RESTLESS CAPITALISM: INCREASING RETURNS AND GROWTH IN ENTERPRISE ECONOMIES

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ABSTRACT:

The purpose of this essay is to develop elements of an evolutionary theory of endogenous growth based on the twin principles of enterprise and market co-ordination. The central theme is the dependence of macroeconomic productivity growth on the microeconomic diversity of firm's behaviours and the resolution of this diversity into patterns of economic change through market processes. Growth rates are emergent phenomena, and growth rates depend on the transformation of the economy.

In the first half of the paper an evolutionary account of the market process and productivity growth rates is built around the idea of the technical progress function and micro diversity in rates of innovation and investment. Building upon Allyn Young's account of interdependence in productivity growth rates the paper then develops the rules for aggregating sectoral productivity change into a macroeconomic rate of productivity growth. The pattern of economic evolution is shown to depend upon the progress elasticities and the income elasticities of demand for the various sectors. This makes the productivity growth rates mutually dependent. The net outcome is that the economy wide rate of productivity growth increases with the aggregate growth rate of employment. The economy wide rate of growth is then established by co-ordination at the level of the capital market.

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INTRODUCTION

The purpose of this essay is to develop an evolutionary theory of economic growth based on the twin principles of enterprise and market co-ordination; principles which are core elements in an evolutionary theory of economic behaviour. In so doing, I intend to develop a theory of growth that reflects the principal features of knowledge-based capitalism. In the process I am also responding to the perceptive arguments of Nelson and Winter (1974) to the effect that explanations of macroeconomic growth grounded in technical progress should be built within frameworks of analysis that are compatible with the vast diversity of events and processes that characterise the innovation record. The essay reflects a long tradition of endogenous growth thinking, in which Schumpeter is the most obvious but not the only author of distinction. Here I shall press the claims of Allyn Young, and the heritage of Adam Smith on which he built, although the work of Kuznets (1954) and Burns (1938) are also very relevant to the arguments developed here. Harrod, also makes his appearance towards the end. Two questions frame the analysis. 'How does enterprise connect with economic growth?', and 'How can we construct theory that is grounded in the idea of enterprise and which captures the creative, adaptive element which is essential to all economic change?' Our answers rely upon a distinction between two evolutionary processes, selection and development, and their interaction. This leads us to a theory of growth premised on the market co-ordination of micro-diversity. Growth rates are emergent phenomena and the economy is never in equilibrium, in the sense that is usually taken in growth theory. Thus the framework presented here is quite different from those that treat growth as a macroeconomic phenomena in its entirety. The emphasis is correspondingly upon the competitive process not competitive equilibrium and a special role is played below by the hypothesis of increasing returns in relation to the growth of the firm and the consequential growth of productivity.

The starting point is that enterprise economies are inherently restless, they experience continual change in relation to the relative importance of different economic activities; they are never in a steady state of growth as this is usually conceived, because there are always reasons to promote change. In turn, their restless nature arises from two attributes of modern capitalism. The highly decentralized nature of creative, innovative activity and the localized conditions for the accumulation of knowledge mean that economic behaviours mutate and mutate unpredictably (Nelson, 1996). Neither investment nor innovation, nor indeed any aspect of enterprise, proceeds in entirely smooth, predictable ways, they are noisy determinants of economic growth. But this is not the aspect I will emphasise, important though it is in the broader context, and as the raison d'etre for stochastic modelling of growth processes. Rather my concern is with the second attribute of restless capitalism, namely the differential behaviour of economic agents. It is this microdiversity in behaviour which is the basis for a competitive process, for structural change and for economic growth. Capitalism is restless because of its unlimited capacity to generate new knowledge and new behaviours and it is this propensity for variation which makes it so dynamic, such that economies may be completely transformed in structure over relatively short periods of historical time. Every advance in knowledge creates the conditions for further advances; in the language of systems theory, economic growth is an autocatalytic process in which change begets change. But variety and change in variety alone is only part of the picture. Equally important is the co-ordination of variety by market institutions to determine how differences in behaviour are resolved into evolving patterns of economic activity. The growth consequences of novel behaviour are deeply dependent on the way in which economic activities are co-ordinated within market processes. We identify the constraining and shaping role of markets at three conceptual levels, within an industry, between industries and at the aggregate economy level;

the balance of saving with investment in the capital market. In this way we concentrate on the shifting balance of resource allocation which is essential for growth to occur. The idea of a steady-state growth of capitalism is, I am afraid, nonsense.

This essay has also been written explicitly to explore how an emphasis on enterprise might contribute to a more formal Schumpeterian account of the connection between economic evolution and economic growth. The underlying motivation is that any macroeconomic approach necessarily hides more than it illuminates about the process of knowledge-based growth in capitalist economies. We can certainly measure at the macro level but to do so inevitably hides the diversity of conditions upon which the growth of the system depends. Aggregate growth is an emergent property arising from the co-ordination of diverse micro behaviours, and it is through the interaction of the micro behaviours that the dynamics of change occur. This is not simply the point that aggregation obscures the transformation of economic structure as if it were a needless statistical complication in the analysis of growth. Rather it is the point that transformation is the way the economy responds to novelty in the form of innovation and to hide this is to hide from view the very process that explains the growth of productivity and output. Transformation in the form of structural change and the shifting balance of resource allocation and creation is the process of growth whether we look within industries or between industries. To put it differently the aggregate properties of the economic process depend on structure and they change with economic structure. Consequently, from a macro perspective we cannot confront two of the most important stylized facts of modern economic growth; namely, the wide micro diversity of efficiency across firms operating in the same sector and the ever present element of structural change over time (Kuznets, 1954, 1971, 1977). Nor can we confront the role of demand in shaping growth within and between industries. Indeed the chief distinguishing feature of the ideas developed below is their relation to differential growth not balanced, uniform growth. Moreover, the growth rates of firms differ not only because of differences in their enterprise characteristics but also because the consequential behaviours are co-ordinated by competitive market processes. Co-ordination is central to the understanding of growth but co-ordination is not equilibrium, it is order, and in knowledge-driven economies order is ever-changing (Loasby, 1999).

There is mounting evidence, based on longitudinal micro data sets, of the great diversity and persistence of productivity differences between firms and industries and of the consequence that changing patterns of resource allocation, within and between industries, play an important role in aggregate productivity growth (Foster et al., 1998; Bailey et al., 1992; Baldwin, 1995; Bartlesman and Doms, 2000). It is clear that this micro diversity cannot be represented as noise around a common productivity level and that there are likely to be a multiplicity of interacting factors that correlate with the dispersion of productivity and productivity change in plants, business units and firms, that Harberger (1998), for example refers to in terms of their one thousand and one causes.

It is a characteristic of the evolutionary approach that no formal role is given to the idea of optimizing behaviour as a heuristic device, and this requires some comment. It is, of course, taken for granted that individuals and firms seek to do the best they can in the circumstances they face. But what is best and what are the relevant circumstances are not always transparent (bounded rationality) and more fundamentally differ from firm to firm (creativity). It is the emphasis on different, individual behaviours that replaces the emphasis upon optimization and which is enshrined in the idea of diversity in behavioural rules (Nelson and Winter, 1982). Hence, the entire focus in this paper will be on firms where behaviour is rule governed and governed by different rules. Naturally, the consequences of changes in rules follow logically but that is not the primary focus. In particular, in the analysis of an enterprise economy, where the production methods are changing endogenously as an outcome of market processes, it is essential to recognize the local diversity in the conditions for the production of new productive knowledge across firms and sectors. Thus what it is important to abandon is not maximization, that is not the significant step, but rather the idea of uniform behaviour. Indeed, to invoke uniform behaviour in a world of innovation would involve an immediate contradiction with the facts. A world of 'representative' uniform agents is simply not the place to undertake any study of the accumulation of knowledge and its connection with economic growth. Once uniformity is abandoned the consequence is profound. For what is now to be meant by representative behaviour (mean, median, mode or whatever) cannot be determined a priori, rather it is an outcome of the analysis. It is a population phenomena not necessarily an attribute of any concrete agent. Because of this our treatment of endogenous growth must start from a micro perspective on enterprise, and the rules have to be found for generating the emergent macroeconomic properties.

It is inevitable that in analysing the process of economic growth we are dealing with an instituted economic process in the Polanyian sense (1957). Our institutions are those of the corporate economy, a conceptual division between firms and households, and a market economy, in which the efficiency of market institutions in establishing more or less uniform prices for goods and services of common quality can vary significantly across sectors. The important point in all this is the role of firms as the creative institutions. They decide what is produced and how, they set prices, they invest in capacity and they innovate (to determine rates of productivity growth). How they decide and determine is shaped by the instituted context in which they are embedded, namely market institutions and the other institutions that shape the growth of practically applicable knowledge. The careful reader will recognize a distinctly Austrian flavour in what follows, despite the classical antecedents which flow from Adam Smith through Allyn Young to Nicholas Kaldor. Our evolutionary perspective is entirely compatible with the idea of economic activity as a discovery process along the lines made clear by Hayek and others.

In developing this evolutionary approach to economic growth I intend to achieve two main objectives. The first is to take evolutionary economic theorising beyond the partial frameworks which have so far characterized its development, and, secondly, to connect it with the immensely rich literatures which study innovation and its management, the history of technology, and the capabilities of firms and other institutions which shape the growth and application of knowledge. These literatures are natural complements to an evolutionary theory of economic growth, they frame our understanding of the processes generating and limiting innovation and they provide countless empirical examples to shape our thinking on the knowledge-growth connection. An equilibrium theory of growth cannot make these connections, an evolutionary theory can (Montgomery, 1995; Foss and Knudson, 1996).

The paper is organized as follows. We began with an analysis of the competitive process based on the efficiency and investment characteristics of firms in a single industry. This selection dynamic is based on replicator theory and is then extended by the addition of a development process in the form of firm specific technical progress functions. The next section develops an accounting framework for productivity growth at the industry level. In this the rate of improvement in productivity depends on the distribution of enterprise characteristics, in relation to efficiency, investment and innovation, and on the co-ordinating role of markets in generating a competitive process between rival firms. Progress depends on co-ordination and the outcome is differential growth, and, through the technical progress functions, differential rates of change in productive efficiency. Taken together, this means that feedback from the competitive selection process reshapes the variety in efficiency which underpins competition, so that selection and development are interdependent. We turn next to the relation between productivity growth in different industries. This builds on Allyn Young's (1928) analysis of economic growth, emphasising the link between income elasticities of demand and the changing composition of economic activity, a theme which has been developed in particular by Pasinetti (1981) and Kuznets (1977). This completes the formal analysis and we turn finally to the question of alternative closures for the relationship between output growth, productivity growth and employment growth, focusing on the role of the capital market in equating investment and saving. The paper concludes with some consequential reflections on enterprise and restless capitalism. The central message is that economic growth is a far from equilibrium process and that it is kept there by the continual generation of economic novelty.

I. Market Selection Dynamics with Variety in Efficiency and in Propensities to Invest

The starting point for any account of economic growth must be the nature and motivation of the firm; for its development is the foundation for economic growth. It is the unit within which knowledge is accumulated and combined to practical effect, and knowledge in this context is not restricted to science or engineering but includes organizational knowledge and market knowledge of what customers will value.

Our firms are profit seeking, they seek growth by investing in new capacity, and they search for new profit opportunities by innovating. The behaviour of a firm is defined by three routines, in relation to its unit costs of production, in relation to the investment and financial rules linking growth of capacity and profitability, and in relation to the rules which determine the rate of technical progress for the individual firm. These routine bundles constitute the selective characteristics of the firm and they may or may not take the firm close to outcomes which optimize its profitability over some horizon. Whether they do or they do not is not the issue. The principal point to grasp is the differences between the firms in their routine bundles: if they are optimizing, their optimizations are local and based upon their idiosyncratic knowledge and strategies. The outcome of these rules for prices, profitability, capital accumulation and productivity growth depend on the way in which the firm is co-ordinated with its rivals within its sector (industry) and with rivals in other sectors. It is the market institutional context which provides the selection framework to turn variety of behaviour into economic growth and which creates a necessary interdependence between the rate and direction of technical progress and the operation of market processes.

Consider a given industry, characterized by a given number of “firms”, producing a uniform good using different, idiosyncratic, production methods (Nelson, 1989, 1991). The chief simplification we allow ourselves is that the capital coefficient, ‘*b*’ is the same for all firms within the industry and that all improvements are Harrod neutral; progress is purely labour augmenting. These capital coefficients will differ between industries in the subsequent analysis. Measured in terms of wage units, at a common wage rate, unit costs for the ith firm are $h_i = a_i + bR$, R being the real cost of capital employed, and a_i being unit labour requirements. Labour productivity for the firm is, of course, $q_i = 1/a_i$. Let s_i be the share of firm i in the output of the industry and e_i be the corresponding share of employment, so that $e_i \bar{a}_s = s_i a_i$, $\bar{a}_s$ being $\sum s_i a_i$, average unit labour requirements. Average labour productivity is $\bar{q}_e = \sum e_i q_i$, from which it follows that $\bar{a}_s \bar{q}_e = 1$. In what follows, all changes in unit costs will be associated with changes in technology, that is with changes in productive knowledge. There is no factor substitution within firms independently from innovation. It is, of course, a considerable simplification that product innovations are ruled out of this account, particularly in the light of the arguments below about the evolution of demand. However, the traditional reasons for following this particular pattern of enquiry will be obvious in terms of the literature on economic growth.

The first step in the analysis is to take the single industry and establish the rates of growth of the individual firms. We do this by means of a two-dimensional replicator dynamic process. This corresponds to a process of competitive selection between rival firms that differ in their labour efficiencies and unit costs and in their willingness to invest and grow.

The investment function of each firm specifies the relation between its desired rate of expansion and the realized profit margin on its current activities. Remembering that the capital:output ratio is the same for all firms in the industry, we can write the ratio of investment to output, to a first order approximation, as

$$\left(\frac{I}{Q}\right)_i = bg_i = -\phi_i + \mu[p_i - h_i], \qquad (p_i - h_i) > \phi_i / \mu$$
$$= 0, \quad otherwise \tag{1}$$

The ratio ϕ_i / μ measures the minimum unit profit margin required by a firm before it will expand its capacity. That μ is treated as the same for all firms is a convenient simplification, not a matter of substance. The difference in the willingness to invest at a given profit margin is captured entirely in the coefficient, ϕ_i. We call ϕ_i the propensity to invest. It is to be noted carefully that a higher absolute value of ϕ_i, denotes a lower willingness to invest; the firm requires a greater compensating return to justify each ratio of investment to output.

Any firm can thus be in two states: profitable and expanding according to (1) or breaking even, not investing and varying the degree to which it utilizes its now historically given stock of production assets. In what follows we focus on firms that are profitable and ignore marginal zero profit firms just as we ignore entry and exit processes.

The second relation concerns the dynamic properties of a firm's own particular market. What determines the growth rate of its own particular market? Let g_{D_i} be the growth rate of demand for the ith firm, then we work with the following demand dynamics,

$$g_{Di} = g_D + \delta\left[\overline{p}_s - p_i\right] \tag{2}$$

where g_D is the overall rate of market growth, $\overline{p}_s = \sum s_i p_i$ is the average price in the sector and δ is a coefficient which determines the speed of the market selection process (Metcalfe, 1998; Phelps and Winter, 1970; Iwai, 1984). In a perfect market, where all price and quality information is fully diffused to all participants, $\delta \to \infty$, each firm is required to set the same price if it is to have any sales at all. If $\delta = 0$ each firm is an isolated monopolist. In general we are working with the intermediate growth of imperfect markets. The given rate of growth of the market for the sector as a whole will be determined endogenously when we turn below to the process of macro aggregation. For the moment take it as a given. Notice that (2) satisfies the requirement that the sum of the firm's market growth rates equals the aggregate growth of the market. The combination of the investment function and the market growth relation is sufficient to establish the growth rate and profitability of each individual firm in the sector, and to demonstrate the mutual interdependence of those growth rates.

Of course, the growth rates of the individual firms are not intrinsic characteristics of the firms, unlike their investment functions and the cost efficiencies. Rather growth rates are mutually determined in the competitive process; they are emergent phenomena and they depend on the manner of market co-ordination. They cannot be determined at the level of the individual firm, only through a higher level process of interaction between firms and the industries to which they belong. Crucially, even if the intrinsic selective characteristics of the firms are held constant, the growth rates of the individual firms will vary over time. Like all evolutionary processes the population adapts even in the special case when its members have invariant selection characteristics. To see how this works out we need to specify a precise process of co-ordination in the market.

This is a non trivial task, and I will focus on a limiting case, normal conditions, where each firm is setting a price to equate the rate of growth of its capacity with the rate of growth of its own particular market, which, of course, also depends on the behaviour of rival firms. On combining the investment function and the market growth function it follows that the normal growth rate of any firm is given by the relation

$$g_i = g_D + \lambda\left[\bar{\phi}_s - \phi_i\right] + \Delta\left[\bar{h}_s - h_i\right] \qquad (3)$$

with $\lambda = \dfrac{\delta}{\mu + b\delta}$ and $\Delta = \dfrac{\mu\delta}{\mu + b\delta}$,

being the market selection coefficients that translate diversity in intrinsic characteristics into diversity in growth rates.

For given coefficients δ, μ and b it follows that each individual growth rate differs from the aggregate market growth rate as the propensities to invest, ϕ_i, and unit costs, h_i, differ from their corresponding industry averages, $\bar{\phi}_s = \sum s_i\phi_i$ and $\bar{h}_s = \sum s_i h_i$. A higher growth rate is associated, ceteris paribus, with lower unit costs and a greater willingness to invest. However, while lower unit costs mean that a firm sets a lower normal price, a lower willingness to invest implies a higher normal price. Equation (3) expresses the characteristic feature of a replicator process; the competitive dynamics depend upon the joint distribution of behaviours around the prevailing population averages. The dynamics of evolution is not a dynamics of distance from equilibria, qua state of rest, but a dynamics of distance from average behaviour. All that information is contained in the current state of the system, it does not involve a comparison between that state and some hypothetical future state.

Only the "average" firm maintains a constant market share, the firm whose difference from average in terms of efficiency is exactly offset by its distance from average in terms of investment propensities. Notice, however, that a firm which is more efficient than average $\left(h_i < \bar{h}_s\right)$ may still grow less quickly than average $\left(g_i < g_D\right)$ if it has a below average propensity to invest and grow $\left(\phi_i > \bar{\phi}_s\right)$. It is not always the case that the more efficient firms will have a strong propensity to invest and grow and conversely.

Different growth rates, of course, translate into a pattern of changing market shares and changing employment shares – restless capitalism. The rate of change of market share is simply $g_i - g_D$, and this is not equal to the change in employment share, in general[1]. If a firm is increasing its share of output, then average productivity is determined to an increasing degree by the productivity of that firm. But there is no guarantee that this selective process works to shift resources in favour of more efficient firms at any given point in time. An immediate consequence of the replicator dynamics embodied in (3) is that the sectoral mean values $\bar{h}_s$ and $\bar{\phi}_s$ are changing over time even when the individual firm characteristics h_i and ϕ_i are treated as given. The population statistics are themselves restless, their dynamic depends on the variety in the sector and the manner of its co-ordination. To see this more formally we first derive the expression for the covariance between unit costs and growth rates, which, making use of (3), is given by

$$\begin{aligned} C_s(h,g) &= \sum s_i \left(h_i - \bar{h}_s\right) g_i \\ &= -\left[\Delta V_s(h) + \lambda C_s(\phi, h)\right] \end{aligned}$$

In this expression $V_s(h)$ is the output share-weighted variance in unit costs and $C_s(\phi,h)$ is the similarly weighted covariance between propensities to invest and unit costs. While the former is necessarily positive, the latter may be positive or negative.

[1] Since $e_i \bar{a}_s = a_i s_i$ it is only for the representative (average) firm that the two shares change by the same amount and direction.

The point is that the outcome of the competitive process depends on the joint distribution of enterprise behaviours, about which little a priori judgement seems possible, it is an empirical matter, contingent on time and context.

Now the rate of change of average unit costs is

$$\frac{d\overline{h}_s}{dt} = \Sigma \frac{ds_i}{dt} h_i$$

that is,

$$\frac{d\overline{h}_s}{dt} = C_s(h, g) = -\lambda C_s(\phi, h) - \Delta V_s(h) \qquad (4)$$

I have called this general type of relation 'Fisher's Principle', after the English geneticist who first enumerated this relation between mean behaviour and variety in behaviour (Metcalfe, 1998; Frank, 1998).

Similarly, for the average propensity to invest

$$\frac{d\overline{\phi}_s}{dt} = C_s(\phi, g) = -\lambda V_s(\phi) - \Delta C_s(\phi, h) \qquad (5)$$

where $V_s(\phi)$ is the variance in investment propensities. If the covariance $C_s(\phi, h)$ is zero, it follows immediately that selection reduces the average propensity to invest and average unit costs in the population. In this sense, the market selection process is growth promoting. Moreover, this process also implies that on average the growth rate of the population of firms is declining over time. Any individual firm may experience accelerating growth but, for the ensemble of firms, these must be retardation. This is the claim association with Burns' (1938) 'law of industrial growth' and it follows naturally from Fisher's Principle and the assumed constancy of the market growth rate. Since $g = \sum s_i g_i$, then

$$\begin{aligned} \frac{dg}{dt} &= \frac{ds_i}{dt} g_i + \sum s_i \frac{dg_i}{dt} \\ &= V_s(g) + \sum s_i \frac{dg_i}{dt} \end{aligned}$$

Since we are, for the moment, taking the market growth rate as a constant, $dg/dt = 0$ it follows that

$$\sum s_i \frac{dg_i}{dt} = -V_s(g) < 0$$

The variance of the firm growth rates follows from the process of market co-ordination and it is related to the distributions of h_i and ϕ_i by

$$V_s(g) = \lambda^2 V_s(\phi) + \Delta^2 V_s(h) + 2\lambda\Delta C_s(\phi, h) > 0$$

Consequently, the weighted sum of the rates of change in firm growth rates is negative, on average the firms in this industry experience retardation in their growth rates.

Thus retardation, on average, can only be overcome by a sufficiently rapid rate of acceleration of the market, measured relative to the variance of growth rates in the population. To what extent is it the case that selection is a "progressive" force, tending to increase the efficiency with which resources are used and increasing the tendency for firms to translate this into growth? Now from (3) and the definition of $V_s(g)$ it follows that,

$$V_s(g) = -\frac{\delta}{\vartheta + \delta}\left\{\Delta \frac{d\bar{h}_s}{dt} + \lambda \frac{d\bar{\phi}_s}{dt}\right\}$$

Consequently, the evolution of the joint distribution of average behaviours satisfies the on average "progress" condition

$$\Delta \frac{d\bar{h}_s}{dt} + \lambda \frac{d\bar{\phi}_s}{dt} < 0$$

Moreover, the average rate of "progress" is greater the greater is the variance of growth rates across the rival firms in the sector. In this very precise sense, of reducing average unit costs and increasing the average propensity to invest, selection promotes economic growth.

Because the dynamics of this competitive process are driven jointly by differences in efficiency and in propensities to invest, it follows naturally that the diversity in growth rates is matched by a corresponding diversity in profit margins and prices set by the firms. These too are emergent phenomena. Thus the average profit margin increases with the market growth rate and decreases with the average propensity to invest, while the distribution of individual margins around this average is given by the relation

$$m_i - \overline{m}_s = b\Delta\left(\overline{h}_s - h_i\right) + \frac{\lambda}{\delta}\left(\phi_i - \overline{\phi}_s\right)$$

from which the variance of margins is given by

$$\begin{aligned} V_s(m) &= \sum s_i \left(m_i - \overline{m}_s\right)^2 \\ &= (b\Delta)^2 V_s(h) + \left(\frac{\lambda}{\delta}\right)^2 V_s(\phi) - \frac{2b\Delta\lambda}{\delta} C_s(\phi, h) \end{aligned}$$

Like the variance in growth rates the variance in profit margins is a "secondary" variance, an emergent property of the competitive process dependent on the "primary" measures of variation in ϕ and h and the manner of market co-ordination.

Of course, marginal, no accumulation, firm just breaks even and cover their costs. It is essential to note that this distribution of profitability is not simply a reflection of imperfect competition. Rather it is a consequence of a process of competitive selection that is driven by the variety of inter-firm behaviour. Profits reflect the dispersion of behaviours not static market power in the traditional sense[2]. Even in a perfect market ($\delta = \infty$) there will be a distribution of profitability, matching the distribution of unit costs and investment behaviours. While the impact of the efficiency differences upon the dispersion of profit

[2] Notice that, when $\delta = 0$, the distribution of margins depends only on the distribution of propensities to invest. When $\delta = \infty$, it depends only on the distribution of unit costs.

margins is intuitive, the impact of the investment parameter ϕ_i on the dispersion needs further comment. Imagine that a given firm has a notionally lower willingness to invest, a higher absolute value of ϕ_i. This implies that its normal growth rate is lower and its unit margin is higher. However, since the growth rate of the overall market is given it follows that the growth rates and profit margins of all its competing rivals must be higher. Consequently not only is the margin in the given firm greater it is greater in the sector as a whole, rivals are setting higher prices than before just as the firm in question is setting a higher price[3].

II. The Growth of Productivity

Having established the growth rates of the individual firms we can now let the productivity characteristics of those firms evolve in a process of development. This is focused, in Harrod neutral fashion, on the unit labour requirements and thus unit costs of the individual

[3] It is easily established that for firm i with rivals k,

$$\frac{\partial m_i}{\partial \phi_i} = \frac{1}{\mu + \delta b}\left[1 + s_i \frac{\delta b}{\mu}\right] \quad and \quad \frac{\partial m_i}{\partial \phi_k} = \frac{\delta b}{\mu(\mu + \delta b)} s_k$$

Since $\overline{m}_s = \sum s_i m_i$, it follows that, for a given pattern of market shares,

$$\frac{\partial \overline{m}_s}{\partial \phi_i} = \frac{1}{\mu} > 0$$

firms. We then establish how average productivity in the industry responds to the coupled dynamics of selection and development. The individual firm is characterized by two measures of technical progress: the proportional rate of change of labour productivity $\hat{q}_i = -\hat{a}_i$; and the proportionate rate of change of total factor productivity which is the same as the rate of reduction of unit cost at given input prices, $-\hat{h}_i$[4]. Define ω_i as the share of labour expenses in unit cost, and it follows that the partial and total rates of productivity growth are related by $\omega_i \cdot \hat{q}_i = -\hat{h}_i$. Notice carefully, that ω_i is not the share of labour expenses in the firm's revenue unless that firm is marginal to the sector, that is to say, its revenue enables it to break even exactly. As we have already established other firms are setting prices which exceed their unit costs.

The development process in the industry is captured by Kaldor's concept of a "technical progress function" specific to the individual firm. This "function" reflects the generation of knowledge but it does not measure the growth of knowledge directly, rather it measures the growth of labour productivity. In some ways it is a device for avoiding any treatment of the accumulation of knowledge per se. Most importantly, it is the source of dynamic increasing returns in this growth framework, and it provides the bridge between selection and development.

To fix ideas, imagine that a macro, radical invention has created the industry and that the development of the technology in each firm depends upon a stream of micro, incremental innovations generated by the progress functions. Each of these innovations enhances labour

[4] Throughout, a 'caret' over a variable indicates logarithmic differentiation.

productivity. We let each technical progress function have an exogenous innovation component, α_i, and an endogenous positive feedback component, β, defined in relation to the growth rate of the firm. This latter could reflect traditional economies of scale (Metcalfe, 1995), more roundabout methods of organization within the firm, learning activity, or the effect of investment as a carrier of increasing efficiency (Scott, 1989; De Long and Summers, 1991). All of the economies obtained are treated as internal to the firm although it would be straightforward to add external economies in the form of spillover effects between firms in the industry, or indeed across industries. The basic point is that scale maps into the organization of the firm which in turn maps onto its productivity. Changes in scale imply changes in organization and in productivity.

For our present purposes it does not matter which of these sources of positive feedback contributes to the overall rate of efficiency enhancement[5]. The essential point is that the increase of productive activity stimulates the acquisition of new knowledge and induces rearrangements of the productive process which are productivity enhancing. The growth of knowledge is industry and activity specific (Dosi, 1997). This technical progress function, specific to each firm we write as

$$\frac{d}{dt}\log a_i = -[\alpha_i + \beta g_i] \quad , \quad 0 < \beta < 1$$

[5] The empirical embodiments of the relationship are the Kaldor-Verdoorn Law and the Fabricant Law. For detailed discussion of the empirical issues see Scott (1989) and Targetti and Foti (1997).

g_i being the growth rate of the firm's capacity, which will also be equal to the growth rate of its output as explained above. That the technical progress elasticity, β, is assumed to be the same for all the firms within the sector is an expositional convenience, we are simply eliminating one further source of variety. That $\beta < 1$, is, of course, the condition for increasing returns.

Now the consequences of adopting a technical progress hypothesis are considerable, for we are linking together thereby selection and development in the industry. Selection processes determine the distribution of capacity growth rates which in turn shape the distribution of productivity growth rates and the evolution of a_i, thus redefining the selection process[6].

With these assumptions and definitions in mind we account for average productivity growth by decomposing it into two components, one reflecting productivity growth within firms and the other reflecting the changing relative importance of firms with different levels of productivity. The first is the development or innovation effect and the second is what I shall call the selection or diffusion effect, the differential growth of the rival firms arising out of the competitive process.

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[6] It follows directly from the technical progress functions that the covariance between productivity growth rates and output growth rates is equal to $C_s(\alpha, g) + \beta V_s(g)$. There is a built in tendency to a virtuous circle provided that $C_s(\alpha, g)$ is not too negative.

Taking account of (3) we soon find that

$$C_s(\alpha\, g) = \sum s_i \left(\alpha_i - \overline{\alpha}\right) g_i = \frac{-\delta}{\vartheta + \delta} C_s(\alpha\phi) - \frac{\vartheta\delta}{\vartheta + \delta} C_s(\alpha h)$$

Recall first that

$$\frac{d}{dt}\log q_i = -\frac{d}{dt}\log a_i = -\frac{1}{\omega_i}\frac{d}{dt}\log h_i$$

Then with average unit costs in the sector defined by $\bar{h}_s = \sum s_i h_i$, it follows that

$$\frac{d}{dt}\log \bar{h}_s = \sum \frac{s_i h_i}{\bar{h}_s}\left\{\omega_i \frac{d}{dt}\log a_i + \frac{d}{dt}\log s_i\right\} \qquad (6)$$

The first term within the bracket is, when aggregated, the development effect, the own rate of technical progress for the industry. The second term is the selection effect, and it is an average of the rates of change of market shares within that particular industry. It is this second term which provides the bridge between selection and development, between evolutionary competition and endogenous technical progress via increasing returns and market co-ordination.

<u>The Development Effect</u>

It follows from this specification of the technical progress functions that the average rate of increase in labour productivity across the population of firms in the sector due to development alone is given by

$$\sum \frac{s_i a_i}{\bar{h}_s}\frac{d}{dt}\log a_i = -\bar{\omega}\left[\frac{C_s(a,\alpha)+\beta C_s(a,g)}{\bar{a}_s} + \bar{\alpha}_s + \beta g_s\right] \qquad (4)$$

with $\overline{\omega}$ being the average share of labour in production cost[7].

For the sector as a whole, this accounting generates a typical evolutionary expression in which the change in average efficiency depends upon the various moments of the relevant population distribution of behaviours. Of those, the average rate of innovation, $\overline{\alpha}_s$, and the covariance, $C_s(a,\alpha)$, between levels of efficiency and rates of innovation, depend upon the specifics of which firms innovate and by how much. Clearly it is beneficial to average progress if high efficiency firms also have high rates of innovation but at this stage in our knowledge there is little more that can be said. How this covariance works out is an empirical matter in each industry. Much more can be said about the second covariance $C_s(a,g)$ between efficiencies and growth rates, and this reflects the dynamics of the competitive process in the industry. The value of $C_s(a,g)$ depends on the market co-ordination of diverse firm behaviours, as established previously.

Thus, making use of (3)

$$C_s(a,g) = \Sigma s_i (g_i - g_s) a_i = -[\lambda C_s(a,\phi) + \Delta V_s(a)] \qquad (8)$$

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[7] This decomposition depends on the fact that $s_i w_i h_i = s_i a_i, C_s(a,\alpha) = \sum s_i (a_i - \overline{a}_s)\alpha_i$, $C_s(a,g) = \Sigma s_i (a_i - \overline{a}_s) g_i$ and $\overline{a_s} = \sum s_i \alpha_i$. The average $\overline{\omega}$ is constructed using the weights $e_i(L/K)$ where e_i is the share of the firm in sector employment, L is total sector employment and K is aggregate production expenses in the sector. It follows that $\overline{\omega} = \overline{a}_s / \overline{h}_s$.

If a and ϕ are positively correlated, so that more efficient firms (lower a_i) have higher propensities to invest (lower ϕ_i) it follows that $C_s(a,g)$ will be negative – more efficient firms will grow more quickly than average. However, if the converse is true and $C_s(a,\phi)$ is sufficiently negative, then $C_s(a,g)$ may turn out to be positive and it is the less efficient firms that will grow more quickly than average.

The Selection Effect

The interaction between investment and efficiency in the competitive selection process also underpins the second term in (6), the selection effect. This term reflects the differential growth of the competing firms and the corresponding comparative rates of diffusion in the market of their different methods of production. It is given by

$$\begin{aligned}\sum \frac{s_i h_i}{\bar{h}_s}\frac{d}{dt}\log s_i &= \sum \frac{s_i h_i}{\bar{h}_s}(g_i - g_s) = \frac{C_s(a,g)}{\bar{h}_s} = \bar{\omega}\frac{C_s(a,g)}{\bar{a}_s} \\ &= -\bar{\omega}\left[\frac{\lambda C_s(a,\phi) + \Delta V_s(a)}{\bar{a}_s}\right]\end{aligned} \tag{9}$$

Again this is a typically evolutionary expression, capturing the flux within the industry and the effects of this on average productivity. The dispersion of behaviours, conditioned by market co-ordination, underpins differential growth which, when averaged across the rival firms, gives (9).

The Average Rate of Productivity Growth

On combining (7), (8) and (9) we have an accounting expression for the overall rate of productivity growth in the industry, namely,

$$\frac{d}{dt}\log \bar{q}_e = -\frac{d}{dt}\log \bar{a}_s = \bar{\omega}\left[\frac{C_s(a,\alpha)+(1-\beta)[\lambda C_s(a,\phi)+\Delta V_s(a)]}{\bar{a}_s}\right]+\bar{\omega}\left[\bar{\alpha}_s+\beta g_D\right] \quad (10)$$

This typically evolutionary expression decomposes the rate of labour productivity growth according to the moments of the joint distribution of efficiency, investment and innovation routines in the sector. These moments are defined in relation to the characteristics of the individual firms (ϕ_i, α_i, a_i) but the way in which they are combined together depends on the manner of market co-ordination. Selection and development lead us to cumulative causation or equivalently, evolutionary endogenous growth.

What broad lessons does (10) contain? The average effects in relation to $\bar{\alpha}_s$ and g_D are straightforward and require no further comment other than to say that the growth rate of the market will be explored in the next section. If all firms in the sector were of identical efficiency and identical innovativeness, the latter being the condition for the former, then only these average effects would appear and that would be the end of the story. The technical progress function alone, would provide all the information necessary to establish productivity growth and the degree of increasing returns. It is the variety of behaviour in this population which gives rise to the other terms in (10). They indicate the particular relationship between micro diversity in behaviour and economic progress. The rate of progress is greater the greater is the value of the covariance between efficiency and rates of innovation at the level of the firm. It is also greater, the greater is the variance in efficiency and the greater is the covariance between efficiency, and the propensity to accumulate. But there is a more subtle effect at work in (10) than at first appears obvious. This relates to the role played by the coefficient $(1-\beta)$. The retarding effect expressed through the feedback component $(-\beta)$ reflects the drag on average progress created by the dispersion of efficiency in the population. It reminds us that all evolutionary processes are to a limited degree wasteful. If all firms had the same efficiency and the same investment function they would create a faster rate of technical progress. The existence of firms of lower efficiency and willingness to grow slows down the average rate of productivity growth. But, of course, in a knowledge-based world the growth of knowledge and innovative creativity must be unevenly distributed, that is the price paid for the possibility of progress.

In interpreting these results it is important to re-emphasize that they depend upon the micro behaviour of firms and the selection of those behaviours in a competitive process. This decomposition is only possible by virtue of the precise manner of market co-ordination of the firms and would change if the rules of co-ordination were to change. Market institutions matter for the rate of productivity growth. The consequences arising from this are twofold. First, the moments which determine the rate of productivity growth are the outcome of the competitive process. Given the dispersion in firm's selection characteristics (a_i, α_i, ϕ_i), different rules of the game, as reflected in Δ and λ, will result in different patterns of capacity growth and productivity growth. A higher value of μ, for example, means that the growth rate of capacity is more responsive to the level of profitability and this is translated into a higher value of Δ and a lower value of λ. Similarly if markets are more efficient, a higher value of δ, this implies a higher value for Δ and λ. Differences in these selection coefficients imply different relationships between the variety in behaviours and the average rate of productivity growth. In this very precise way the competitive process and the rate of productivity growth are mutually interdependent. It is thus a gross oversimplification to treat the rate of productivity growth as an attribute of firms alone.

From this follows the second consequence, the rates of productivity growth are restless simply because the underlying moments of the distribution of behaviours are themselves restless. Steady productivity growth is not to be expected either in the firm or in the industry. Take, as an example, the evolution over time of the average of the innovation rates α_i. Invoking Fisher's Principle we soon find that this evolves according to the evolutionary rule,

$$\begin{aligned} \frac{d}{dt}\bar{\alpha}_s &= \sum s_i (g_i - g)\alpha_i = C_s(g,\alpha) \\ &= -[\lambda C_s(\alpha,\phi) + \Delta C_s(a,\alpha)] \end{aligned}$$

In this expression we see that the restless nature of the average is dependent on the diversity in the system and the way markets co-ordinate that diversity. As with all evolutionary processes, diversity is the fundamental element which drives change, and diversity is generated within the economic process. This is the transformative nature of restless capitalism.

III. <u>Structural Change, Sectoral and Macroeconomic Productivity Growth</u>

Having established the patterns of change within an industry we turn now to the patterns of change which arise between industries and their macroeconomic consequences. The overall rate of productivity growth between two dates is clearly an amalgam of three separate effects: productivity change within industries as discussed above; changes in the relative economic importance of these industries and the addition of new or deletion of old industries between those dates. In terms of innovation this is much in line with Mokyr's (1990) distinction between micro innovations, incrementally developing the efficiency of an established sector, and macro innovations which create new sectors. For the moment we leave aside the latter and focus on the developments within and between a given number of established industries. We consider here the interdependence which arises between the sectoral rates of technical progress in the presence of increasing returns, and which gives rise to what I shall call "the Young effect", to signify Allyn Young's major contribution to the growth literature.

Demand, Sorting and Structural Change

In section I we have shown how the evolution of average productivity within sectors has depended upon investment, innovation and selection, and results in the mutual determination of the different growth rates of rival firms in relation to their different behaviours. This kind of competitive process has been shown by Bailey et al. (1992) and Bartlesman and Doms (2000) to be particularly important in the empirical explanation of productivity growth.

In contrast to selection, the idea of sorting involves non-competitive differential growth and the most commonly postulated source of such intersectoral changes lies in hypotheses about the evolution of demand. Indeed, in pursuing this theme it will be clear that the evolution of demand must occupy a central position, for, as Pasinetti expressed it "... any investigation into technical progress must necessarily imply some hypotheses ... on the evolution of consumer preferences as income increases". And he went further "Increases in productivity and increases in income are two facets of the same phenomenon. Since the first implies the second, and the composition of the second determines the relevance of the first, the one cannot be considered if the other is ignored" (my emphasis, 1981, p.69). In dealing with demand there are three general matters to be considered: shifts in “preferences” as a direct consequence of technical progress particularly associated with the emergence of new sectors; changes in average prices between sectors particularly if the outputs concerned are close substitutes; and, the matter which Pasinetti considered, different income elasticities of demand for the different sectors. Like him, I treat only this latter effect, leaving the other aspects of demand and innovation for further study[8].

Of course, in emphasising the role of income elasticities in the intersectoral sorting process we should not be deluded into thinking that we have said anything terribly profound. What is needed is some empirical and conceptual understanding of the determinants of income elasticities in general, and in relation to innovation in particular. This we do not yet have[9].

As is appropriate for this kind of growth analysis we continue to assume that within each sector the growth of capacity matches the growth of demand, and use the same symbol g_j to denote both[10].

Let n be the aggregate rate of employment growth and ψ_j be the per capita income elasticity of demand for sector j. Then we can write the rate of growth of demand in that sector as

$$g_j = n + \psi_j \hat{q} \tag{11}$$

where $\hat{q} = d \log \bar{q}_e / dt$ is the yet to be constructed aggregate rate of productivity increase.

[8] Montobbio (2000) contains a detailed discussion of price driven selection effects on the comparative growth of different industries.
[9] See Bianchi (1998) for a very useful discussion of innovation and consumer behaviour.

Now clearly $\hat{q}$ is a weighted average of the sectoral productivity growth rates but what are the appropriate weights to construct this average? To determine these let n_j be the rate of growth of employment in sector j so that $g_j = n_j + \hat{q}_j$, whence $n_j - n = \psi_j \hat{q} - \hat{q}_j$. Now if we weight this last expression by the employment shares e_j we find that

$$\sum e_j (n_j - n) = (\sum e_j \psi_j)\hat{q} - \sum e_j \hat{q}_j = 0$$

[10] From now on I suppress intrasectoral subscripts. Thus g_j is to be read as the appropriate sectoral average.

since $\sum e_j n_j = n$ by definition. Thus our weighting scheme is provided by

$$\hat{q} = \frac{1}{\sum e_j \psi_j} \sum e_j \hat{q}_j \qquad (12)$$

Unless $\sum e_j \psi_j = 1$ these weights do not sum to unity[11].

To elaborate further upon the employment weighted sum of income elasticities, let z_j be the share of sector j in total output and note that $\sum z_j \psi_j \equiv 1$, since aggregate output equals aggregate income. It follows immediately that

$$\sum e_j \psi_j = 1 + \frac{C_z\left(\psi_j \bar{a}_j\right)}{\bar{a}_z}$$

where $C_z\left(\psi_j \bar{a}_j\right)$ is the 'z'-weighted covariance between sectoral income elasticities and average unit labour requirements in each sector. Thus the employment weighted average of the income elasticities has unit value only if this covariance is zero, which absent any compelling reason to think otherwise, we assume not to be so[12].

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[11] In case it might be thought obvious to weight productivity <u>change</u> by the employment shares given that $\bar{q} = \sum e_j \bar{q}_j$ it should be noted that differentiation of this expression gives

$$\hat{q} = \sum z_j \hat{q}_j + \sum z_j \hat{e}_j$$

where z_j is the share of sector j in aggregate output and $\hat{e}_j$ is the proportionate rate of change of the sector's employment share.

[12] To derive this result write $\sum e_j \psi_j = \sum z_j \psi_j + \sum\left(e_j - z_j\right)\psi_j$ and note that $e_j \bar{a}_z = z_j a_j$, with $\bar{a}_z = \sum z_j \bar{a}_j$. The result follows immediately. Notice also that $\bar{a}_z \bar{q}_e = 1$.

This detour on weights being complete let us return to the main argument and consider how the sectoral productivity growth rates are mutually determined. In so doing we are following the line of enquiry first introduced by Allyn Young (1928) who saw clearly how increasing returns generates reciprocal interdependence of productivity growth between sectors. Divide the elements in (10) into those whose aggregate contribution, H_j, is independent of the sectoral growth rate of output, and those whose contribution depends on that growth rate of output through increasing returns. Then we can write the sector level technical progress function as

$$\frac{d}{dt}\log \bar{q}_j = \hat{q}_j = H_j + \beta_j g_j \tag{13}$$

where the term H_j contains all of the average, variance and covariance effects explained in the derivation of (10), arising from the intraindustry process of development and selection. This expression is the industry technical progress function, properly aggregated from the technical progress functions of the individual firms.

Now using (11) and (12) this becomes

$$\hat{q}_j = H_j + \beta_j \left[n + \psi_j \left(\frac{\sum e_j \hat{q}_j}{\sum e_j \psi_j} \right) \right] \tag{14}$$

Thus productivity growth in any one sector increases with productivity growth in all other sectors provided that its output is a normal good, these growth rates are mutually determined in the market process. Such goods have complementary effects on each others productivity growth. Equation (10) constitutes a set of simultaneous productivity growth equations, the solution of which in the two-industry case is sketched in Figure 1. The schedules Q_1 and Q_2 are the reciprocal interdependence functions for each industry derived by averaging across the firms, and they intersect at 'a' to determine the respective co-ordinated rates of productivity growth.

Through point 'a' draw the straight line L-L with slope, e_1 / e_2, the relative employment shares, to intersect the 45^o line at 'b'. This point measures the rate of aggregate productivity growth $\hat{q}$[13]. As drawn, $\hat{q}_1 > \hat{q} > \hat{q}_2$. Consider now point 'c' and its related point 'd' which jointly depict the pattern of productivity growth if there are no feedback effects in either sector. The difference between point 'b' and 'd' is then a measure of the importance of reciprocal interdependence in the growth process, it measures what I shall term the "Young effect". It represents the stimulus to growth generated by the autocatalytic nature of increasing returns.

What then of the aggregate rate of productivity growth? To establish this we simply weight each sectoral equation (14) by the corresponding employment share weights and sum to yield the following

[13] Strictly speaking it determines the value of $\left(\sum e_j \psi_j\right)\hat{q}$, but the simplification for diagrammatic purposes is obvious.

$$\hat{q} = \frac{\overline{H}_e + \overline{\beta}_e \cdot n}{\left(\sum e_j \psi_j\right)\left(1 - \overline{\beta}_u\right)} \tag{15}$$

In this expression, $\overline{H}_e = \sum e_j H_j$ and $\overline{\beta}_e = \sum e_j \beta_j$. However, $\overline{\beta}_u = \sum u_j \beta_j$ is derived from the weights $u_j = e_j \psi_j / \sum e_j \psi_j$, the contribution which that sector makes to the employment weighted average of income elasticities. Of course, the u_j are proper weights satisfying $\sum u_j = 1$[14]. With $\overline{\beta}_u < 1$ we have semi-endogenous growth (Jones, 1995), and with $\overline{\beta}_u = 1$, explosive growth of a rather implausible kind. The interpretation of (15) is clear; productivity growth and employment growth in the aggregate are positively related.

Equation (15) combines the reasoning which underlies the Kaldorian technical progress function with the reasoning behind endogenous growth theory, with the very important proviso that the development of knowledge (productivity) cannot be separated from the growth of the individual sectors. The growth of applicable knowledge is to this degree a market dependent process and positive feedback process. The point about positive feedback, as Young emphasised, is that it augments growth, within and between sectors, amplifying the wellspring of progress which is provided by the within sectoral innovation and diffusion rates[15]. In this way we can comprehend his insistence that changes in one sector induce changes in other sectors mutually reinforcing the growth of productivity in and within all the

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[14] Since $u_j \sum e_j \psi_j = e_j \psi_j$, it follows that $\overline{\beta}_e$ and $\overline{\beta}_u$ are related by the condition

$$\overline{\beta}_e = \overline{\beta}_u + C_e(\psi_j \beta_j) / \sum e_j \psi_j$$

When the covariance (employment weighted) between income elasticities and technical progress elasticities is zero then $\overline{\beta}_e = \overline{\beta}_u$.

[15] Of course, it is trivially obvious that without innovation there would be no technical progress functions, no positive feedback and no productivity growth. We haven't yet escaped from Usher's warning that no progress means no growth (1980).

sectors. As he put it, "Every important advance in the organisation of production … alters the conditions of industrial activity and initiates responses elsewhere in the industrial structure which in turn have a further unsettling effect" (p.533). The precise form those changes in organization take is not the issue, it is the reciprocal effects on productivity growth which matter. Could growth be more endogenous than that?

The conclusion from this is that growth amplifies the effects of innovation and selection within industries and links the productivity dynamics of different industries together in a transparent way which depends upon demand sorting linkages[16]. Notice carefully, however, that Figure 1 represents a process of growth co-ordination at a point in time. It does not represent a growth equilibrium in some more general sense, a fixed attractor on which productivity patterns converge and stabilise. Indeed, it is a fundamental assumption of the evolutionary perspective that growth is open-ended, there is not any state of dynamic rest in the presence of innovation driven growth. Thus points 'a' and 'b' are continually on the move as the relative employment shares and the rates of innovation and diffusion vary over time. The economy is simultaneously co-ordinated and restless, as all knowledge-based economies must be. One way to emphasise this is to recognise that neither of the aggregate progress elasticities $\overline{\beta}_e$ and $\overline{\beta}_u$ are constants; they vary with each change in the composition of employment, and, just as one should expect, the dynamic properties of the economy change as its structure changes[17].

[16] Another way to generate interdependence would be to assume spillovers between technical progress functions but that is another story. One way forward might be to make the innovation rate in each firm also depend on the innovation rate in the sector. But clearly there are a wide range of options to explore.

[17] A little manipulation establishes that, for example, in relation to (15) $d\overline{\beta}_u / dt = C_u(\beta, g)$ and that $d\overline{\beta}_e / dt = C_e(\beta, g)$. As with all evolutionary arguments, variety drives change and the theory tells us how to measure variety.

IV. Closing the System: The Determinants of Aggregate Growth Rates

It will not have escaped the reader's notice that we have yet to determine a growth rate for the economy as a whole from the sets of relations which led to (15) above. There are at least two possibilities. The first is to claim that the rate of growth of employment, n, is given, by virtue of arguments in relation to the growth of population, labour migration, changing gender composition of the population, and change institutional rules in relation to the provision of labour. Whatever the rationale, 'n' determines $\hat{q}$ through (15) and correspondingly determines the growth rate for the economy g. This is the route followed by Jones (1995) in his version of endogenous growth.

The alternative approach is to argue that the growth rate of the economy is determined by aggregate investment and saving behaviour. Productivity growth and employment growth follow as this growth rate is cascaded down through industries and firms. A higher growth rate of output increases both, but necessarily increases productivity growth more than employment growth whenever the productivity elasticity $\overline{\beta}$ (however weighted) is less than unity in value.

On this view, the requirements for macroeconomic co-ordination set the aggregate constraints in the relation between growth and firm behaviour. In following this approach some hypothesis has to be adopted on the nature of capital markets in this corporate economy. To illustrate, let us take a simple case in which firms distribute all their profits and finance their investment by borrowing from households. Take the household saving rate, s_H, as given, then the aggregate consistency condition that saving equal investment, that is, that investment plans are financed by households, determines the growth rate of the economy. This is precisely Harrod's argument, indeed Harrod can be claimed to be the first of the endogenous growth theorists, in the modern sense[18].

Since z_j is the share of industry j in total output then from (1) it follows that the aggregate ratio of investment to output is

$$\frac{I}{Q} = \sum z_j \left(\frac{I}{Q}\right)_j = \overline{\phi}_z + \overline{\mu}_x \overline{m}_z \tag{16}$$

where $\overline{\phi}_z = \sum z_j \left(\overline{\phi}_j\right)$, $\overline{\phi}_j = \sum s_{ij}\phi_{ij}$, $\overline{\mu}_x = \sum x_j \mu_j$, and $x_j \overline{m}_z = z_j m_j$, so x_j is the share of sector j in aggregate profits. Finally, $\overline{m}_z = \sum z_j m_j$ is the average profit share across the economy. Equating savings and investment then determines this average profit level, thus

$$\overline{m}_z = \frac{s_H - \overline{\phi}_z}{\overline{\mu}_x}$$

[18] The Harrod model is a more sophisticated version of the so-called A.K model of modern growth theorists. See Kurz and Salvadori (1998) for an elaboration and critique.

Now, because $(I/Q)_j = b_j g_j$ we can also write the aggregate investment ratio as

$$\frac{I}{Q} = \sum z_j b_j g_j = \bar{b}_y g$$

where $g = \sum z_j g_j$ and $\bar{b}_y = \sum y_j b_j$, the average capital:output ratio, is defined using the weights $y_j g = z_j g_j$, so that y_j measures the contribution that each industry makes to the aggregate growth rate. From this we immediately obtain the Harrod condition

$$g = \frac{s_H}{\bar{b}_y}$$

Consequently, this particular hypothesis about the financing of investment implies that the aggregate growth rate of capacity is independent of the investment decisions of the firms. What investment decisions do determine in the aggregate is the average share of profits in income. If instead, we allow firms to retain profits for investment purposes, it would follow that the savings ratio would increase with the profit share and that g and $\overline{m}_z$ would be mutually determined. However, let us remain with the base case because this gives to our economy a particularly simple dynamic structure. These properties can be summarized as follows.

The aggregate growth rate of capacity is independent of investment and technical progress at the level of the firm and depends only on the saving ratio and the average productivity of the capital stock. It is, moreover, an emergent property, determined by the co-ordination process in the capital market. Given the growth rate of output, it follows from (15) that the aggregate growth rate of productivity is

$$\hat{q} = \frac{\overline{H}_e + \overline{\beta}_e \left(s_H / \overline{b}_y\right)}{\left(\sum e_j \psi_j\right)\left(1 - \overline{\beta}_u\right) + \overline{\beta}_e}$$

and of aggregate employment is

$$n = \frac{\left(\sum e_j \psi_j\right)\left(1 - \overline{\beta}_u\right)\left(s_H / \overline{b}_y\right) - \overline{H}_e}{\left(\sum e_j \psi_j\right)\left(1 - \overline{\beta}_u\right) + \overline{\beta}_e}$$

In each case the structure of the economy matters fundamentally for the relations between capacity growth, productivity growth and employment growth. Moreover, this structure is evolving in line with the diversity of firm behaviour and selection processes in the different industries, it is time varying in a way which reflects the co-ordinating role of markets. To repeat, capitalism is restless.

But structure matters in another sense too. For given the growth rate of employment we can determine via (14) the distribution of productivity growth rates in the particular sectors. Given the growth rates of employment and aggregate productivity we can also determine the growth rates of demand in each industry and thus the relations between prices and growth rates within them. How this works out depends on the differences within and across industries of the fundamental selective characteristics of firms in relation to efficiency, investment and technical progress. While the aggregate rate of output growth is resolved at the macro level of the capital market, the rate of productivity growth cannot be explained without a detailed knowledge of micro structure and market processes.

Of course, nothing we have said even in this special case, implies that the aggregate rate of growth will be constant over time. Even if the saving ratio is constant, the aggregate capital:output will drift with the changes in economic structure. Since one of the famous stylized facts is the alleged constancy of the capital:output ratio it may be of interest to enquire into the conditions in which this is possible given that the economy is subjected to ongoing structural change between industries[19]. The answer leads us to an important property of evolving economies.

Consider first the capital:output ratio defined as $\bar{b}_z = \sum z_j b_j$. Then, since the b_j are given by assumption, it follows that

$$\begin{aligned}\frac{d}{dt}\bar{b}_z &= \sum\left(\frac{d}{dt}z_j\right)b_j = \sum z(g_j - g)b_j \\ &= C_Z(b, g)\end{aligned}$$

so that the capital:output ratio is invariant to structural change when the growth rates and capital:output ratios of the industries are uncorrelated. This is an example of a more general evolutionary theorem. Namely, that an aggregate is stationary if its components are uncorrelated with the dynamic process that determines the changing relative importance of each component in the aggregate.

But we can go further. Since $g_j = \psi_j \hat{q} + n$ it follows that

[19] The assumption that the capital co-efficient is the same for all firms within industry breaks the link with structural change at that level. However, the argument generalises without difficulty.

$$C_z(b,g) = \hat{q}C_z(\psi,b)$$

Thus, the underlying condition for the aggregate capital:output ratio to be independent of structural change is that the industry capital:output ratios be uncorrelated with the industry income elasticities of demand.

Now in determining the aggregate growth rate of capacity (the Harrod formula) we have of necessity used a capital:output ratio constructed with the weights y_j. They measure the contribution each industry makes to the aggregate growth rate, not the contribution, it makes to aggregate output, that is measured by z_j. The relation between the two aggregates is given by

$$\bar{b}_y = \frac{C_z(b,g)}{g} + \bar{b}_z$$

Thus the condition for $\bar{b}_z$ to be stationary in the processes of structural change is also the condition for $\bar{b}_y$ to equal $\bar{b}_z$ and thus to be stationary also.

The above case of capital market co-ordination is a special one but it is nonetheless a useful benchmark for further investigation. In this approach only one determinant of firm behaviour influences the aggregate growth rate at a point in time, the efficiency with which they use capital inputs. As soon as we depart from this special case, investment behaviour would also matter for the growth rate of capacity and thus for the growth rate of productivity. But this is another story.

The Mode and Tempo of Evolutionary Growth: Revolutionary Gradualism

We have argued that economic growth resides in the diversity of creative behaviours and their co-ordination within and between sectors. However, the pattern of co-ordination is restless, it changes incessantly from within as economic growth regenerates the variety in efficiency which ultimately underpins the dynamic of capitalism. This is the Schumpeterian theorem that capitalism develops from within. Now it is clear that our awareness of these dynamic processes will be critically sensitive to the level at which we observe them. It will be greatest within the sectors when we compare the different fortunes of the rival producers. At the sectoral level these fluctuations will to a degree have been averaged away, the basis for the Fisher Principle. As we move to progressively higher levels of aggregation, it is simple arithmetic which ensures that changes are progressively extinguished from view, so that one expects aggregate productivity growth to be a slow moving consequence of development and selection. The more we aggregate the more we hide the underlying mechanisms of enterprise and economic change, the more we emphasise inertia rather than flux.

One can see immediately that there is a long chain of influences through which a new innovation is ultimately captured in the statistics of aggregate productivity growth. The improvement within the individual firm is reflected in the productivity growth rate of the sector in proportion to the market share of that firm, and is in general changing with the process of competitive selection. Even if selection has a positive effect on that firm’s market position the effect on the aggregate economy depends on the relative size of the sector in which it operates. In a multi-sectoral economy it is a remarkable innovation indeed which shows up from its inception as a measurable change in the aggregate productivity growth rate. Such innovations need to affect many sectors simultaneously and these are rare[20]. This helps throw some light on the one important category of change that we have ignored, the addition of 'new' sectors and the demise of 'old' ones. New sectors can be vibrant sources of innovation and evolutionary competition but their emergence is likely to have little initial aggregate effect simply because they will, at this stage, only account for a small share of total employment. Similarly old sectors tend to fade away, to disappear not with a bang but with a whimper. They have ceased to be economically significant perhaps long before they disappear from the economic record[21]. In this way, the choice between economic gradualism and economic punctuation as descriptions of change depends very much upon the level at which one is looking. But this is an inherent feature of enterprise capitalism in which immense microdiversity is co-ordinated to produce the greater semblance of order at higher levels of aggregation. The simple point about capitalism is that it has, as it were, the characteristic of turning anarchy into order.

[20] Recent contributions have called these generic developments in technology. (Ref)
[21] This bears on the disputes in relation to the Industrial Revolution and the rate of productivity growth in the UK at the turn of the 18th century. In its early stages modern manufacturing could not be expected to have much of an effect, its weight was too small. Cf. Mokyr (1987), Crafts (1983). In general, it is impossible to identify the micro restlessness of capitalism from the record of aggregate growth rates.

Concluding Remarks

Why is capitalism restless? The answer provided here is that economic agents are not passive recipients of messages emanating from the environment, they are not cybernetic reactors to use Langlois' perceptive phrase (Langlois, 1983). Rather they are imaginative and creative interpreters of messages flowing from an environment which is itself a product of human design. Consequently, knowledge grows inseparably from the day-to-day conduct of economic activity, and this new knowledge inevitably is unevenly distributed and inevitably opens up further opportunities for innovation and investment, that is, new growth opportunities. Such knowledge driven systems are not only unpredictable in detailed consequences, they are necessarily evolutionary in their nature. Thus I have sought to clarify the links between variety in efficiency, innovation and investment as the pillars of the creative view on economic growth.

I have chosen restless capitalism as a suitable metaphor for the nature of economic growth, precisely because of its link with evolutionary processes. Growth depends on variety in microeconomic behaviours, on investment and innovation, and in the co-ordination of those behaviours by market processes. In the immense micro-diversity of creative behaviours lies the foundation for growth in output and productivity. I have not attempted to connect this picture of open-ended growth with the important growth and development literature developed in the 1950s by among others Hirschman (1958). This highly original literature linked growth to structural change within a world of disaggregated economic sectors, demand interlinkages and increasing returns to create exactly the kind of dynamic complementarity highlighted in this paper. In his Ohlin lectures, Krugman (1995) has provided a detailed critique of that literature, advancing the claim that it failed to develop, and is now largely forgotten, because it did not come to terms with the connection between increasing returns and imperfectly competitive markets. I doubt whether this is the whole story. For the issue is not a question of increasing returns and imperfectly competitive equilibrium but rather increasing returns in relation to the competitive process. This is the core of the Smith-Young-Kaldor perspective on which part of this essay has been built. There are many sources of and kinds of increasing returns, many of which are incompatible with any competitive equilibrium. In contrast competition as an evolutionary process takes all forms of increasing returns in its stride, they simply speed up and influence the direction of change, and in no way threaten the wreckage of the economic analysis. They are the link between competition and the regeneration of variety. Hence growth, technical progress and the competitive process are inseparable. They are genuinely endogenous evolutionary processes driven by microeconomic diversity and co-ordinated by market and other institutions to generate emerging, ever-changing patterns of economic structure. If those development theorists have been forgotten it is more likely to be because the idea of equilibrium, competitive or not, was for them anathema.

Space precludes any development here of the implications for growth policy. Suffice it to say that they depend on a bottom up rather than an aggregate economy down perspective; that they depend on the stimulation of enterprise and entrepreneurship; and that they depend upon the open, unbiased operation of market institutions. They are properly described as policies for an experimental economy (Foss and Foss, 1999) and the problem for the policy makers is that they must accommodate the waste and narrowly conceived inefficiency which is essential to all evolutionary processes.

I have made much of the idea that capitalism in equilibrium is a contradiction in terms. By this I do not mean that we can dispense with market co-ordination as a central element in our economic understanding. One can dispense with particular hypotheses about individual behaviour, one cannot dispense with interaction. How the pieces fit together is what the economics of growth and competition is about and this means that one must treat seriously the instituted context in which enterprise paints its picture. This requires that we pay attention, not only to capital, labour and commodity markets but equally to the institutions which shape the growth and application of new knowledge at the level of the firm. In this regard the innovations systems literature has an important contribution to make to our understanding of economic growth as an evolutionary process (Edquist, 1996; Carlsson, 1995; Nelson, 1993; Freeman, 1987). Enterprise is as much about context as it is about idiosyncratic behaviours. History is open-ended, so is economic growth.

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