is “... descended from the ‘Austrian’ theory of Böhm-Bawerk and Hayek – a theory which had gone out of fashion, because of an obstacle which appeared to confine it to particular and practically unimportant applications. By developing an idea that was already present in *Value and Capital*, I was able to show that this obstacle could be overcome. There was something to be made of an ‘Austrian’ theory after all.” (Hicks, 1965, p vi).

The “obstacle” he refers to is the Austrians’ inability to handle *fixed* capital. They analysed production using a dated linear sequence of “point inputs” of circulating or *working* capital to yield a single dated “point output” of consumer goods. By contrast, Hicks’s neo-Austrian approach (p 8) would “... use an elementary process that converts a sequence (or stream) of inputs into a sequence of outputs ... The former difficulty of dealing with fixed capital is wholly overcome.”

In this, his Second Traverse Analysis (STA), Hicks defines two alternative dynamic paths, viz. “full-employment” and “fixwage”. In each case, the “reference path” has a certain growth rate of “starts” of unit “elementary processes”, each yielding a standard basket of consumption goods by using labour for a short *construction*, then for a longer *utilisation*, period. Labour is the only factor of production. Capital equipment comprises intermediate goods produced as part of the process and cannot exist outside it.

Steady-state growth proceeds according to a demographic metaphor. The population of identical processes expands due to births exceeding deaths, i.e. process starts outweigh the number of processes reaching the end of their optimal service lives. Thus, in the steady state, a balanced age-distribution of live processes is maintained. But suddenly, at time  $t = 0$ , a new “forward-biased”

technique (using more construction but less utilisation labour) is invented and these “more mechanised” new processes begin to replace the less mechanised old processes throughout the model economy. Replacement can be *via* natural attrition and/or “truncation”, the premature scrapping of old processes because their internal rates of return (IRRs) or “yields” are less than those of the new processes.

Along the full-employment “actual path”, the real wage rate gradually rises with growth, while along the fixwage actual path, the workforce poses no constraint. The rate of new process starts depends on saving behaviour, supplemented by resources released *via* the truncation of old processes. Saving is governed by Hick’s “full performance” assumption: “extrawage consumption” (principally by capitalists) is a simple function of time, while workers consume all their income, and these demands precisely exhaust the economy’s available supply of consumption goods. With neither expected nor realised capital gains and losses along the traverse path affecting extrawage consumption, the labour market is likely to struggle towards its new equilibrium in a series of “jerks”.

Traverse begins with an “early phase” of old processes being wound down (or truncated) and new, more productive and profitable, ones entering the population of live processes. The “late phase” opens once all the old processes have been killed off, thanks to their relatively lower IRRs. The late phase ends once a final steady state (compatible with the innovation) has been attained.

As in Ricardo’s *On Machinery*, although the traverse initially is unfavourable to labour, its longer-term effects are likely to go the other way because the new steady-state path has greater expansionary potential. However, such steady states “... will be no more than a means to an end – to the study of an economy which is *not* expanding uniformly, an economy in which things actually happen.” (p 47). With these words, Hicks signalled that his interest had switched from the “neoclassical traverse” of *Capital and Growth* to the “neo-Austrian traverse” of *Capital and Time*.

### **Defining the Observed Traverse**

To John Hicks, the traverse is “neo-Austrian”. It comprises an historical-time disequilibrium adjustment-path that is sparked off by some technical process innovation which promises higher

yields (IRRs) to those entrepreneurs who choose to adopt it. The traverse *may* converge on a final steady-state growth path, but it is quite likely that the late phase never actually terminates. Thus, the “population” of live processes continues to feature some “mix” of the old and new technologies.

To J.R. Hicks, the traverse is “neoclassical”. It comprises the conceptual logical-time adjustment path that connects two steady-state growth equilibria, following some exogenous shock or impulse to the economy. His traverse *is* a genuine disequilibrium phenomenon but, as a true neoclassical, Hicks permits an *equilibrium traverse* to run its course, provided there is sufficient flexibility in quantities, prices, saving behaviour, or techniques of production.

To Lowe, the traverse is “instrumental”. It comprises the optimum historical-time adjustment path that a democratic society would choose to implement (*via* the deliberate exercise of economic policy), in order to absorb growth in its stock of labour and reach an economic goal-state that has been stipulated *via* democratic processes.

To both Kalecki and Robinson, the traverse is “observed”. It comprises the actual historical-time adjustment path traced out by a capitalist economy, as plotted by its statisticians. Disequilibrium states are so pervasive in Kalecki’s cycles, distribution and growth (CDG) models that one could even say “Life is a Traverse”, according to Peter Kreisler (1989, p 10).

Kalecki, Robinson and Lowe share much the same opinion concerning the effects of (uncontrolled) pure capitalism. Their particular traverse concepts only differ in that the first two economists use positive economics to *describe*, whereas the latter uses normative economics to *prescribe*. J.R. Hicks, on the other hand, had not yet renounced his neoclassical past, so his traverse not only leads to a final growth equilibrium, but may *itself* constitute an equilibrium path of adjustment!

As noted above, *Capital and Time* presents the Second Traverse Analysis of Hicks. When he published *Methods of Dynamic Economics*, John Hicks (1985, pp 144-4) finally disowned his First Traverse Analysis.

We had to suppose, when analysing a Traverse, that capital (tractors) could be transferred, in various quantities, from one ‘industry’ to another, between one period and the next. If the end of the one and the beginning of the other are simultaneous, the transfer must take place instantaneously. But that is quite hard to accept. (Marshall, assuredly, would not have let us have it.)

One gets no help ... from the celebrated device of von Neumann, according to which the whole of the terminal capital (of the period) is treated as output of the period, while the initial capital is treated as input. For it remains the case that it must be possible, at the join, for the capital to be reallocated. Von Neumann’s device is quite acceptable, and very useful, so long as we confine attention to equilibrium paths – in the sense of paths where the whole course of production, over many periods, is being planned at the start and is being carried through.

Having jettisoned his neoclassical traverse, Hicks even considers moving towards Lowe’s normative instrumentalism. He states that “Instantaneous reallocation may well be practicable if it is *planned* reallocation” (p 145, italics added) – only to immediately discard the instrumental traverse: “But this will not do for Traverse analysis, for the study of what happens when an equilibrium is disturbed.” This rejection by Hicks of both the neoclassical and instrumental traverses makes unanimous the opinion in favour of the observed traverse (at least for *positive* economic analysis) among all seven pioneers and progenitors

Courvisanos (1996, p 67, fn 29) credits Allen Oakley (private communication) with coining this apposite term “observed traverse” which, broadly defined, is Kalecki’s “... dynamic (out of equilibrium) adjustment path in historical time”, according to Kriesler (1989, pp 1-2). As for what, precisely, the economy is always adjusting to, Kalecki’s voluminous writings most frequently point to changes in the powerful investment aggregate, which (on the supply side) embodies technical progress and determines productive capacity while (on the demand side) determining aggregate demand and driving cycles, distribution and growth.

In narrowing down Kriesler’s definition, Courvisanos (p 50) has written that

The traverse examines a sequence of irreversible events within the structure of production. When a change occurs (or is induced by policy) to alter the level of demand or supply in the economy at a macro level, there is a sequence of slowly evolving production decisions made by industries and firms in response to such changes. This production sequence is the [observed] traverse, or path of economic growth.

For abstract theoretical purposes, the Robinson-Kalecki observed traverse concept, in its broad and narrow definitions, can be simplified rigorously into:

That set of dynamic disequilibrium adjustment-paths traced out over historical time by all endogenously-driven economic variables, following perturbation of one or more structural parameters of an economy that initially was evolving in long-period stationary- or steady-state equilibrium.

The observed traverse tracks the path-dependent evolution of an initial stationary state into some final state, which may or may not have the same long-period equilibrium character. In the real world, of course, steady states are uncommon and stationary states even rarer. In the eyes of many post-classical and neo-Austrian economists, it seems that “Dynamic Disequilibrium Rules” and that, really, “Life is a Traverse”.

### **Afterthought: The Hidden Literature**

It is no accident that all but the first of our progenitors and pioneers of traverse analysis also developed theories of output fluctuations, cycles and crises. Such theories are to be found, *inter alia*, in Marx (1885), Kalecki (1933), Lowe (1926), Hicks (1950), and Robinson (1964, 1962). In terms of dynamic analysis, there exist close connections between the analysis of “CDG models” and the disequilibrium adjustment path that constitutes the traverse.

This connection is drawn out further in the following conjecture concerning the existence of a “hidden literature” on traverse phenomena. There also exists, it is conjectured, a vast trove of unrecognised traverse analyses, an “esoteric” or “hidden” literature which treats dynamic disequilibrium adjustment phenomena (possibly misrecognised) in a translucent, implied or even opaque, fashion.

Perhaps economic dynamicists have been “speaking prose all their lives”. The possibilities are legion: the “cumulative causation” processes of Knut Wicksell, Johan Akerman, Erik Lindahl, and Gunnar Myrdal; the increasing returns growth spiral of Adam Smith, Allyn Young and Nicholas Kaldor; the cobweb theorem explanation of the hog cycle; most early trade cycle theorists, as well as the

European inter-war business cycle theorists; Austrians like Friedrich von Hayek; Thorstein Veblen and Joseph Schumpeter; process analysts like Dennis Robertson, Knut Wicksell, Erick Lindahl, Bertil Ohlin, Gunnar Myrdal, and Mabel Timlin; Walter Rostow's process of "take-off into self-sustaining growth; the "unbalanced growth" development theorists, including Albert Hirschman; and Nicholas Kaldor.

To survey this putative *corpus* is beyond the scope of my paper, but it may represent an interesting research opportunity for specialist historians of economic thought.



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