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Restless Knowledge, Capabilities and the Nature of the Modern Firm

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Introduction

In this essay we address a number of questions of relating to the nature of the modern firm and its role within a broad evolutionary economic approach. The central questions we pose are "What should we expect from a theory of the firm?" and "To what extent is the form and functioning of firms dependent on the wider set of economic contexts in which they operate?" Of course, these are not new questions but we will show that they are capable of generating rather different answers to those normally associated with traditional theories of the firm.

In addition to locating the firm in a modern economy in terms of technology and organisational innovations, we consider the instituted context of a modern economy in asking what type of firm is particularly fit in the environment there generated. Firms coexist in a bewildering variety of sizes, scope of operations, forms of governance and strategic objectives. The vast majority of firms remain small, are privately owned and produce a limited range of products serving a narrow range of customer needs. Many of these firms have short lives, and, of those that discover longevity, a very small number grow to a size and scope where there economic impact is vastly greater than their relative number in the overall population of firms. We need a theory of the firm to explain why some firms survive and grow, becoming the large and complex firms that dominate modern economies. In other words, we need a theory of the firm to understand why economies develop.

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We follow Richard Nelson who famously asked "Why firms differ and why does it matter" (Nelson 1991, 2008). In general terms, the proximate differences in firm behaviour that matter are differences in the nature, design and quality of what they produce, differences in the methods they use to produce these goods, differences in the rate at which they invest to expand their capability and capacity to produce the goods, and differences in their capacity to innovate to change what they produce and the technical and business processes they use to produce and distribute it. Of course, firms are complex organisational systems. Typically they produce more than one kind of commodity or service, sell in different kinds of markets to customers who put their goods and services to different uses, and purchase many different kinds of input to support their production activities. Each firm is typically a set of quasi-independent business units, each unit charged with a particular set of tasks, some centralised (investment planning or corporate research and development, for example), and others decentralised to the business units. These are the surface phenomena, and what we need to understand is what lies behind the content of a firm's activity and why this changes.

The complexity of the firm's organisation, the fact that it consists of multiple interdependent components connected in different ways is the natural starting point to explain why and how firms differ in their economic performance characteristics, the characteristics that underpin their scale, profitability, growth and innovativeness. One strand of this relates to the emergence of a sophisticated division of labour in the firm and the associated capabilities, whether managerial or shop floor, to execute particular tasks and to coordinate the operation of those tasks. This is the Penrose (1959) line of capability development within an administrative framework and we shall explore it in more detail below.

But there is a perhaps more fundamental strand to contend with in explaining why task and coordination capabilities differ across firms even those working in the same trade producing broadly similar products. This is the strand that relates to the knowledge and understanding contained in the firm. The claim developed below is that activity depends on reliable belief, which is to say on knowledge that "works" in the sense that it has yet to be falsified or tested to its detriment by a rival hypothesis. If several firms differ in their economic performance it is largely because they know differently, so we

need to understand the differential processes by which firms come to know what they know and the different ways that they articulate this knowing to competitive effect. To explore this theme we must turn to the question of knowledge, information and understanding.

Modern firms are organisations that involve many different types of individuals, including shareholders, managers, worker, suppliers and buyers. An effective organisation serves the many and often incompatible interests of its constituent members and is effective at combining their different skills in pursuit of its objectives. In economics it has become standard to measure the interests of individuals or organisations using an aggregate index, particularly utility or wealth. Here, we focus as well on further aspects of outcomes, aspects that are related to the dynamics of economic life. In particular, we put emphasis on change, the continual flow of novelty in economy, and on the variability of outcomes that ensue. We recognise failure (loss of livelihood, default, bankruptcy, repossession) and success (growth, accumulation, bonuses, esteem) as motivators of behaviour that provide a rationale for the attraction of individuals to organisations. Related to this, are the feelings of security (and insecurity) that come from involvement with an organisation.

The firm in traditional theory operates with given technology, given products and faces given factor supply conditions that serve to constrain its behaviour. These constraints have correspondingly been the focus of analysis, particularly the comparative statics of the impact of exogenous changes in technology and factor supply conditions. What is missing is an understanding of how firms might develop from within, to use Schumpeter's phrase, how they develop endogenously and deliberatively. The modern firm imagines and then pursues its products, technology and resources. It does not take its environment as given. It can't know the future but acts purposefully to change the constraints it faces.

One might reasonably suggest that the modern economic problem is fundamentally a problem of ignorance, a problem of the imperfection of human understanding and so cannot be portrayed in terms of perfectly and fully informed individuals or organisations. In a world of perfect knowledge no firm would differ from any other, it is only in a world of imperfect knowing that firms can be expected to be

different. Imperfect knowledge necessarily means differentiated knowledge because the knowledge of how further knowledge is to be acquired is different. Each firm develops its own individual way of dealing with the challenges and opportunities posed by this ignorance by pooling knowledge, pursuing new knowledge and acting on discoveries. Of course, for the firm to be able to function effectively in the realm of ignorance it requires more than the computational efficiency ascribed to it by neoclassical economics. It requires imagination as the counterpoint to ignorance. We propose that it is the requirements for functioning effectively in a realm of ignorance that shape the nature of the modern firm

Why Have Differentiation in the Theory of the Firm?

Why not start the theory of the firm, as in the modern neoclassical approach, with a uniform firm? After all, this simplification allows the analysis to proceed to questions of competition at the level of an industry without the clutter of myriad different actors. Furthermore, even when the modern neoclassical approach allows firms to choose among different technologies, inputs and outputs, the end result of competition among them is equilibrium with all firms acting in identical manner. Firms that don't achieve best practice disappear. Even in the short run, when firms have different assortments of fixed inputs, the firms producing a homogenous product end up with the same marginal cost and marginal product, so that they are equal in terms of optimality conditions.

A principal notion in any evolutionary theory of the population kind is the concept of variation, the idea that the members of the population in view differ in certain essential dimensions, that is to say, dimensions that determine their comparative rates of growth and decline. Evolutionary theory in this sense is naturally dynamic, it is an explanation of why and how the world changes in the way that it does. Such economic variations are the complement to the mechanisms of selection, economies evolve as they adapt to the potential for change implicit in the variation-cum-selection process. Consequently, an evolutionary approach is not concerned to explain similarities in behaviour but rather to explain the differences, precisely because a world of identical behaviours contains no evolutionary potential. Indeed, the idea of the uniform agent is a denial of the evolutionary process. In a sense, the traditional analysis can be viewed as

starting where the evolutionary analysis ends, with uniformity across the population of firms operating in a given environment (such as an industry). In this section, we ask what is lost to the theory of the firm by starting from uniformity.

First, and most obviously, starting from uniformity rules out having anything to say about a wide range of observable phenomena. Firms do differ. They differ in readily observable characteristics like size, productivity, quality and range of output, supply chain alliances, marketing campaigns, research and development activities (including external collaborations), human resources policies, etc. These differences in characteristics are then reflected in differences in observable firm performance in terms of survival, profitability, innovativeness and rates of growth.

Second, with uniform firms there can be no analysis of the competitive process that might ultimately lead to uniformity. Who wins, who loses, who grows, who declines, who survives and who becomes extinct? There is no answer to these questions in the modern neoclassical approach, except by tautology that the optimal firm conquers all. Only a thorough analysis of the process of dynamic competition can determine the conditions under which optimal behaviour will dominate. Once allowance is made for path dependency, mistakes can come to dominate, as the history of technology clearly reveals. Witness the QWERTY keyboard.

Third, starting from uniform rules detracts attention from the alternatives that firms might employ to guide their decision making. Optimisation, for example, suggests a calculation of across alternative actions and their possible consequences. This presumes the choice set is well defined and the consequences are known with certainty or with correct probabilities. The world is not so neat. Under the circumstances of the real world, does an attempt at optimisation as characterised in modern neoclassical economics, emphasising the correct choice of inputs to produce given outputs, outperform other decision rules?

The field of business strategy has a much richer conception of the rules for decision making available to firms. Porter (1985) poses the problem as one of choosing a strategy that is intended to result in sustainable competitive advantage. Calculations may be involved, but there is no equating of expected gains and losses at the margin. The essential difficulty is that what works best depends not only on the present state of the

world but on future states of the world and these states are not known, and indeed are unknowable, as we discuss in later sections of this essay. This opens the door to differentiation in strategy, meaning that otherwise similar firms may make different decisions about what to produce, what price to set, etc. Indeed, Roberts (2004, p.283) goes so far as to suggest that, 'there must be something distinctively different about the successful firm's strategy and organization' and that 'chasing after best practices is largely futile'. This puts paid to the idea that firms converge to a best-practice equilibrium characterised by all firms having identical optimal actions.

In order to understand the competitive process among firms following any rule of decision making, we ask what happens when knowledge is incomplete and indeed ever changing. When problems are well defined, optimisation is a feasible and desirable method of solution and in many cases a firm will face well defined problems. That is to say, a well defined problem is one for which knowledge is sufficient, in this sense knowledge is complete. Incomplete knowledge opens the door to rules for decision making that incorporate mechanisms other than optimisation because the problems are ill defined.

A key ingredient for dealing with such problems is imagination. Conjuring up the unknowable is a fuzzy process at best. The limitations of codified approaches, such as scenario planning, illustrate the nature of the problem which is to imagine the range of contingencies that define possible solutions. The imagination of different contingencies is equivalent to the imagination of different problem solutions, and no two individuals need identify the same list of contingencies. More generally, firms devise decision making processes that take account of both what can be calculated and their conjectures about the unknowable. Both the process and the outcome depend on what firms know and therefore how they think. This is the question to which we now turn.

What Do Firms Know and How Do They Know It?

Like many modern evolutionary scholars, we recognise that the firm is a knowledge based organisation, that the elaborate division of labour that characterises its internal operation is reflected in the multiple kinds of internal knowing and connections with external spheres of understanding. Of course, to say that a firm is knowledge based

carries little purchase, what else can it be? All activity, all organisation, presumes some human knowing, the possession of reliable beliefs about cause and effect, and changes of activity or organisation normally follow from some change in knowing within the firm. So the issue is not the brute connection between action and reliable belief but rather the processes that generate the many different sets of reliable beliefs on which the performance of a firm is premised. Not only different kinds of knowledge are in play (chemistry versus statistical inventory control versus the characteristics of its customers, for example) but different ways of accumulating knowledge and different ways of storing and transmitting knowledge.

But the chief characteristic of human knowing that we emphasise is its restless, self-transforming nature. Human beings are by nature inquisitive and although they may seek answers to the same question they will often have different answers. Indeed it is a defining aspect of success in science and enterprise precisely to formulate different answers. Humans are individuals to the extent that they think differently and are able to conjecture different answers to the same question. Different answers transform the state of knowing, such that every solution to a problem has the capacity to define further problems and the growth of human knowing becomes autocatalytic and open.

We begin to see in the light of this the fundamental reasons why firms differ. They differ because their employees conjecture differently and because the interaction and coordination between employees is organised differently. What employees conjecture differs because they are different individuals, with different capacities to understand different phenomena and different capacities to change their understanding. The firm's organisation further differentiates the learning process because of differences in the manner of learning across firms. Employees conjecture differently, they learn differently and so they imagine differently. While it might be tempting to treat the formation of conjecture as a random process, we would suggest that in fact it is a guided, path dependent process, contingent upon the particular entwining of creative ability and experience of each individual.

This is perhaps the most basic of the sources of business differentiation. New conjectures are constantly being added and diffused within the firm, whereas old conjectures are forgotten or even rejected. Without such a hypothesis about the dynamics

of knowing it is impossible to let the firm change endogenously, impossible to conceive of innovation, and if firms conjecture differently they necessarily must come to innovate differently. Because what each firm knows is distinct and individual its knowledge is necessarily incomplete. Several consequences follow.

First, with imperfect knowledge it is impossible to avoid making mistakes in the sense of taking actions that lead to outcomes inferior to what might have been achieved on the basis of better knowledge. Thus, neoclassical equilibrium based on perfect information (possession of the same knowledge by all participants) overstates the performance to be expected from individuals, organisations or from the decentralised market. Firms can improve on the actual performance of a group of individuals by providing an environment conducive to the pooling of knowledge.

Second, much behaviour is motivated by the pursuit of knowledge through learning or discovery because, for example, new knowledge can bring greater profitability or improved working conditions. This is dealt with in neoclassical economics only peripherally as activity leading to changes in equilibrium, but a knowledge based firm can never be in equilibrium unless the individuals within it have ceased to learn, ceased to imagine new possibilities. Modern firms contain internal and external learning networks that lead to discovery and potentially to the exploitation of these discoveries for the benefit of the group. Importantly, the exploitation of such discoveries becomes critical to long-run success in a dynamic economy and the modern firm is able to act on discoveries in spite of uncertainty regarding the outcome.

Thirdly, differential knowledge is fundamental to understanding the distribution of individual success or failure. Hence, the control of knowledge is an important motivator of behaviour. The ability of individuals to control complex knowledge is limited. Firms are better situated by size and by potential longevity to reap benefits of successfully controlling knowledge. They are also well suited to sharing the losses from failure, thereby insulating individuals within the firm from unfavourable consequences of uncertainty.

Let us hold to the idea that knowledge is conjecture that has been verified by experience, what does this imply about the knowledge base of a firm? The contrast is with belief, conjecture that is imagined but not verified. Knowledge and belief are states

of the individual mind, but the behaviour of firms depends on joint action, on coordination within and across teams of individuals, such that it cannot be that the knowledge of the team members is randomly associated. How is it that individual knowledge and belief can be mapped over to the action of the firm? This is a matter of coordination achieved through organisation.

Coordination depends on a degree of correlation of the knowledge of the team members, that they understand their tasks in common, that when asked a question or confronted by a command they act in very similar, typically indistinguishable, ways. This is crucial, correlated behaviour is constrained behaviour, reliable behaviour that is confidently shared. The degree of sharing of course is highly uneven, depending on the context. At one level it may involve knowledge that is shared with very few others, but by degrees of generalisation we find kinds of knowing that are shared across the business department, the whole firm and indeed an entire nation. How is this necessary correlation brought about?

To understand these complex phenomena is to clarify the relation between knowledge and information. If, as we claimed above, knowledge is a property, state of, the mind, it is necessarily inseparable from the person who knows. Information, by contrast, is an expression in some form of what the individual knows, it is not knowledge *per se*, but rather a particular representation of that knowing. Thus, information is a public representation of private knowing that is inherently incomplete.

As is often observed, some information is expressed in codified form, in writing, in film, in sound recording and in visual demonstration (the restaurant owner better have a good sense of smell and taste too!). Codification, and the technologies on which it depends, is indeed vital for the growth of human knowing, for it creates information in durable forms, forms that can be stored and transmitted over space independently of the original act of their creation. A distinct advantage to the modern firm is that information and communication requirements can be economised through appropriately designed organisation (Arrow, 1974).

Within the firm, the requirements for effective communication of information are of two distinct kinds. On the one hand, each team requires a high level of correlated knowledge to perform specialized tasks. On the other hand, the firm as a whole requires

overlapping knowledge to effect the coordination of tasks, meaning there can be gaps in correlation or at least a different degree of detail that is shared. The knowledge required for effective management of the organisation is different in detail, and perhaps in form, than that required to carry out the multitude of specialised tasks.

As we need hardly labour, information exists in many forms and is generated by widely different kinds of processes that appeal to different human senses. To interpret some new information may indeed require a considerable expenditure of time and effort in acquiring other complementary information before that new information can be read with effect. This differential capacity to transmit and receive is a fundamental aspect and consequence of the elaborate division of labour in the firm and in an economy. Putting it informally, individuals typically know a great deal about very little, they are trained to read some information with great facility but to be quite blind to other flows of information and the consequence is that the collective productivity of our knowledge based economy is in fact premised on large scale ignorance. We might as well speak of the ignorant society as the knowledge society for it is the feat performed in any modern economy to create wealth from knowledge by means of the widespread propagation of ignorance. There is nothing new in this claim, as Adam Smith knew very well. All of this has a considerable bearing on those approaches to the firm that treat it as an information generating and diffusing system, a system of transmitters, receptors and communication channels (Boulding, 1951).

As Polanyi (1975) suggests, any individual knows more than they can say and can say more than they can write. It is not necessarily the case that some forms of information are intrinsically non-codifiable, rather that, in many contexts codification would be an economic waste of resources, a process of recording very localised information soon to become obsolete. In such cases the spoken word dominates and authority, the exercise of power, is a typical correlating mechanism and it works because the messages are usually transient in their importance.

Every team based activity will need its own language to ensure that commands are understood in the correct way, and Arrow has hinted how this system or architecture of codes is one of the major capital investments distinguishing one firm from another. Other scholars, Nonaka and Tacheuchi (1995), in particular, have stressed the importance

of the tacit in internal communication processes and they are surely right to do so and thus to make clear the point that communication is more than a matter of (physical) communication channels.

Here we might add a point of some importance, given the suggestion that the boundaries of a firm are premised on a market failure in relation to the public good nature of knowledge. It is often and rightly said that information is a public good in that what is in the public domain may be accessed by many individuals other than the originator of that information and, moreover, may be used in any number of production processes. What it is not right to claim though is that the transmission of understanding can occur at zero real cost. Of course, the physical costs of transmission of information may be effectively zero but the costs of acquiring the capacity to transmit and, more fundamentally, the capacity to receive and learn from those messages is not costless-it often requires major investments in human capital.

A second aspect of the interplay between information flow and the change in the distribution of human knowing is the fact that it is transformed by introspection and by reason. This is what we mean by conjecture and imagination being an independent source of further knowledge which interacts with the processes of information communication. Absent human imagination and conjecture, beliefs held within the firm would not change. No new information would be generated to challenge prevailing states of knowing, knowledge of the firm would be stationary. Innovation would not be possible without this second aspect. This is the world of the stationary state, a logical statement of what an economy could not be as long as human individuality persists.

The crucial interplay between the diversity of conjectures and the development of knowledge has a very important implication, namely that while much information flow has the effect of correlating human understanding some of it has the quite opposite effect, it de-correlates what is known. In fact our economic progress has as much depended on successive cases of decorrelation as it has on necessary correlation. Every breakthrough in science, every discovery of a lost manuscript, every invention or innovation has the effect of decorrelating the prevailing state of understanding, leading to the abandonment of prior practice and the establishment of a new consensus. That is why modern societies assign great status to the leading scientist and to the leading entrepreneur, who have

much in common. They are valued because they disagreed with the prevailing state of knowing, while living in the same world as others they had the capacity to conjecture and establish that the present is not necessarily an image of the future. The successful entrepreneur is engaged in creative destruction of knowledge as well as the destruction of established market positions. As Schumpeter insisted, this is a defining feature of modern capitalism. The contrast to traditional societies where such individuals are persecuted and their ideas suppressed is clear as is the difference in the rates of technical change that are achieved (Mokyr, 1990, especially Chapters 7 and 8).

For the evolutionary theory of the firm the distinction between information and knowledge presents several challenges. First, it implies that the information processes within the firm cannot be focused exclusively on correlating the understanding of its employees without risking the possibility that the firm will become ossified and overtaken by rivals who innovate. Any firm that wishes to survive must accept that it has to modify or abandon in whole or in part the pattern of knowing that served it well in the past. To do this it must establish knowledge decorrelating procedures that explicitly question its future. In any firm the pressures to adhere to what has served in the past are powerful, as it is this consistency in the application of knowledge that generates the firm's immediate performance. To challenge the status quo is to court unpopularity. Schumpeter (1934) well understood the entrepreneurial type is rarely thanked for the fact that they have disrupted that which had worked.

Secondly, the firm's present state of knowing not only enables it to read some externally generated information flows, indeed is designed specifically to do so, it also inhibits its capacity to read discordant information, precisely the information that may undermine its competitive position in its markets. The ability to read the external information flux will require investments in organisation and personnel, Marshall's external organisation that is needed to benefit from external economies. This external organisation has to connect with the internal organisation of the firm, not always a task that is easily accomplished.

What the firm can articulate on the basis of the internal distribution of knowing depends on how it is organised, on the distribution of communication channels and procedural routines that establish who can talk with whom to what effect. Important

differences can be found in this regard as organisational scholars have established. Patterns of hierarchy lead to one kind of information dynamic, flatter structures, cellular forms of organisation, for example, lead to others. The point is that the evolution of the firm is deeply connected to its form of organisation.

Business, like economic activity in general, is a process of problem solving but problem solving is not a finite task. Each solution typically serves to change the knowledge of those who generate it and thus to open up further problems for solution, the firm is restless because the knowings of its employees are restless. This is naturally a path dependent process and different paths lead in different directions and are traversed at different rates. This is why firms differ and the fact that they differ today implies that they will continue to differ in the future – but differently.

One might be tempted to say that all of this is a matter of the growth of knowledge within and between firms but the growth metaphor is not helpful. What we have in fact is an uneven process of development of knowing qualitatively and quantitatively, some knowing is abandoned, other kinds of knowing decline in relative importance as new knowings take their place. If we see knowledge as a structure, it is a structure that changes unevenly, the idea of a balanced growth of all the elements of human knowing is indeed a strange idea.

It would be tempting to imagine that metrics can be devised to capture the different knowledge states of different firms and to a degree this is possible, patent statistics, for example, provide *prima facea* evidence that firms do indeed differ in what they know. But to measure more generally is to miss the point. Multiple kinds of knowledge are involved for which there is no obvious standard of reduction to a common dimension. There is no stock of knowing as if it were a homogeneous substance to match the famous "jelly or leets (steel spelt backwards)" of capital theory, rather knowledge for any firm is an organised matrix of things that are reliably known arrayed against the individuals who know them. It is naturally an uncomfortably large matrix.

To the question "Why do firms differ?" we have answered that the differences lie in the variety of knowledge between firms. Each firm's knowledge matrix differs in the dimension of things known and the individuals who know them. That is fundamental, but

it is a necessary and not sufficient requirement in an evolutionary theory of economic change.

Knowing and Acting

There is a general problem in modern economies of deciding and acting in the presence of uncertainty (Levine, 1997). The certainties of traditional society have been removed and replaced with an environment subject to the vagaries of restless knowledge. No matter how carefully we develop knowledge, we may be surprised by an unexpected outcome, as most action takes place in an environment of at least partial ignorance. Every action generates new information and potentially leads to a change in knowing. For understanding the nature of the modern firm, this implies a critical distinction is between what a firm has the capability to do and what it decides to do, or in other words, between knowing and acting.

Each of the approaches mentioned in the section above focuses on what a firm can do, but none of them mandates that a firm engage in all the activities that are within its capability (or for that matter refrains from activities outside its capabilities). When does knowledge translate into a decision to act and when does it remain an unexploited potential or, more generally, when are capabilities deployed and when not?

What is known in the firm extends beyond the range of things that are known by any individual within it. The modern firm contains many individuals who know many different things and who decide and act in many different ways. The survival and performance of the firm depends greatly upon the degree of compatibility and indeed complementarity of the individual actions. Compatibility and complementarity provide coherence and coherence is essential to the effective operation of the firm. Lacking coherence, the firm is open to attack from both within and without.

Individual knowing has to be correlated to a requisite degree if a chosen task is to be implemented as desired, with the proximate expression being the emergence of routines. Routines can here be considered as templates for action. In many cases is rigid and doesn't permit deviation from a prescribed course of action. The division of labour can then yield gains from specialisation while minimising surprise and without the requirement of leadership. This is the task of management as opposed to leadership,

providing a reliable internal environment for reaping the advantages of coordinated action.

Not all routines are of such prescriptive nature. They guide action, but allow scope for initiative, experimentation and surprise, for example, the rules that govern the conduct of R&D in terms of the financing, choice and termination of projects. It is these routines that are particularly important for the development of the firm. They are the context for learning and the generation of new knowledge. However, surprise carries danger, leading to the de-correlation of localised knowledge within the firm.

As discussed above, in the context of acting on discoveries that arise from learning and creative problem solving, firms may refrain from acting on new knowledge. When new routines displace established ones, knowledge becomes de-correlated Action based on correlated knowledge can be widely understood and supported throughout the firm, but not so for action based on de-correlated knowledge. This is where leadership is required for action to be taken, where entrepreneurship can be seen to be a special form of leadership required for implementing radical change.

Care needs to be exercised in the application of leadership to overcome resistance to change when actions can lead to surprising outcomes, with some surprises having negative consequences for the firm. Where leadership is held responsible for the action, the negative outcomes may undermine confidence in the leadership and the loss of confidence is especially high among those who do not share the knowledge on which the action is based. Leadership thus requires decisions that imagine the potential gain from action against the possibility of surprises with negative consequences. Such decisions are strategic. They involve purposeful change to the scope and structure of the firm, stimulating the discovery of further knowledge and opening additional opportunities for the continuing development of the firm.

These strategic decisions are taken in historical time against the background of imperfect knowledge both within the firm and of the external environment (Schumpeter, 1939). Each decision has a uniqueness that defies generalisation of the type assumed in the calculus of optimisation assumed in neoclassical economics. Two particularly extreme cases serve to illustrate the general problem.

Consider first the case where a negative surprise is a known but unlikely possibility and where the occurrence is always associated with historically specific circumstances. An example is the possibility of a catastrophic accident at a nuclear power plant, such as has occurred at Three Mile Island, Chernobyl or Fukushima. Does one refrain from building such plants because of this possibility? We can calculate an expected value of the loss associated with the accident and consider it against the expected gain from safe operation of the plant. However, the result of this calculation depends very much on the subjective probability we assign to the catastrophe. Raising the probability from .000001 to .00001 raises the expected loss tenfold, but knowledge of the choice of probability in this sort of range is highly imperfect. Further, the occurrence of catastrophe will depend on a combination of human errors and design faults, which can't be foreseen in the specific circumstance. The usefulness of the calculation is illusory when the data on which it is based are arbitrary.

A second case is when the surprise is complete. Here, at a most basic level we have in mind the fate of firms when there are major changes on technology. For example, the shifts in motive power from human to animal to steam to fossil fuels and electricity have left many surprised firms out of business. Firms that stay with routines based on the outmoded form of motive power, agriculture with horse-drawn ploughs or steam-driven tractors, drown in the wave of creative destruction. On the other side are the firms that amass fortunes from change, who are often all too happy to claim that they correctly foresaw their success. It may be possible to undertake ex post calculations of expected value that show the decision maker has optimised, but again the calculation is illusory as it implausibly assumes knowledge is available at the time of decision when, in fact, it is only revealed as a consequence of the decision.

Leadership and entrepreneurship are responses to the absence of knowledge and, as such, are subject to dangers of ex post rationalisation. After the fact, explanations of unfavourable outcomes as the unavoidable consequences of making decisions under uncertainty may be seen as face-saving attempts to rationalise poor judgement based on inadequate knowledge. Calculating the gains and losses to firm cohesion that are associated with uncertain outcomes for a given distribution of knowledge across the firm might be possible, but the information necessary is not currently available.

The importance of leadership and entrepreneurship are well recognised in the management literature, but there is limited quantitative research into the metrics of the costs and benefits of coherence and the impact of unexpected negative consequences of decision making under uncertainty. As is generally the case with an evolutionary economy, recognition of a problem precedes its solution often by decades rather than years when the problem is complex. Learning may eventually bring the evaluation of the costs and benefits of firm coherence into the some sort of codified assessment by management, but that time is yet some way off.

Correlation of knowledge is but one component of forces that contribute to the cohesion in the firm. Shared knowledge may lead to shared understanding but not necessarily to shared objectives and actions. Individual interests differ across the firm, both in the narrow sense of pecuniary reward and in the broader sense of mission or purpose. Indeed, conflicting interests may actually interfere with the sharing of knowledge (Ramazzotti, 2004). We have also to consider the more practical aspect of how differential knowledge connects to differential action. This is the province of the capabilities theory of the firm to which we now turn.

Firm's Capabilities

Utilising knowledge to undertake action requires some means of coordinating the contribution of distinctive individuals. Only individuals know but their coordination requires them to understand some things in common. This is the problem of organisation of capabilities for effective action.

Here, we follow Penrose (1959) in treating the firm as an administrative framework for developing the capabilities of a complex organisation that integrates the many levels of specialised knowledge into a functioning whole. Penrose emphasises the emergence of a sophisticated division of labour in the firm and the associated capabilities, whether managerial or shop floor, to execute particular tasks and to coordinate the operation of those tasks. The full range of firm activity is covered by Penrose but in the modern setting it is worthwhile to emphasise areas that lie outside the production sphere, particularly the "corporate" areas of finance, information systems, human resource management, marketing and strategy. These are areas in which the explosion of the

specialised knowledge of individuals, and the corresponding explosion of collective ignorance, has magnified the payoffs to complex organisations that are able to effectively coordinate individual knowledge.

The Penrosian firm directs the use of bundles of resources that it either owns or rents from the market. The resources, however, are not the inputs into the productive process rather they are funds from which heterogeneous services are drawn and the services that are so drawn from any one resource depend on the other services that are available to the firm. Thus the services derived from any given manager in a given time interval, for instance, are not simply a property of that manager but rather a potential that is to be realised, a potential which depends on the surrounding managerial team and organisational context and which in its realisation changes the services that are available. This is the nub of her connection between the development of the firm and the development of its managerial team, with the essential task of organisation being to act as an operator, translating the knowledge of individuals into the appropriate degree of shared understanding. As in Marshall, management is the basis of performance and management as an integrated team activity dependent on practice of working together.

The logic of firm differentiation follows immediately once we recognise the epistemic element in Penrose's theory. In order to operate effectively, the management team must develop a coherent sense of common understanding as to their respective duties and how these are coordinated in the organisation. Correlation of understanding is essential for the cohesion of the firm. But performance of any activity changes that knowing and gives rise to new understandings in the form of unexploited, latent managerial services for the firm to act upon and no two firms will develop in the same way. Thus Penrose's firm is neither an equilibrium firm nor a uniform firm and it is this fact which makes strategy meaningful as we suggest above.

Enterprise in this scheme involves the decorrelation of understanding, the conception of alternative ways of conducting the activities of a firm and of putting the new perspectives into effect. Enterprise, like management is multi-dimensional and a given team may vary in its entrepreneurial versatility, fund raising ingenuity, ambition, and judgement in assessing and taking risks, all dimensions that impinge heavily on the development of the firm. If enterprise and innovation are at the core of what we mean

by economic development then a theory of development needs a Penrose style theory of the firm.

Penrose is quite careful to distinguish between the size of the firm and its rate of growth when discussing the possibility of limits imposed by the difficulties of organisation. She argues there are no limits to firm size but definite limits to the rate of growth. The distinction rests on the process of integrating new managers into the firm, which requires the diversion of effort from existing managers.

We view the distinction as more general. Penrosian firms are learning organisations. We extend this notion from the individual learning associated with the integration of new managers to collective learning associated with extending the capabilities of the organisation. Discovery through learning might send the firm off in novel directions. Of course, as suggested above, this creates tensions by challenging the correlation of knowledge on which effective functioning of the firm as an organisation depends. We might add that the manner in which different firms learn will be different too and this further differentiates the outcomes of their learning processes.

Discovery is particularly useful if the scope for expansion along the lines of existing activities is limited by the size of the market or the intensity of competition. Firms that enhance their ability to learn new things, such as through organised research and development efforts, are that much more likely to make discoveries and alter the boundaries of their activity. Indeed, the organised pursuit of new knowledge on which to base new activities is an intuitively attractive response to the perceived limits to expansion of existing activities.

If the generation of new knowledge undermines the boundaries to the modern firm's activities and thereby relaxes the limits on firm size, how do we place a particular firm in the landscape of the economy? Government statisticians traditionally classify firms into industries based on the type of goods and services they produce, with products classified into industries generally based on related production technologies, for example, wood products, dairy products and legal services. This approach is problematic when discovery leads firms to regularly undertake new activities that don't fit within their pre-existing set of products or technologies.

An important early contribution was by Richardson(1972) who was concerned to explain the elaborate internal and external division of labour that marked the modern firm. We shall say more on his contribution below but for present purposes his key contribution was to see the firm as a bundle of activities with each activity depending on the possession of specific, appropriate capabilities. He then defined capabilities in terms of "appropriate knowledge, skills and experience" which enabled the firm to perform similar, specialised activities but did not allow it to engage in complementary activities.

Penrose's view has been further developed into approaches that focus on firm competencies, dynamic capabilities and the resource-based view of the firm (Barney, 1991, Dosi, et al, 2002). As with the shared knowledge approach set out above, the scope of the firm in terms of products and technologies is fuzzy at best. Instead, the firm's place in the economic landscape is defined by the competencies and resources it has for undertaking activities or, perhaps more broadly, the capabilities it can bring to bear on an activity. Even here, the boundaries to firm are subject to controversy (Ramazzotti, 2004).

Of course, a firm's capabilities rest on more than just the knowledge of individuals within the firm. The practical skills of the individuals are crucial as are the firm's other tangible and intangible resources. Further, the firm's connections with other firms, individuals and organisations (governments, universities, etc) invariably play a key role in constraining or enhancing the firm's activities. All of this immeasurably increases the complexity of the modern firm and makes its boundaries even fuzzier (Bloch and Metcalfe, 2011). The changing activities of the modern firm creates difficulties for the concept of the industry and for evolutionary analysis more broadly within the economy, as the industry concept provides an ideal grouping within which to consider the working of competition as a selection mechanism (Bloch and Finch, 2010). This brings us to our main concern, what is the nature of the modern firm?

The Nature of the Modern Firm

We now apply the reasoning of restless knowledge and its manifestation in decision processes of the firm to the question raised by Coase (1937) in his seminal article, "The Nature of the Firm", asking why some economic activity involves transactions in the

market while other activity occurs by direction inside of the firm. In other words, why do firms exist in a decentralised market economy?

Coase's answer to the question of firm versus market is based on minimising transactions costs throughout the economy, such that internal direction is employed as long as the cost of organising the activity within the firm is less than the cost of employing a market transaction. Firms have an incentive to expand their activities under their direction when they can organise activities internally at a lower cost than buying or selling in the market. Likewise, they have an incentive to downsize when the market can provide goods or services at lower cost. Coase identifies transaction cost as the key factor affecting these incentives and suggests in addition that competition imposes an external discipline to ensure firms that do a better job of minimising transaction costs will displace laggards.

Imperfect knowledge plays an important role in Coase's analysis. He identifies discovering prices in the market as part of the transaction cost of using the market. With perfect knowledge, it would be possible to organise a complex division of labour through the market without incurring costs associated with collecting information and protecting against the unknown. Of course, with perfect knowledge everyone knows everything and the organisation of production and distribution can be done optimally by the self-organising market, a single firm, the state or any combination thereof. All that is required is the ability to calculate the optimal outcome and Coase assumes this ability is costless to acquire and implement in spite of imperfect knowledge.

In reflecting on the influence of his work fifty years after the publication of the 'The Nature of the Firm', Coase (1993, p.73) notes that his analysis was limited in its scope and that 'if one is to explain the institutional structure of production in the system as a whole it is necessary to uncover the reasons why the cost of organizing particular activities differs across firms.' Here, Coase is acknowledging that using the transaction cost approach to explaining the existence of firms has limited operational implications. We still do not know much about which activities are in the domain of the market and which are carried out through direction within the firm.

An evolutionary approach suggests that neither markets nor firms are historically fixed. The costs of transactions through the market have in many cases fallen

dramatically over time and the efficiency with which firms organise production internally has risen dramatically. Even when a competitive selection process operates to reduce aggregate transaction costs, there are many different configurations of the division of activities between firms and markets that might emerge. The outcome is historically specific, which helps to explain why different configurations are observed in different points of time and in different economies.

We suggest that the answer to the questions, what is the nature of the modern firm and why do firms exist, lies deeper in the realm of imperfect knowledge and uncertainty than is admitted by consideration of transaction costs alone. By imperfect knowledge we mean that knowledge is limited and differs across individuals, in this sense it is specialised and a natural concomitant of the division of labour. In this context the idea of perfect knowledge is a distorting mirror in which to reflect the distinction between the modern firm and the market. We cannot comprehend their respective spheres of influence without recognising the limitations on and the diversity of human knowing, nor can we understand the inherent connections between economic change and the development of new and different knowing.

Firms and markets play quite different roles in the modern economy. The modern firm is an administrative institution that effectively manages the pooling of knowledge wherever there are advantages from integrating specialised knowledge, thereby reaping gains from the division of labour. Markets lead to gains from the division of labour as long as knowledge of internal processes is not required to pass between the transacting bodies. Firms and markets require different capabilities for their functioning and are to this degree are complementary, not substitutable, forms of organisation. Only firms have the knowledge to make the strategic decisions what to produce and how to produce it, something that markets cannot do.

Our discussion in prior sections suggests there are many dimensions of the influence of imperfect and constantly changing knowledge on the firm. One of the most important is that the ability to calculate optimal outcomes is limited. Firms may be able to calculate some of the current costs and revenues associated with the type of make or buy decision to which the Coasian analysis is often applied. However, as Richardson (1972) carefully explains there are many forms of linkage between the extremes of the

unitary firm and the pure market, including formal and informal contracts, supply chain alliances, joint ventures, interlocking share holdings and other forms of collaboration between buyers and sellers. Each of these forms of linkage is suitable to particular distributions of knowing and has implications for the further development of knowledge in the respective bodies. Any change in knowledge may induce a change in the pattern of linkages. Thus innovations arise that are not even imagined at the time of the initial decision whether to use simple market transactions, full vertical integration or some hybrid arrangement that explicitly or implicitly ties the buyer and seller together for a long interval.

Here lies an essential point. Markets can transact, but only firms can innovate. In making decisions about what actions to take, modern firms conjecture the future development of current observables and imagine, as best they can, the novelty that is inevitably generated by the developing economy and their own creative processes. In taking action to advance their own interests firms are creative as well as reactive. In the process, they recreate themselves and alter the institutional setting in which they operate.

This is the insight that Schumpeter (1934) brings to the fore in his analysis of economic development. Schumpeter initially identifies change as a special activity within the economy and associates it with a special agent of change, the entrepreneur, and clearly distinguishes the activity of the entrepreneur from that of management. In this Mark 1 version, the entrepreneur is typically an individual acting outside of the established industry. He is distinguished sharply from the inventor for his role is not ot discover new technical opportunities but rather to introduce new business combinations into the prevailing economic structure. As far as the economy is concerned, it is not invention but innovation that is the determining constraint on its development. Imagination is clearly central to this role, the entrepreneur conjectures, not always correctly, that the prevailing economic structure can be organised differently and has the drive and personality to implement the desired change and overcome the hostility of incumbent firms and interests in the process. In Schumpeter's account the primary role of the innovator is to successfully challenge the status quo. An economy with enterprise is an economy that is out of equilibrium, its fundamental properties relate not to its structure but to the processes by which that structure is changing from within.

Interestingly, Schumpeter (1942) later moves the location of innovation to within the large business organisation and treats it as part of the bureaucracy of the modern economy. It is from this treatment of Schumpeter "Mark 2" that we take the key distinction between family-run firm of classical or early neoclassical economics and the modern firm, namely the incorporation of the entrepreneurial function into the ongoing functions of management of a large and complex organisation.

How does the modern firm incorporate the entrepreneurial function? These firms need to be able to create specific capabilities by combining knowledge, skills and experience of individuals in a way that achieves specialisation and economies of scale through the division of labour. This raises the question of how firms choose to organise themselves, which Coase suggests needs further development. These choices impart a strategic function to the modern firm in the sense it most decide on actions among alternatives for which there are no guaranteed outcomes, only imagined possibilities. As Vickers (1994) argues persuasively, the treatment put forward in modern neoclassical analysis that firms only make decisions about how to employ known technology to produce outputs to meet given preferences of consumers is an extremely damaging fiction.

Change in knowledge potentially undermines the shared understanding that contributes to the cohesion, and hence, stability of the firm. This is problematic because of the tension between the practices that underpin the efficiency of the firm and the quite different practices required for change. The former depends substantially upon a degree of shared understanding within the firm as to its routines, whereas the latter depends on challenging and breaking the rigidity associated with the pursuit of efficiency. The former is the domain of management in a narrow sense, while the latter is the domain of imagination, of thinking through how the firm could be different with respect to activity and organisation. If the modern firm is to be fit it must be efficient and it must be innovative and if this tension is not resolved the firm is unlikely to survive. This is one reason why modern firms devote substantial effort to the integration of new knowledge within the firm.

As Penrose (1959) argues, this puts limits of the growth of the firm as the time of existing managers for integrating new managers is limited. However, there is no limit on

the size of the firm *per se*. Of course, this assumes that the routines for dealing with existing activities can be implemented with a constant level of management effort. It also assumes that the structure of the firm is sufficiently open to permit the emergence of new routines and the associated changes in management and organisation. A larger firm or more diverse firm may require a different structure to accomplish this function.

The modern firm is also able to generate new knowledge and assimilate new knowledge generated outside the firm, bringing this knowledge to bear with existing capabilities to be able to innovate and to adapt to changing external conditions. The activities undertaken by the firm are changing over time. IBM no longer produces typewriters, but continues as an evolving organisation. There is no position of equilibrium or rest for the modern firm. As Shackle (1970, p.155) notes, 'The paradox of business, in its modern evolution, is the conflict between our assumption that we know enough for our logic to bite on, and our *essential*, prime dependence on achieving *novelty*, the novelty which by its nature and meaning in some degree discredits what had passed for knowledge.'[italics in the original]

Conclusions

We consider the nature of the modern firm, focusing in particular on the large and complex firms that dominate modern economies. We locate the distinctive competitive advantage of the modern firm in its ability to cope with restless knowledge. These firms are able to develop extensive capabilities from the specialised knowledge of large numbers of individuals, thereby reaping economies through the coordination of a division of labour. Importantly, firm capabilities expand organically from the interaction of the knowledge of individuals, enhanced by introspection and creative problem solving, which provides potential protection for the firm against the ravages of creative destruction in the competitive process. Because the modern firm can survive in the face of restless knowledge, it is in a position to provide security to the individuals on whose efforts the success of the firm depends.

Cohesion in the firm, especially in the face of negative outcomes to decisions made under uncertainty, depends on the understanding that comes from shared understanding. Yet, fully exploiting the capabilities of the firm involves action that

extends beyond the domain of this shared understanding. This is especially the case with the expanded capabilities that come from learning and discovery through creative problem solving. Strategic choices must be made about how far to venture beyond the domain of shared understanding and how much effort to devote to further integration of the knowledge within the firm. This is the role of leadership and, in the case of acting on new knowledge, entrepreneurship, for which the calculus of optimisation is of little use. This leadership function of management incorporates the traditional role of the entrepreneur, so the modern firm is an entrepreneurial firm.

The modern firm has fuzzy boundaries in terms of activities determined by its capabilities, resources and the strategic decisions of management. Further, these boundaries are subject to change over time that is sometimes dramatic in response to developments in the rest of the economy driven by restless knowledge, as well as internally by changing personnel and other resources, by learning and by changing strategic direction. In order to survive and prosper the firm needs to maintain cohesion in the face of these forces of change. Most importantly, the modern firm must organise itself to enhance innovation without destroying cohesion, which means that its structure and functions are both historically specific and changing over time. Thus, the modern firm is a restless firm.

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