

Innovation, Profits and Growth: Schumpeter and Penrose

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1. Introduction

In this paper the Schumpeterian theory of profits and growth through innovation is revisited and recast, with explicit reference to the changing institutional form of innovation during the twentieth century. It is shown how many clues for the restatement and modernisation of Schumpeter's approach can be found in Edith Penrose's theory of the growth of the firm, her 1959 book having benefitted from her reading of what for our purposes are the crucial aspects of Schumpeter (1943). The paper has three parts following this introduction. Section 2 sets out an evolutionary or institutional account of how profits are created through innovation, which is contrasted with the standard interpretation of Schumpeter's theory found in the literature. It is argued that the standard interpretation does not do justice to Schumpeter's theory, but that the original theory requires adaptation in any case to better reflect the means by which capitalist institutions have promoted innovation during and beyond the twentieth century. The third section reviews Penrose's work on the growth of the modern firm, demonstrating how she incorporated Schumpeter's insights into her thinking, and explaining how her approach provides a link between Schumpeter's theory and the modern institutional form of innovation in the large firm. The remainder of the paper in section 4 illustrates and elaborates upon the argument through some evidence on the changing form of innovation in large firms in the major industrialised countries during a first phase roughly from 1900 to 1970, and a more recent phase from around 1970 onwards.

It is contended that innovation has relied on the creation of technological or social capability, through problem-solving or learning activities principally within (and between) large firms. The development of new products and processes is the outcome of a path-dependent building upon established capabilities and achievements, by the critical revision of emergent new products or methods and the search for relevant novelty. This insight into the form of innovation is an amalgam of the conclusions of the work of Usher (1954) and Rosenberg (1976, 1982, 1994) on the history of technology, Nelson and Winter (1982) on the evolutionary theory of economic change, as well as Penrose's (1959) theory of the growth of the firm. Thus, innovation depends upon the generation of feasible new capabilities, the operation of which adds new value to the existing circular stream of income, and thereby creates new profits and higher income.

By contrast, the standard interpretation of Schumpeter's theory of profits through innovation focuses upon the quasi-monopoly positions developed in markets by entrepreneurial firms that enjoy first mover advantages. This common approach to Schumpeter's theory renders it understandable within the conventional framework of market-based analysis, in which institutions are discussed only

with regard to their role in the process of economic exchange, primarily through markets (or with reference to a hypothetical alternative market in the case of transactions within firms). Since the leading innovators establish a temporary monopoly within some output (product) or input (process) markets they obtain 'super' profits from innovation, typically associated with higher output prices and lower input prices or costs. But this brings us back to issues of the distribution of the circular flow of income, a flow that is sustained through markets, rather than the question of how that flow can be increased over time as new value-generating activities are added into the stream. In other words the standard treatment reduces the means by which profits can be earned through innovation to a matter of the capacity for static appropriability through the exercise of market power, and hence analytically no different to any other kind of 'normal' profits. The relevant markets may be new, but their newness is significant only for its relationship to the scope for temporary monopolies. The distinctiveness of Schumpeter's notion of adding to the existing circular flow of income is lost.

Schumpeter's (1934) original theory of innovative profits emphasised the role of entrepreneurship (his term was entrepreneurial profits) and the seeking out of opportunities for novel value-generating activities which would expand (and transform) the circular flow of income, but it did so with reference to a distinction between invention or discovery on the one hand and innovation, commercialisation and entrepreneurship on the other. This separation of invention and innovation marked out the typical nineteenth century institutional model of innovation, in which independent inventors typically fed discoveries as potential inputs to entrepreneurial firms. After his early work on entrepreneurship, Schumpeter became only too aware of the rise of in-house corporate research and development (R&D) in large firms in the twentieth century, to the extent that the literature now distinguishes his 'Mark I' model of innovation from his 'Mark II' model in which innovation was envisaged as a more routinised process within large firms (Phillips, 1971). The Mark I model is associated with Schumpeter (1934) originally published in 1911, and the Mark II model with Schumpeter (1943). Indeed, this shift in Schumpeter's thinking towards the role of large oligopolistic firms as the key agents for innovation might be thought to reinforce the conventional interpretation of his earlier theory of innovative profits, since these large firms certainly exercise market power, and in what has become known as the 'Schumpeterian hypothesis' Schumpeter himself is now widely believed to have thought in terms of a link running from market power to the extent to which resources are devoted to innovation. However, I argue here that the so-called 'Schumpeterian hypothesis' which links profits based on market power with innovation is a misunderstanding of Schumpeter (1943) which is due to an attempt to recast his insights from within what he labelled traditional theory; and that Schumpeter himself did not revise his earlier theory of profits when

advancing his Mark II model, but in fact reiterated his view of the distinctiveness of profits from innovation as opposed to market power, although without working through the implications of endogenous innovation in large firms for his theory.¹ In any case, recent empirical research has cast doubt upon the alleged association between market power, firm size and innovation, and suggests that smaller firms may be highly innovative as well, especially through their interactions with large firms in the same industry (Pavitt, Robson and Townsend, 1987; Audretsch, 1995). In other words, the critical contribution of large firms to modern innovation may lie instead in their creation of novel technological capability run by skilled teams and developed through their continual problem-solving activity, which becomes a resource for other firms with which they cooperate as well as for themselves (Loasby, 1998). This alternative perspective returns us to Schumpeter's original emphasis on creating new value-generating activities as a means of searching for higher profits from innovation, as opposed to statically maximising profits by appropriating higher rents from an existing income stream.

In section 3 of the paper it is argued that Penrose (1959) relied on an approach to profits and innovation in the firm that implicitly embodies the most important elements of Schumpeter's original theory (that is, the elements which are most important for our purposes), and she explicitly incorporated the role of in-house research and development and endogenous innovation in large firms. As such, she helps us to link together these two aspects and from that vantage point to expand upon Schumpeter's theory of innovation, profits and growth for a modern institutional setting. What is more, as is perhaps better known and is referred to in other chapters, she anticipated the recent approach to technological change and the firm with her resource-based perspective on corporate growth. Hence, we can trace to Penrose the foundations of the approach taken here, which aims to connect Schumpeter's theory of innovation, profits and growth to the changing institutional reality of innovation since the start of the twentieth century.

In the final section 4 we relate our discussion to some evidence of recent studies on the changing institutional form of innovation over the last hundred years. By understanding how profits are created from innovation in an alternative evolutionary way through corporate learning and search processes, it can be appreciated how innovative profits are of steadily rising significance relative to the more traditional kind of profits derived from market power, given the way in which capitalist institutions have evolved during the twentieth century through to today. In the first phase or

¹ My attention was called to this by Richard Nelson's presentation in the plenary session 'Joseph Schumpeter 50 years on' at the International J.A. Schumpeter Society conference held in Manchester in June 2000, in which he argued that

paradigm in about the first three-quarters of the twentieth century, science-based innovation in large scale production facilities (as documented by Chandler, 1990) depended upon the capabilities that were associated with the rise of in-house corporate R&D in large industrial firms. Large firms became the key actors in combining the processes of invention and innovation, each individual firm being technologically specialised in a way that reflected the specific profile of corporate technological competence that it accumulated through cumulative path-dependent learning processes. An inter-company variety of capabilities gradually extended the reservoir of social capability for innovation, and hence broadened the foundations for the creation of profits through innovation.

In the most recent phase or paradigm from the latter part of the twentieth century onwards, science-based innovation has been combined with information and communication technologies in computerised and flexible production facilities. Large firms have remained the key actors in the accumulation of technological capabilities, but in an institutional context that now emphasises the economies of scope to be obtained from the fusion of interrelated capabilities, and a new role for the internationalisation of economic activity. Between firms this has taken the form of a growing number of inter-company alliances for the purposes of promoting innovation. Within large firms in-house R&D is increasingly directed to the emergent benefits of corporate technological diversification through novel and more complex combinations, and to the development of technological competence through internal international company networks. These latter international corporate networks for innovation mark a change in the institutional character of multinational firms in terms of how they innovate and organise their R&D. While in the past the internationalisation of firms was mainly a matter of the internationalisation of their markets and hence supporting through adaptation the wider exploitation of their established technological competences, it is now also becoming a matter of the internationalisation of their ability to create technological competences through the combination of geographically distinct lines of innovation. Of course, the greater scope for establishing such international research-based networks has depended upon organisational innovation and new types of managerial capabilities, as stressed by scholars of business strategy. The emergence of institutions that can accommodate successful international integration of corporate innovation implies a shift away from obtaining profits through the exploitation of established capabilities through new positions of market power abroad, towards the creation of innovative profits by building new capabilities through knowledge exchanges and

there was no evidence of what has subsequently become known as the 'Schumpeterian hypothesis' to be found in Schumpeter's own writings.

cooperative learning, and thereby utilising cross-border networks for the establishment of new value-generating activities. These recent changes have further reinforced the growing relative importance of innovative profits of the original Schumpeterian or Penrosian kind, when the conceptualisation of innovative profits is suitably reinterpreted to fit the current institutional conditions for innovation.

2. Schumpeter's theory of profits through innovation revisited

Schumpeter (1934) relied on a distinction between two realms of economic analysis, and corresponding to these realms are two different means for creating profits. The first realm is grounded on the circular flow of income, and this is the realm of traditional economic theory focused upon the determination of prices and quantities in the markets that link together the flows of inputs and products. In this realm the economy is most easily analysed as either stationary or as growing at a steady state in the form of a simple reproduction of at least some existing elements of the economy on an expanded scale. Profits derive from positions of market power (some might say from market imperfections), since in perfectly competitive conditions profits would be driven to zero. However, Schumpeter (1943) argued that perfectly competitive markets had never existed and would never exist, so comparisons with this hypothetical state are unhelpful. So let us suppose that there is some irreducible degree of market power inherent in every market in practice, which is then associated with positive 'normal' profits (in equilibrium, leaving aside issues of recession or declining demand and the like). In this traditional context of price and quantity setting in the realm of circulation or markets, an increase in profits to values above the 'normal' must be attributed to a rise in the degree of market power. Now when profits are achieved through the market-based adjustment of prices and quantities by firms that possess the market power to do so, then it is appropriate to use the conventional apparatus for the analysis of profit maximisation and optimisation by rational economic agents. This is the sphere of most mainstream or orthodox economic analysis.²

The second realm is that of novelty-creating economic activity which generates new sources of value-adding productive endeavour, and which disturbs the circular flow of income. In this realm growth must be understood as an inherently disruptive rather than as a smooth process, which the later Schumpeter (1943) termed 'creative destruction' (although this term is also often misunderstood, as the disruption referred to relates to the circular flow and established market structures, but the creative process itself is likely to be cumulative and incremental, as argued below and by Cantwell and Fai, 1999). Profits derive from creating new fields of productive activity, given

that there is an inertia in the wages of the firms responsible, such that their wage costs only rise with a lag. A traditional theorist might reply here that such profits are still conditioned on the fact that markets do not adjust instantaneously (wages being bid up immediately in the labour market to match higher productivity), but the source of the profits is the creative process that added new value to the income stream - and this type of departure from a hypothetical absence of any kind of market power is highly socially beneficial, since everyone enjoys higher income in the long run as a result. Following successful innovation workers do earn higher wages on average, but only high enough to leave room as well for a return as well to the creation of a collective social capability, which is jointly exercised especially in large firms, and does not initially accrue to the individuals that make up an innovating firm's team. The value created by the collective operation is greater than the sum of the parts, and the individuals concerned could not appropriate a higher return on their own particular knowledge or contribution were they to set up independently, so in this sense there is no market failure or departure from rational behaviour. The increase in profits over and above the 'normal' are not in this case due to an increase in the degree of market power at a given point in time, but rather are due to a continual process of creating new value-adding activities. It is a process of incessant change and improvement despite a tendency within markets for such profits to be subsequently whittled away (were there no further change) through technological competition. The elements of market power in the position of an innovating firm are not the source of the new value, but are rather a coincidental by-product (when viewed from the perspective of the realm of circulation) of the uneven character of the creative process (which stems principally from the realm of production). Given the uncertain and the experimental nature of the process of innovation which follows a course of trial and error including an inevitability of some mistakes (Nelson and Winter, 1982), this second category of profits is best characterised analytically in a framework of a search for higher profits, and not within the standard framework of profit maximisation strictly interpreted (even if stylised as 'long run' profit maximisation, since this is not achievable as a behavioural strategy in the context of experimentation).

These two different realms of profits, which correspond to two different realms of economic analysis with alternative focuses of attention and corresponding methodologies, can be linked as well with two different functions of the firm, as discussed by Penrose (1959) in the early sections of her book. The firm is in part a price and output decision-taker, in which guise it can earn higher profits through increasing its degree of market power, but the firm is also a device for innovation, problem-

² It might be noted in passing that it is also the sphere of a lot of non-orthodox economic analysis, such as that of Marxists that emphasise the market power of multinational firms, or neo-Ricardians that emphasise the bargaining strengths of capitalists as against workers.

solving and cumulative learning in production, the incentive for which is to generate higher profits through creating new areas of social or productive capability. While Schumpeter suggested that the first realm of the market-based allocation of resources and coordination could be left to the closed system of Walras and his own contribution was focused instead mainly on the second realm of innovation, for her part similarly Penrose suggested that the first realm could be left to the conventional theory of the firm which was thus set apart from her separate theory of the *growth* of the firm ("so long as it cultivates its own garden and we cultivate ours", Penrose, 1959, p.10) (see Loasby, 2000).

It turns out that both the common misunderstandings of Schumpeter's two primary arguments to which we referred earlier can be reduced to attempts to recreate his contentions about the source of innovative profits and their relationship to market power within the framework and constraints of the first realm of analysis, when they can only be properly and fully comprehended when placed in their original and more appropriate context of the second realm. His theory of innovative profits depends upon creating new fields of productive endeavour to add to and restructure the established circular flow of income and cannot be understood by means of a simple reference to the building of temporary positions of market power within that circular flow. Likewise, Schumpeter's view that when areas of market power are the occasional effects of a continuous stream of innovation from within large firms such monopolistic positions in the market are an incidental by-product and not the source of innovative profits, became inverted in the so-called 'Schumpeterian hypothesis' which held that market power is the cause of innovation by providing resources and safeguarding against the potential downside of risk-taking activity. The attribution of the latter idea to Schumpeter (1943) seems to come from a misreading of his Chapter 8 on Monopolistic Practices, in which his criticisms of the notion of perfect competition and its inconsistency with a regime of innovation and creative destruction were taken as an advocacy of the benefits of market power and imperfect markets for innovation, when viewed through the lens of conventional market-based analysis. Instead, Schumpeter's real point was that the very intellectual framework which gave rise to the hypothetical concept of perfect competition as an extreme point on a spectrum of market structures was misplaced when it comes to the analysis of innovation, but this point could hardly be absorbed by those whose objective it was to try and introduce reference to the scope for innovation within the confines of the traditional analysis of market structure and resource allocation. His idea was simply too revolutionary to be taken on board, and so it could only be accommodated partially and hence in the process in a misleading fashion.

So in order to better understand and appreciate the significance of Schumpeter's own view let us allow him to speak for himself. First of all, it is important to understand the context which was set for his chapter on Monopolistic Practices by the preceding Chapter 7 on The Process of Creative Destruction. In a quotation that is now well known amongst evolutionary economists, as part of an effort to show the need for the analysis of a process in its own right and not through the device of comparative statics, Schumpeter says:

"The essential point to grasp is that in dealing with capitalism we are dealing with an evolutionary process. It may seem strange that anyone can fail to see so obvious a fact which moreover was long ago emphasised by Karl Marx."³ (Schumpeter, 1943, p. 82.)

The profits that derive from evolutionary processes over time can be best characterised as the outcome of profit-seeking activities, in contrast to the strict notion of profit maximisation which better describes the profits that result from coordinating activities at a given point of time and with given technology; and over the longer term innovative profits are probably more important:

"A system - any system, economic or other - that at *every* given point in time fully utilises its possibilities to the best advantage may yet in the long run be inferior to a system that does so at *no* given point in time, because the latter's failure to do so may be a condition for the level or speed of long-run performance." (Schumpeter, 1943, p. 83.)

Crucially, in order to understand how to interpret Schumpeter's subsequent discussion of monopolistic practices (which follows immediately in his book), he goes on to argue that when monopolistic positions are created through innovation they are not intentionally profit-maximising despite any appearance of being so since they are merely one aspect of a wider process of transformation, and so innovation requires competition to be analysed in a fundamentally different framework:

³ In turn, in order to understand the context for this remark it should be recalled that the first four chapters of Schumpeter's book were devoted to an appraisal of Marx, from which there are three points worth noting for our purposes. First, Schumpeter draws a contrast between the evolutionary Marx as an economist and the revolutionary Marx as a sociologist, and believed that it was possible to isolate the evolutionary economic aspects of his work: "To say that Marx, stripped of phrases, admits of interpretation in a conservative sense is only saying that he can be taken seriously" (Schumpeter, 1943, p. 58). Although Schumpeter's view runs against the whole tenor of twentieth century Marxism, perhaps it might be more readily accepted today. Second, Schumpeter criticises Marx's supposed solution to the question of the origins of profit (surplus value) through the concept of a market for labour power in place of the conventional labour market. But in doing so Schumpeter focuses his attack on Marx's use of this device to explain the creation of absolute surplus value through lengthening the working day or increasing the intensity of work; while arguably the more significant application was how Marx explained the creation of relative surplus value through productivity-raising innovation, and hence introduced the distinction between the two types of profit emphasised by Schumpeter himself. Third, indeed, just as Marx learned much through an intense criticism of Ricardo (as noted by Schumpeter), so Schumpeter appears to have learned much from his detailed critique of Marx, and this is reflected in his own theory of innovation which incorporates many of Marx's insights (on which see Rosenberg, 1976, 1982, 1994). Just as Marx took the parts of Ricardo that he needed and critically demolished the redundant parts that didn't fit with his argument, so Schumpeter did the same with Marx.

"In other words the problem that is usually being visualised is how capitalism administers existing structures, whereas the relevant problem is how it creates and destroys them.....However, it is still competition within a rigid pattern of invariant conditions, methods of production and forms of industrial organization in particular, that practically monopolizes attention. But in capitalist reality as distinguished from the textbook picture, it is not that kind of competition which counts but the competition from the new commodity, the new technology, the new source of supply, the new type of organization...." (Schumpeter, 1943, p. 84.)

Schumpeter claims that with innovation output expands despite restrictive practices, unlike in the conventional account of the effect of monopoly, but this is not because these restrictive practices are themselves the source of the incentive to innovate. In this context the motive for restrictive practices is to facilitate further learning and inter-company knowledge transfer in an environment of rapid change, within which such practices provide some temporary stability so as to be able to introduce new products or processes more gradually (in an evolutionary and path-dependent fashion, learning in the process) and hence more effectively, so as to raise the longer term growth of output. Thus, any monopolistic price and output decisions in a changing market are a coincidental (and transitory) source of profits, and should be distinguished from the profits due to innovation as such:

"Thus it is true that there is or may be an element of genuine monopoly gain in those entrepreneurial profits which are the prizes offered by capitalist society to the successful innovator. But the quantitative importance of that element, its volatile nature and its function in the process in which it emerges put it in a class by itself. The main value to a concern of a single seller position that is secured by patent or monopolistic strategy does not consist so much in the opportunity to behave temporarily according to the monopolistic schema, as in the protection it affords against temporary disorganization of the market and the space it secures for long-range planning." (Schumpeter, 1943, pp. 102-103.)

This is a quotation which we can be sure does not appear in orthodox references to the 'Schumpeterian hypothesis', since it disputes the so-called 'Schumpeterian hypothesis' and challenges the very notion of analysing innovation as the outcome of the degree of market power associated with one particular kind of market structure as opposed to another. Schumpeter does then go on to show how the hypothetical regime of perfect competition would be even less desirable with respect to technological dynamism, but he did so in the context of a thorough critique of the conventional market structure framework as a whole, rather than (and indeed explicitly not) to associate innovative profits with market power. From here, in what would become a link with Penrose, Schumpeter argued that the large firm was more an innovator and an organizational device for

learning beyond being a price and quantity decision taker, and within innovation (much more clearly than in his first book) he stresses the centrality of technological change in production:

"What we have got to accept is that it [the large-scale establishment or unit of control] has come to be the most powerful engine of that [economic] progress and in particular of the long-run expansion of total output not only in spite of, but to a considerable extent through, this strategy which looks so restrictive when viewed in the individual case and from the individual point of time....Was not the observed performance due to that stream of inventions that revolutionized the technique of production rather than the businessman's hunt for profits? The answer is in the negative. The carrying into effect of those technological novelties was of the essence of that hunt." (Schumpeter, 1943, pp. 106 and 110.)

So we have seen that far from abandoning his earlier theory of innovative profits in his analysis of the later phase of trustified capitalism, Schumpeter reasserted that theory and continued to draw a clear conceptual distinction between the profits which are due to the market power of monopolistic or oligopolistic firms and the profits they earn from their capacity to innovate, and indeed to insist on the priority of the latter over the former. However, in this event the original theory was in need of extension in order to accommodate the significance of inter-company technological cooperation as well as competition, and the blurring of the distinction between innovation and imitation to which Schumpeter continued to adhere, but which is by now more obviously unsustainable (since with greater technological complexity imitation requires the related absorptive capacity that comes from innovation, and innovation always incorporates some elements of imitation). In this respect the problem with the original formulation of the theory is that it stresses the need to identify the original sources of innovation as opposed to subsequent imitation in order to determine the distribution of innovative profits, with the initial leaders (innovators) earning the higher share. It is true that a useful recent literature has continued in this tradition to distinguish between 'Schumpeter Mark I' and 'Schumpeter Mark II' technological regimes, according to whether innovations are introduced mainly by new entrants or by established firms (Malerba and Orsenigo, 1995; Breschi, Malerba and Orsenigo, 2000). Yet moving beyond this to link innovation with the distribution of profits and growth across firms, a drawback of Schumpeter's approach is that the first mover in a successful innovation does not always perform best.

Empirical evidence indicates that among large firms technological leaders tend to retain leadership positions from one phase of development to another (they are the companies specialised in the fields of technological opportunity), but at the level of the industry innovative profits and technology-based growth is highest the faster that other firms catch up (Cantwell and Andersen,

1996). This suggests that innovative profits are created by 'followers' and not just by 'leaders'. What is more, the technological leaders are not in general the firms that earn the highest profits within the industry or experience the most rapid growth (Teece, 1992; Andersen and Cantwell, 1999). Now none of this need be a problem once we accept that although social capability is created through internal learning processes within firms such learning is interactive and involves continuous exchanges of knowledge, whether through deliberate cooperation in learning or independent exchanges through licensing, imitation or the like (Cantwell and Barrera, 1998). Defining innovation to be what is new to a firm with its own differentiated area of expertise or what is new to a particular local context rather than as something new to the world as a whole (Nelson, 1993), the most effective corporate innovators are not necessarily the technological leaders whose expertise is focused on the leading edge fields as such. They may be other firms that have found the most productive industrial applications of the leading edge technologies, which applications themselves require further innovation and other supporting capabilities - linked in part to the process of critical revision of new technologies which enhances their workability and effectiveness, as emphasised by Usher (1954) and Rosenberg (1982).

This line of argument is now entirely intelligible in terms of the most recent literature on the evolutionary approach to technological change which has stemmed from the work of Nelson and Winter (1982) and Rosenberg (1982), and in the process rediscovered the contribution of Penrose (1959). In the evolutionary theory of technological change innovation is always context-specific and localised, and so requires the cost of further innovation to be transferred into some other context, but the cost or difficulty of subsequent innovation depends upon the initial degree of technological relatedness or complementarity between the activities (Cantwell and Barrera, 1998), and upon the degree of absorptive capacity in the recipient or imitating firm (Cohen and Levinthal, 1989). When firms have a higher degree of technological complementarity between their profiles of specialisation they will each have a greater absorptive capacity with respect to taking advantage of the knowledge being created by the other, and so they will be better able to mutually make use of technology-based alliances and the external capabilities that can be accessed through inter-firm cooperation (Cantwell and Colombo, 2000). In the network of inter-company interaction in innovation the greatest profits are likely to accrue to the firm with the best fit between initial capabilities and the new field of opportunity, as opposed to the firm that first initiates a new line of innovation. The greatest benefits go not to the 'first to discover' or the 'first to commercialise' a core technology with important implications, but rather to firms whose social capabilities are best adapted to absorb and to further develop and entrepreneurially to apply the new lines of innovation that emerge from the areas of

greatest technological opportunity to novel contexts and in new combinations with other branches of (and perhaps more traditional) technology.

According to this view Schumpeter's theory of innovative profits should be retained, but his underlying theory of innovation needs to be strengthened in the modern institutional context. It is not necessarily technological leaders that become the best innovators, let alone the only innovators, but rather the firms that succeed in making the most effective combinations between new and old technologies and uncovering the most conducive new fields of application. Actually, abolishing the hard distinction between innovation and imitation only goes to reinforce Schumpeter's point about the distinctiveness of innovative profits which has been stressed above. Innovative profits should not be understood as the returns to the temporary positions of monopolistic market power enjoyed by first movers, but rather represent a return to the creation of the social capability that enables firms to experiment with new technological combinations and solve the problems that arise in doing so, and hence to learn and to innovate in production successfully.

3. Penrose on profits, growth and path-dependent learning in large firms

Penrose identified herself clearly with those such as Schumpeter that were mainly interested in the second realm above of innovation, productive experimentation and novel creativity, rather than in the first realm of coordination, exchange and market power. She focused on innovation as the source of profits, which would be achieved through learning to develop new applications of the current resource base of the firm, as opposed to profits due to the market positioning of the firm or the rents achieved through market power. So like Schumpeter before her and Nelson and Winter subsequently, Penrose stylised the firm as a profit-seeker rather than as a profit-maximiser. She argued that in the most successful and longest standing firms (on which her attention was concentrated) profits were typically desired for the sake of the firm itself, to facilitate a stream of continued longer-term profit creation through the expansion of the firm, by developing and taking advantage of the opportunities provided by the firm's capabilities or resources. Thus, she claimed that the goals of profit-seeking and raising through appropriate investment the long run rate of growth of the firm became equivalent, since each was derived from the innovative adaptation and extension of the firm's resource base. Echoing Schumpeter's view that innovation is the only reliable basis for longer-term corporate growth as distinct from the shorter-term gains that might be made from monopolistic practices or market power she states:

"Examples of growth over long periods which can be attributed *exclusively* to such protection [market power] are rare, although elements of such protection are to be found in the position of nearly every large firm." (Penrose, 1959, p. 113.)

While acknowledging that the firm could create new opportunities through marketing and advertising by better exploiting its established competence as well as through the development of new technological competence, Penrose suggested that such a strategy is only feasible within its existing market areas. To diversify into new areas of specialisation requires the appropriate technological base to do so. In other words she asserted the ultimate primacy of the realm of productive and technological competence over that of exchange and selling relationships, since purely market exploiting activity works only within the confines of an established market area, and so must sooner or later run up against limits. Like Schumpeter she contrasted the attainment of a monopolistic market position and technological progressiveness as conceptually alternative (although in practice quite possibly correlated) routes to profitability and corporate survival. She argued that the seeking of the innovative profits needed for longer-term survival led to a wider range of diversification based on the underlying technological complementarity or relatedness of activities:

"Firms....'specialize'....in a much wider sense than the logic of industrial efficiency [cost minimisation and price competition] would suggest, for the kind of 'specialization' they seek is the development of a particular ability and strength in widely defined areas which will give them a special position *vis-à-vis* existing and potential competitors. In the long run the profitability, survival and growth of the firm does not depend so much on the efficiency with which it is able to organize the production of even a widely diversified range of products as it does on the ability of the firm to establish one or more wide and relatively 'impregnable' bases from which it can adapt and extend its operations in an uncertain, changing and competitive world." (Penrose, 1959, p. 137.)

Hence, Penrose had little use for her purposes for the standard model of the firm as a price and output decision-taker (the coordination-based theory of the firm), which was not designed for the analysis of a firm that is free to internally vary the kind of products it produces as it grows and to innovate by creating from within new products and processes (as in the capabilities-based approach to the firm, which she effectively initiated). She remarked:

"...we will be dealing with the firm as a growing organization, not as a 'price-and-output decision maker' for given products...." (Penrose, 1959, p. 14.)

She goes on to explain how the very nature of the social capabilities of the firm as embodied in its organisational structure is transformed as the technological base of the firm is expanded and increased in complexity. She was especially interested in large successful firms not because she

believed them to be representative of the population of firms as a whole (indeed she was careful to distinguish between the two), but rather because it is these large firms that encapsulate a repository of competence for the economy of which they are part, which today we might refer to as social capability but which she termed administrative organisation. Penrose spent some time discussing the relationship between the productive competence of firms and market demand, acknowledging of course that external changes in the structure of demand may be responsible for growth opportunities. However, as noted above she argued that a firm which lacked an adequate technological base would lack the capability to diversify, while conversely a firm with a strong degree of technological competence would find its opportunities for expansion likely to be so prevalent that it would have to choose carefully between many different possibilities of action. Indeed, in a view that anticipates quite well the later Cohen and Levinthal (1989) argument about the role of absorptive capacity, she emphasised that the very ability to perceive opportunities in the firm's external environment (including new market opportunities) depended upon the initial capabilities and resources of the firm:

"I have placed the emphasis on the significance of the resources with which a firm works and on the development of the experience and knowledge of a firm's personnel because these are the factors that will to a large extent determine the response of the firm to changes in the external world and also determine what it 'sees' in the external world." (Penrose, 1959, pp. 79-80.)

In this context Penrose referred as well to Schumpeter's contention that new products may be forced on consumers by the initiative of entrepreneurs where the latest fashion or model comes to be desired in its own right, but this is not necessary to understand why she wished to focus on the firm as a repository of capabilities or resources as opposed to the coordination functions of the firm. Rather she believed that innovation-based profitability and growth is essential to the firm's longer-term survival, that it is 'built into' or inherent in the characteristics of every successful firm, and hence that the firm can be most usefully depicted as a device for learning and the posing and solving of new problems in its field of expertise and production. New products and processes are in her view created through learning from the established resources and technological base of the firm, by extending and adapting it for novel purposes:

"Consequently if we can assume that businessmen believe there is more to know about the resources they are working with than they do know at any given point in time, and that more knowledge would be likely to improve the efficiency and profitability of their firm, then unknown and unused productive services [from existing resources] immediately become of considerable importance, not only because the belief that they exist acts as an incentive to acquire new knowledge, but also because they shape the scope and direction of the search for knowledge both

an automatic increase in knowledge and an incentive to search for new knowledge are, as it were, 'built into' the very nature of firms possessing entrepreneurial resources of even average initiative. Physically describable resources are purchased in the market for their known services; but as soon as they become part of a firm the range of services they are capable of yielding starts to change. The services that resources will yield depend on the capacities of the men using them, but the development of the capacities of men is partly shaped by the resources men deal with. The two together create the special productive opportunity of a particular firm." (Penrose, 1959, pp. 77-79.)

Indeed, Penrose began her book by remarking that there are forces inherent in the nature of firms that induce expansion even if all external conditions remain unchanged, and that the internal interaction between inherited resources and managerial perception is a dynamic process which encourages continuous corporate growth, but which constrains the achievable rate and direction of growth. From all this the centrality to her perspective of capabilities, corporate learning and innovation is quite clear, and as with Schumpeter conceptually separate from issues of market power or other aspects of the exchange and coordination of established products or activities. What is interesting here is not just her linking of Schumpeter's second realm of innovative profits to the resource-based theory of growth of the firm, but also the way in which as a result she depicted the direction of corporate learning and growth as a path-dependent resource-constrained process. In this respect she anticipated current ideas on the evolutionary approach to technological change, and in particular the notions of corporate technological trajectories (Dosi, 1982), corporate technological diversification (Pavitt, Robson and Townsend, 1989; Granstrand and Sjölander, 1990; Grandstrand, Patel and Pavitt, 1997) and corporate coherence in diversification (Teece, Dosi, Rumelt and Winter, 1994). Anticipating as well the argument of Cantwell and Fai (1999) that since innovation is rooted principally in internal learning within the firm, technological competence evolves gradually and changes much less dramatically than the composition of downstream products or markets, Penrose claimed that each successful firm had a continuity which was provided by its capabilities or resources:

"In practice the name of a firm may change, its managing personnel and its owners may change, the products it produces may change, its geographical location may change, its legal form may change....[yet] the identity of the firm can be maintained through many kinds of changes, but it cannot survive the dispersal of its assets and personnel nor complete absorption in an entirely different administrative framework. The general direction of innovation in the firm (including innovation in production) is not haphazard but is closely related to the nature of existing resources...and to the type and range of productive services they can render. The Schumpeterian

process of 'creative destruction' [of established products] has not destroyed the large firm; on the contrary, it has forced it to become more and more 'creative' [in the adaptation and application of its capabilities].when it [a firm] develops a specialized knowledge of a technology which is not in itself very specific to any particular kind of product...it [research] enables at least the large firms to turn aside the process of 'creative destruction' and to thrive on the novelty which might otherwise have destroyed them." (Penrose, 1959, pp. 22-23, 84, 106 and 115.)

As was argued that has now actually occurred at the start of this paper, from here Penrose was led to forecast that there would be an increasing impetus to innovation as the basis for profits (innovative profits, as opposed to profits due to market power) as the role of technological competition rises. However, at the same time she noted that greater technological competition would compel firms to specialise in a narrower range of basic areas of production, since resources would be increasingly tied up in continual innovation which would restrict the rate at which they can diversify their fundamental activities (Penrose, 1959, pp. 106-107). This was a remarkable anticipation of the modern trend towards corporate technological diversification or more properly a restructuring of diverse technological capabilities around the clusters of greatest interrelatedness (Cantwell and Santangelo, 2000), accompanied by greater product concentration (less diversification across products or lines of business activity). However, as was more appropriate to the historical period in which she herself was writing, and to the earlier stages of large firm growth, Penrose tended to stress how technological diversification would in general facilitate and support greater product diversification:

"There is no reason to assume that the new knowledge and services [from corporate exploration and research] will be useful only in the production of a firm's existing products; on the contrary, they may well be useless for that purpose but still provide a foundation which will give the firm an advantage in some entirely new area." (Penrose, 1959, pp. 114-115.)

As has now been described in a detailed historical survey by Chandler (1990), and as Penrose had observed from her own collection of case study evidence, for most of the twentieth century large firms grew through a combination of technological diversification from their initial resource base linked to related product diversification, or what Chandler later depicted as the interlinkage between the economies of scale and scope. Penrose indicated as well that the greater market spread that accompanied technological diversification through innovation from within the resource base of the large firm may entail either product diversification or geographical diversification. Hence, industrial diversification or internationalisation could be considered substitutes for a particular firm at a given point in time given the resource constraint upon its overall rate of growth (see Cantwell and

Piscitello, 2000, for a discussion of how this relationship later shifted from one of substitutability to one of complementarity). However, it should be underlined that for Penrose the substitutability between different types of new market entry was not a result of her trying to focus on the realm of market exploitation rather than competence creation (selecting between alternative ways of exploiting a given competence), but was on the contrary the outcome of her focus upon the nature of competence creation in the specific historical context in which she was writing, at which time any diversification of the basic market area(s) of the firm tended to require a supporting diversification of the firm's technological base. This emphasis upon capability formation from the resource base of the firm rather than market exploitation should already be clear from what has been said of Penrose's central focus upon the firm as a device for innovation and knowledge creation rather than as a means of coordinating established activities. However, she believed that the scope of feasible technological diversification would not only regulate the degree of market spread, but a move into markets that require a complementary technological base may result in positive feedbacks to further innovation. If there were no such feedbacks the long-term rationale for common ownership in the firm would be weak and the character of the investment association between the parts of the enterprise would be qualitatively different than in a coherent corporate group:

"...expansion by acquisition does not necessarily, or perhaps even usually, mean that a firm is entering a field for which it would otherwise have no qualifications. Acquisition is often a profitable process precisely *because* the firm has peculiar qualifications in the new field. In some cases [of exceptions in which foreign subsidiaries operate independently of their parents]...the acquisition of foreign subsidiaries should be treated...simply as an investment akin to investments in financial assets [as a portfolio rather than as a direct investment]" (Penrose, 1959, p. 129 and 193.)

Thus, Penrose asserted the need for coherence in the technological and productive activities of the firm from the perspective of the capacity to continue to innovate and grow as a combined organisation, although not necessarily from the perspective of the pure realm of coordination, which may be instead essentially a financial perspective. By thinking in terms of feedbacks to subsequent growth perhaps Penrose also to some extent anticipated the notion of intra-firm networks of competence creation, but at least at an international level for cross-border innovative feedback to become fully effective was to wait for the new historical phase of integrated multinational firms only from around 1980 onwards (Cantwell, 1989; Cantwell and Piscitello, 2000).

4. The changing institutional form of innovation

Something has already been said of the way in which the institutional conditions for innovation in large firms have shifted since Schumpeter's day, and to some extent since Penrose's early contribution as well, although she said much which anticipated these changes. The import of this shift in institutional regime has been to reinforce the significance of innovative profits as against the profit and growth strategies associated with market power. Hence, the arguments of Penrose and Schumpeter are still more relevant today than at the time they were writing, once their essential themes are related to the modern context. The two major reasons why innovative profits are now even more relatively important are first that innovation has been increased in what modern Schumpeterians such as Freeman (1987) have termed a new techno-economic paradigm, and with a greater intensity of international competition positions of protected market power are increasingly under threat; and second, the firm must now rely on more complex combinations of related technologies to serve even more narrowly defined product markets, so relative to some given level of cost of the innovative development of resources the opportunities for establishing downstream monopolistic positions are reduced in this way as well. A by-product of these changes is that inter-company cooperation between large firms is increasingly motivated by the need for mutual technology-based exchanges and coordinated learning relative to the more traditional collusion to secure jointly exercised positions of market power.

Taking a step back for a moment, in the first phase of the growth of large firms that ran up until about 1970, as described by Chandler (1990) there was an interleaving between the economies of scale and scope. Large firms grew by diversifying their technological base, and in the process diversified their product markets in similar proportion, and together this combined diversification supported a rise in the scale of output. An essential plank behind this process was the rapid growth of in-house corporate R&D in the largest firms, as stressed by Schumpeter, which improved their innovative search activities, and their capacity for problem-solving and learning in an age in which science and technology began to become more interdependent with one another. Using the patents that large firms are granted from these problem-solving activities, we can trace their individual profiles of technological specialisation (Cantwell, 1993; Cantwell and Fai, 1999; Cantwell, 2000). What emerges from these studies is that these patterns of corporate technological specialisation are differentiated and firm-specific, that groups from common countries of origin have certain country-specific features in the form of their expertise, and that the profiles of specialisation persist over time, reflecting a path-dependent technological accumulation or corporate technological trajectories.

One other aspect of this empirical evidence on the history of corporate innovation patterns is worth emphasising in particular. This is the relationship between the degree of diversity of

technological activity in the firm and the overall scale of technological effort, the latter serving as a proxy as well for the scale of output of the firm since the various measures of size tend to be correlated across firms. It is well established that the degree of diversification rises with size, and we can plot a size-diversification relationship across large firms (size is measured by the total number of patents granted, and diversification by the reciprocal of the coefficient of variation across sectors in the index of corporate technological specialisation - see eg. Cantwell and Santangelo, 2000). Now the interesting point is that whether we are working with firms (Cantwell and Fai, 1999) or at the level of countries (Cantwell and Vertova, 1999) for most of the twentieth century the size-diversification frontier didn't shift very much. That is, most growth took the form of the joint achievement of increased scale and greater scope through a movement along the frontier, as diversification and growth went hand in hand, a statistical confirmation of the case study conclusions of Penrose and Chandler. However, in more recent times the size-diversification frontier has shifted quite markedly (Cantwell and Santangelo, 2000), which shows how the relationship between technological diversification and growth has become less simple than in the past. For firms the size-diversification frontier has tended to shift upwards (so the average extent of technological diversification controlling for size has risen), but it has also shifted rotationally so that the very largest firms have tended to reduce the diversity of their technological profiles. There is now an impetus for firms to achieve a minimum threshold degree of technological diversification to take advantage of greater interrelatedness, but the combinations constructed by the firm must also be coherent enough to focus upon potential linkages in which interrelatedness or technological complementarity is at its highest. At the level of countries instead the size-diversification frontier has shifted downwards, which shows that on average countries have increased the extent of their technological specialisation for any given size (Cantwell and Vertova, 1999). This is likely to be due to the effects of internationalisation of activity, leading locations to become more focused in their efforts while the largest firms span more technological fields and more geographical areas.

The increasing significance for firms of technological interrelatedness and fusion is one aspect of the historical shift mentioned earlier as having been termed a new techno-economic paradigm (Freeman and Perez, 1988). In this context a techno-economic paradigm is a system of scientific and productive activity based on a widespread cluster of innovations that represent a response to a related set of technological problems, relying on a common set of scientific principles and on similar organisational methods. The old paradigm until around 1970 was based on energy and oil-related technologies, and on mass production with its economies of scale and specialised corporate R&D. In recent years this has gradually been displaced by a new paradigm grounded on the economies of

scope as distinct from scale, and derived from the interaction between flexible but linked production facilities, and a greater diversity of search in R&D. Individual plant flexibility and intra-company network linkages both depend upon the new information and communication technologies (ICT).

Part of the reason for the increased extent of technological interactions within and between firms lies in the more sophisticated modern system of production as well in the more intensive linkages between science and technology in the current techno-economic paradigm, which relies on flexibility through computerisation and diversity through new combinations drawing upon a wider range of disciplines. Firms increase the returns on their own R&D through suitably adapting their underlying tacit capability so that they can absorb and apply the complementary knowledge acquired from other locations or from other firms more intensively in their own internal learning process. Technological diversification and internationalisation have become positively related in more internationally integrated multinational corporations (MNCs) since around 1980 (Cantwell and Piscitello, 2000). Apart from the rise in technological interrelatedness, the potential opportunities for cross-border learning within MNCs have been enhanced by an increased take-up of ICT technologies (Santangelo, 1999). ICT specialisation seems to amplify the firm's technological flexibility by enabling it to fuse together a wider range of formerly separate technologies. In this sense, in the current ICT-based paradigm government intervention is better geared towards the promotion of cross-firm and cross-border knowledge flows (presuming that firms follow the model of a continually interactive search for better methods and improved products, and hence a search for higher profits through experimental innovation in the fashion of Schumpeter and Penrose); rather than to provisions to protect the monopolistic and separate exploitation of knowledge by those that have independently invested in its creation (which could be more easily represented through an underlying model of static profit maximisation by firms through the exercise of market power) (Cantwell, 1999). Yet as stressed above, the theory of innovative profits needs revising in this era of greater technological interrelatedness in which firms must not only sustain an adequate spread of coherent in-house diversification but must be able to access other related capabilities through partnerships. It is not leadership in ICT as such that is likely to count for most, but rather the capacity to blend ICT with other technologies as a means of fusing them together and creating new combinations.

However, the creation of technology may be locationally concentrated or dispersed according to the degree of complexity embedded in it. Some kinds of technologies are geographically easily dispersed, whilst the uncodified character of others makes cross-broader learning within and across organisations much more difficult. Thus, although multinationals have shown a greater internationalisation of their R&D facilities recently, it depends upon the type of technological activity

involved. The development of science-based fields of activity (eg. ICT, biotechnology and new materials) and an industry's core technologies appear to require a greater intensity of face-to-face interaction (Cantwell and Santangelo, 2000). Nonetheless, it may sometimes still be the case that science-based and firm- and industry-specific core technologies are dispersed internationally. The main factors driving the occasional geographical dispersion of the creation of these kinds of otherwise highly localised technologies are either locally embedded specialisation which cannot be accessed elsewhere, or company-specific global strategies that utilise the development of an organisationally complex international network for technological learning (Cantwell and Santangelo, 1999).

The more typical pattern of international specialisation in innovative activity within the MNC is for the development of technologies that are core to the firm's industry to be concentrated at home, while other fields of technological activity may be located abroad, and in this sense the internationalisation of research tends to be complementary to the home base. Thus, when science-based technology creation is internationally dispersed it is most often attributable to foreign technology acquisition by the firms of 'other' industries - for example, chemical industry MNCs developing electrical technologies abroad, or electrical equipment MNCs developing specialised chemical processes outside their home countries (Cantwell and Santangelo, 1999, 2000; Cantwell and Kosmopulou, 2001).

Evidence has now emerged that the choice of foreign location for technological development in support of what is done in the home base of the MNC depends upon whether host regions within countries are either major centres for innovation or not (termed 'higher order' or 'lower order' regions by Cantwell and Iammarino, 1998, 2000). Whereas most regions are not major centres and tend to be highly specialised in their profile of technological development, and hence attract foreign-owned activity in the same narrow range of fields; in the major centres much of the locally-sited innovation of foreign-owned MNCs does not match very well the specific fields of local specialisation, but is rather geared towards the development of technologies that are core to the current techno-economic paradigm (notably ICT) or earlier paradigms (notably mechanical technologies) (Cantwell, Iammarino and Noonan, 2001). The need to develop these latter technologies is shared by the firms of all industries, and the knowledge spillovers between MNCs and local firms in this case may be inter-industry in character. Thus, ICT development in centres of excellence is not the prerequisite of firms of the ICT industries, but instead involves the efforts of the MNCs of other industries in these common locations.

It may also be the case that the development of the capability to manage a geographically complex international network lies in a firm's specialisation in ICT. The opportunities created for the fusion of formerly unrelated types of technology through ICT has made feasible new combinations of activities, the best centres of expertise for which may be geographically distant from one another. The enhanced expertise in ICT seems to provide a company with greater flexibility in the management of its geographically dispersed network, and an enhanced ability to combine distant learning processes in formerly separate activities. If this is the case for manufacturing companies in general, it is all the more true for electrical equipment and ICT specialist companies. Affiliate networks are increasingly used to source new technology. Accordingly, global learning has become an important mechanism for corporate technological renewal within MNCs.

The key importance of ICT to the now more complex management of innovation in MNCs is that it enables firms to better exploit their corporate technological diversification across national boundaries (Cantwell and Piscitello, 2000), owing to the role of ICT as a means of combining fields of knowledge creation that were previously kept largely apart (or what Kodama, 1992, terms technology fusion). However, while this use of ICT has led many smaller firms to extend the breadth of their technological diversification to create new combinations, in some of the very largest MNCs the extent of technological diversification has been reduced, so as to better focus on the most promising possible combinations from amongst the broader initial dispersion of innovative activity that such companies have inherited from the past (Cantwell and Santangelo, 2000). Thus, we find some convergence in the average degree of technological diversification across large firms, including amongst others in the pharmaceutical industry (Cantwell and Bachmann, 1998).

Freeman and Perez (1998) had argued that in the latest techno-economic paradigm ICT has become a 'carrier branch' or a 'transmission belt' for the transferal of innovation across sectors, analogous to the role played by the capital goods sector in the mechanisation paradigm in the nineteenth century (Rosenberg, 1976). Company evidence now suggests more than this that ICT has become also a core connector of potential fields of technological development within firms (or between firms in technology-based alliances) that facilitates the technological fusion of a formerly disparate spread of innovative activity. Thus, while in the past the machine-building industry simply passed knowledge of methods from one field of mechanical application to another, ICT potentially combines the variety of technological fields themselves and so increases the scope for wider innovation. Hence, innovation has become a still more central part of corporate development in the ICT age. Internationalisation through the MNC to connect together in a network related streams of locationally specialised innovation, in-house technological diversification and inter-company

technology-based alliances, and the corporate development and application of ICT have become intertwined in a new era of innovative capitalism. The perspective of Penrose and Schumpeter on innovation, profits and growth in the large firm has not only stood the test of time, but provides a crucial theoretical backdrop to the analysis of this modern form of innovative and international capitalism.

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