Microfoundations of Capabilities

Brian J. Loasby

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Department of Economics
University of Stirling
Stirling
Scotland
Introduction

At the DRUID Winter Conference this year Nicolai Foss called for an attempt to provide microfoundations for the concept of firm capabilities that has become popular among strategy theorists. This paper is a response to that call, and it is based, by happy coincidence, on my own presentation to that Conference, in which I made a complementary case for more attention to the social context of individual actions. In relation to theorising about the firm, that case implied explanations of the firm which are not restricted to issues of incentive compatibility between undifferentiated agents. I shall not develop those implications today, but will simply state my view that the potential for opportunistic behaviour, and the means of discouraging it (not only by contractual means) are important considerations in determining the scope, structure and practices of a firm, that they are also important considerations in developing the institutions and practices of a market, but (in agreement with Ronald Coase) that they are an inadequate basis for explaining the choice between firm and market. My present objective is to demonstrate that it is precisely because of particular human characteristics that firms are often – but certainly not always – the most appropriate location for the development and use of individual abilities, and to indicate some consequences for the analysis of firm capabilities and for business strategy.

Methodological prelude

We cannot analyze wholes without careful attention to the parts, which exist separately from the wholes. But to understand wholes we must also add information – like compositional principles, filtering mechanisms, institutions, etc. – that are not logically derived from a consideration of the behavior of the parts. This includes the possibility that the interactions among the parts may lead to “emergent” phenomena, at least so long as we do not get sloppy and let the idea of emergence become equivalent to Claim 3 [that we can and should study wholes directly].

Richard Langlois (2004, pp. 261-2)

My argument in this paper is intended to conform to this principle. If we are to lay emphasis on the capabilities of firms, we must ensure that what we consider ‘capabilities’ are properly founded on the knowledge and skills of individuals. We are not, however, required to decompose firm capabilities into nothing but individual knowledge and skills; indeed we would be unwise to attempt this, because the effectiveness of individuals is often powerfully affected by their interactions with other individuals, which is precisely what the organisational structures and procedures of a firm are intended to achieve. I shall also apply this argument at the next level above: the product of any particular firm’s capabilities depends on their interaction with the capabilities of other firms, and indeed with agents which are not firms – but it is not to be explained solely by such interactions.

This methodological principle is, I believe, consistent with John Ziman’s (2000) examination of the enterprise of science. He argues that the scientific norms of communalism and universalism provide powerful support for an ultimate goal of unified science, and for an operational principle of reductionism. Moreover the attempt to reduce apparently complex phenomena into separable units is often a very
effective means of discovery. However, there are both practical and conceptual objections to an exclusive commitment to reductionism. The practical objection is that the potential scope of research exceeds by some orders of magnitude the capacity of our brain’s storage and operating systems – a limitation noted by Hayek (1952) in his pioneering study of the construction of knowledge within the human brain; therefore we must often be content to work at one level (or sometimes two levels) while relying on some simplified assumptions about the underlying levels with which we accept (in principle) that our thinking should be consistent. The conceptual objection is that the interaction between the elements of a system can lead to the generation of states which cannot be predicted even in principle – even though they may be explicable after the event. (Ziman 2000, pp. 321-7). The permutations of the possible patterns of connection between the elements of any moderately-sized system (such as a game of chess) are beyond both analysis and simulation.

Ziman argues that it is precisely this ‘spontaneous emergence of novel modes of order in complex systems’ which produces the simplifications that make science possible, as a quasi-decomposable structure of disciplines, for creatures equipped with human brains. It is, of course, Hayek’s fundamental insight that it is the spontaneous emergence of novel forms of order, which are very often the unintended product of intentional human action, that makes modern economies possible (at least for a time: success is always provisional). This unpredictability of emergent outcomes is the fundamental root of Knightian uncertainty, which is an essential context for the significance of firm capabilities. Modelling rational choice equilibria is not an appropriate research strategy, though we shall have frequent recourse to the principle that people are acting for what they believe to be good reasons. By a similar argument, we shall reject the argument that an analysis of firm capabilities can lead to the prescription of an optimal strategy; etymologically as well as practically, competition is a discovery process, in which people seek together, but in different ways.

What an individual can achieve with a personal equipment of knowledge and skills depends on the particular connections that are made with particular other people; these connections provide the context, but what any individual derives from that context depends on that individual – and consequently such derivations are likely to differ between people in what may appear to an observer to be identical situations. Moreover these connections will have some influence, often significant, on the further development of that individual’s knowledge and skills and the uses to which they are put. The growth of knowledge is an evolutionary process of trial and error within particular but changing environments; it is not a Cartesian construction. In conceptual terms, we shall be considering systems which cannot be explained solely by their constituent elements; an adequate explanation also requires consideration of the selective connections between them.

The incompleteness of connections is the fundamental fact about systems (Potts 2000); and a strong asymmetry in this incompleteness produces the quasi-decomposability that Simon (1969) identified as the architectural principle of complexity. This, I shall argue, is the principle which links organisational capabilities to individual knowledge and skills. We may immediately note that the behaviour of any quasi-decomposable system cannot be explained by theorising about a ‘representative agent’, because this suppresses two features which are essential to the
working of the system: the variation between agents and the structures in which they are embedded. General equilibrium theorising relies on a fully-connected system, with no intermediate levels; game theory relies on a single intermediate level within an unanalysed larger system, which is fully connected internally and completely isolated from any external influences. It is an instructive paradox that the familiar prisoners’ dilemma model ignores an essential part of the original story; the prisoners’ options are provided by the interrogator, who is therefore engaged in a game with each prisoner, as well as games with superiors and (potentially) with prosecuting and defence lawyers. In the story, unlike the model, the prisoners’ options are not basic data but endogenous to the network of interactions; an accurate representation may be too difficult to handle, but analysts should then be very cautious about making inferences from dubious approximations. That caution may be applied to all kinds of modelling, informal as well as formal.

Because of the specific objective of this paper, the principal focus in what follows is on the individual, and the secondary focus on firms as systems that are composed of individuals and selected connections between them. However, I shall make limited, but I believe essential, use of the principle of reductionism to go below the level of the individual to the cognitive and emotional processes within each person: preference functions, opportunity sets and rationality are not sufficient to explain why organisations can enhance human capabilities. I shall also make selective reference to levels above the firm, because I believe (as Marshall so clearly did) that no theory of the firm can be adequate which does not incorporate its external relationships: here too selective connections matter.

Cognition

I propose to begin my investigation of capabilities by considering three basic features of human cognition, which reflect the long evolutionary processes from which we emerged. One feature is the set of emotions which, as David Hume recognised, stimulate and constrain our cognitive processes, and which seem to have extremely ancient origins. These are poorly represented by standard economic models, not least those that seek to explain firms. In any comprehensive account of the behaviour of individuals or of groups, or in any comprehensive study of human cognition, human emotions would need extensive consideration; but it is necessary to limit our agenda. For our limited purposes it may be sufficient to confine our attention initially to three characteristic human emotions which Adam Smith thought particularly important: the motivation to seek some explanation of the apparently inexplicable, which is often more effective in driving discovery than tangible rewards, the interest that we take in the welfare of other members of our group, and our pleasure in communication, including our delight in persuasion. All three are important in explaining why capabilities are often located in firms.

The second basic feature is the importance of automatic operations, some of them apparently genetically determined and about which we can do very little, others acquired during our personal development, but which may also become very hard to override. It is important to recognise that reliance on automatic operations is not to be regarded as either a failure of reasoned behaviour (analogous to market failure in its effect on allocative efficiency) or as an obstacle to reasoned behaviour, though it may sometimes have either of these effects; because of the limitations of human cognition
it is actually a prerequisite of reasoned behaviour, which requires so much cognitive power that it has to be severely rationed. Automaticity is an economising device; this is one of the persistent themes of biological evolution. Because capabilities are often associated with routines, it will be necessary to consider them in a little more detail later.

Nevertheless, by comparison with all other creatures our cognitive abilities are quite extraordinary; this is the third basic feature, and much the most interesting for our present inquiry – but it is not independent of the others. We are born with an extremely wide range of potential for developing knowledge and skills. However, each of us can develop only a small fraction of this potential, because the process of development crowds out many other possibilities; at the neural level the establishment of elaborate networks makes increasingly difficult the creation of substantially different networks. What networks are developed depends on the ways in which each of us interacts with our particular environment and with changes in that environment. This particular combination of wide potential, as part of our genetic endowment, and restricted possibilities for realisation, has an implication which is of fundamental importance for our present enquiry. If members of a community exploit this (largely common) potential in substantially different ways then that community can develop a range of knowledge and skills that any one member could hardly imagine. This is the reductionist foundation, part biological, part psychological, for Adam Smith’s proposition that the division of labour is the highway to the growth of human knowledge. It is worth remembering that he applied this principle to the development of science before the development of economics; however this did not lead him to a science-based theory of economic growth but to a common basis for the growth of science and the economy.

As a secondary, but still very important, consequence of this combination of wide potential and limits on its realisation, even people who are building very similar knowledge and skills are likely to develop variations, because of differences in their environments and the sequential development of their particular interpretations of those environments. These variations serve as loosely-controlled experiments within each field of knowledge, the results of which are subject to selection and imitation, thus generating improvements within each particular domain which complement the variety across domains. The diffusion of improved knowledge and skills is greatly accelerated by the ability to imitate, which operates so much more rapidly than genetic selection. This is not exclusively human, but its manifestations in humans are of a scale and scope sufficient to justify thinking of it as if it were. (We shall consider another manifestation when we come to consider routines.) That we should so often be willing to learn from other people requires us to recognise them as individuals with identity; this is also the precondition of social interaction, including participation in negotiated exchange and in social arrangements, some of which are firms. An important corollary, to be noted immediately, and to be applied later, is that because we so often look to others who are acting somewhat differently for suggestions of how we may act more effectively, we may treat others as potential resources rather than potential rivals. (Opportunism and opportunity may sometimes be as close in thought as they are in spelling.) The results of both differentiation and local variation are embedded in individuals, but they emerge from the relationships between individuals – the structure of the society.
Cognition and organisation

Knowledge is crucial, but what knowledge is developed, and how it is applied, depends on organisation. Indeed there is a fundamental link between the two. Knowledge itself is created by building up networks of selective connections: phenomena are grouped into classes which are based on supposedly-relevant principles of similarity (Knight 1921, p. 206), and these classes are linked to other classes by ‘connecting principles’ (Smith (1980 [1795]). This is the way that our cognitive processes operate. An organisation, formal or informal, is also created by forming selective connections between groups. The neural networks in which our knowledge is coded are organisations within our brain; and what knowledge we form is influenced by the external organisations, formal and informal, to which we belong. (A more substantial treatment of the relationships between cognition and organisation may be found in Loasby 2002.)

A firm structures interaction between its members, and also the interaction of its members with particular elements of its environment. This is what Marshall called a firm’s internal and external organisation, and it parallels the internal and external organisation of each individual just noted. These structures encourage the formation of connections between the ideas and skills of those who are organisationally linked, and discourage the formation of connections between the ideas and skills of those who are organisationally separated. For the present we will concentrate on the internal organisation, for which we may use a classic example. Chandler’s (1962) explanation of the development of the product division system at Du Pont turns on the increasingly obvious failure of the functional organisation to link together the most relevant ideas and operating practices within their increasingly diversified businesses. In Knight’s (1921, p. 206) terms, the criteria for grouping activities in ways that were appropriate for acting intelligently had changed from similarity of function to similarity of product. The firm’s response was delayed because it violated the standard doctrine of organisation, which the Du Pont family knew very well and greatly respected – a warning not to be overawed by academic argument.

Penrose’s (1959) location of the firm’s resources within an administrative framework was the first of her crucial contributions to the theory of the firm, because it is this framework that juxtaposes individuals’ existing ideas and skills in particular configurations, and in so doing provides the context in which these individuals develop new ideas and skills. It provides a set of selective connections to frame the interactions that stimulate new connections within particular brains. Because all choices entail opportunity costs, it also impedes the development of ideas and skills that would be encouraged in other contexts. What ideas and skills will actually be developed nevertheless depends on the individual. The administrative framework itself is a product (not in all respects intended) of the brains of those who create and operate it.

Continuing with Du Pont as our example, we can observe that the enabling conditions for the discovery of nylon were supplied by a research programme that was designed to expand and exploit the scientific knowledge and research skills of the company’s central research department, and so to provide Du Pont with distinctive capabilities. However, two individuals played a crucial and perhaps indispensable role in this discovery. It was Carothers who freely chose the line of fundamental research out of...
which nylon emerged; and it was the research manager Charles Stine who persuaded Carothers to join Du Pont. Moreover the research department as it then existed and its major research programme were both primarily the product of Stine’s ideas. These ideas had been gradually developed as an interpretation of Stine’s interactions within the company during a time of substantial change. Without this particular history it is very unlikely that Stine would have chosen to do what he did; nevertheless we have no reason to believe that this history would have generated the same response whoever had experienced it. As Kelly (1963) reminds us, ‘experience’ is not constituted by a sequence of events, but by the particular construction that we place upon them. Du Pont’s success in turning nylon into a highly profitable product – which was not easy – was greatly helped by Stine’s insistence on close working relationships between the central research department and the operating divisions, and by his focus on developing individual skills in product development, two principles which he had distilled from the problems encountered in Du Pont’s diversification (Hounshell and Smith 1988). This is a story of individuals; but what the individuals did and why, and even what they knew, cannot be explained without the organisational context – which is itself the product, not always intended, of individual actions.

The resources within a firm consist of the knowledge and skills of individuals and the links between them. Before developing this theme it is important to note, for later consideration, that in considering what a firm can actually achieve we should not make the potentially serious error of assuming that the resources within a firm are necessarily available to that firm; the relationship between the two depends on motivation and incentives, which includes opportunism and much more. Closing the gap has an important place in Barnard’s (1938) account of ‘the functions of the executive’.

Since it is rather natural for economists to think of these resources as human and organisational capital, we should note that this capital is not only differentiated but resistant to aggregation, in value or any other terms. Lachmann (1978) has emphasised the heterogeneity of capital goods: they are complementary within each use because every production plan requires some specific structure of capital, but they are substitutes between uses because different kinds of production, or even alternative ways of producing a particular good, require different structures. He summarises these twin characteristics as multiple specificity, and examines its implications in a context of uncertainty, where (in Knight’s terms) there are no procedures, known to be correct, for deducing the optimal capital structure. This combination of multiple specificity and uncertainty is no less applicable, and no less troublesome, in dealing with human and organisational capital; each individual and each established connection between individuals may be regarded as a bearer of capital, but the effectiveness of each unit of capital depends on the structure in which it is embedded. As with physical capital, alternative structures may be possible which would be effective in different ways, but restructuring is not costless; and although it may be easier to change people than machinery it may be very hard to change their ways of thinking and acting.

Although the overall value of the skills and knowledge of a set of individuals depends on the arrangement of the connections between them – in Penrose’s formulation the value of a pool of resources depends on the administrative framework in which they
are embedded – that is not all that it depends on. We must now turn to Penrose’s other major analytical contribution: in contrast to standard theory, which assumes that every potential use of every possible input is specified in the firm’s production set, there is no definitive link between a resource, or even a particular combination of resources, and the services which that resource or combination can deliver. Nor is there a definitive link between any service and the productive opportunities to which it can be applied. There are two steps between resource and added value; and both steps require imagination. The second step, at least, also requires some connections to the world outside the firm, and so the generation of added value results from new combinations both within the firm and across some of its boundaries. Sometimes, as Allyn Young (1928) pointed out, in order to make these new combinations effective it may be necessary to redefine both internal and external organisational boundaries: if organisation aids knowledge, we should expect changing organisation to result in changing knowledge, and changing knowledge often to require changes in organisation if it is to be used effectively. Resources are continuously evolving; firms are not extracting rent from a fixed quantity but seeking profit from a varying quality.

**Routines and organisation**

Nelson and Winter (1982) defined routines as the skills of an organisation; it is now common to treat a firm’s capabilities as being embodied in its routines, and its comparative advantage as resting on its superior routines. However there seems to be some ambiguity, or at least some differences between authors, about what constitutes a routine, as is illustrated in the report of a careful and extended discussion which resulted in the following definition: ‘A routine is an executable capability which results in superior performance in some context that [has] been learned by an organization in response to selective pressures (Cohen et al. 1996, p. 683; italics in the original). That in this discussion ‘routines’ are grouped with ‘other regular reaction patterns’ clearly indicates that both the degree and scope of regularity necessary to qualify as a routine resists specification. There is also some mystery about the concept of capability as a property of a firm which is apparently independent of its members, as is implicit in the definition just cited. (How can an organisation learn?) I believe that some clarification of both issues may be achieved by starting at the level of the individual and then seeking to explain how the activities of people, based on the knowledge and skills that they have learned while interacting with each other, might constitute a performance that might credibly, if loosely, be ascribed to a firm.

We have already observed that automatic operations within the human brain economise cognitive resources. We have also noted that some automaticity is genetically programmed; this is an important aid to economising, and makes room for the development of programmes which channel less-specific potential through the interpretation of particular environments and our own actions in specific contexts. This automatic knowledge-preserving and reproducing system has three major functions. First, it is the means of embedding new knowledge and skills; indeed as is clear from Hayek’s (1952) theory of the mind, the formation and strengthening of neural connections is the physical means by which the selective connections which constitute knowledge of a particular kind, applicable to particular domains, are consolidated and become available as patterns. The process may make substantial cognitive demands, even denying the possibility of developing other kinds of
knowledge; but once substantially complete these demands fall away, releasing cognitive resources for investment in the development of knowledge in other domains.

As well as releasing cognitive resources, established automatisms also contribute to the effective use of these resources in two major ways. They become reference standards against which anomalies can be recognised and problems or opportunities singled out for attention; this is the basis of management by exception, a crucial, and usually unconscious, cognitive mechanism. That is why we usually respond to indications of differences rather than levels, as noted by Pounds (1969). They may also suggest ways of tackling such problems or opportunities. Kirzner’s (1973) explanation for the dispersion of entrepreneurial activity is that people will tend to be alert to what they are interested in; interest is normally associated with the pre-existence of patterns which guide perceptions. This is an important aspect of absorptive capacity, which will receive separate attention shortly.

In addition, each newly-consolidated knowledge subsystem (which we might wish to call a cluster of routines or a multi-specific subsystem of cognitive capital) becomes available for connection to complementary subsystems of domain-limited knowledge, in order to produce a new combination which is oriented to a particular purpose. This is set out by Marshall (1994) in his early model of cognition and in his discussion of industrial organisation in the *Principles* (Marshall 1920, pp. 250-2). Notice that this sequence corresponds, at an individual level, to Penrose’s theory: the development of new resources in the course of current activities leads to the imagination of new productive services and thence to the imagination of new productive opportunities. Notice also that, by appropriating (her own term) the concept of ‘image’ from Kenneth Boulding, Penrose is insisting that the connections are made within a particular human mind; but the ordering of knowledge within this mind has been influenced, though not determined, by the context in which the order has emerged. Allowing the context to influence the development of knowledge and skills, after all, is what the division of labour is about.

The creation of knowledge in this way becomes itself partly automatic. However, we are not restricted to building up our own knowledge within our own context. By interpreting the actions of other people in contexts which we believe are relevantly similar (acting in accordance with Knight’s definition of intelligence) we can leverage other people’s cognitive processes, and if we observe many other people acting in an apparently effective way we may adopt their practices as a standard procedure. Often we adapt rather than adopt, sometimes consciously but sometimes simply because our brain makes different connections. These external standards are commonly called institutions; they are a consequence of human cognition and our ability and willingness to imitate others, which we have previously noted. Smith’s (1976 [1759]) *Theory of Moral Sentiments* explains in considerable detail the advantages that we derive from these capabilities and attitudes. By combining together internally generated and adopted knowledge and skills, we come to rely predominantly on what Jim March has called ‘the logic of appropriateness’, which does not require any consideration of the consequences of our actions; this is a major cognitive economy, especially in conditions of Knightian uncertainty.
The ability to import knowledge from outside depends on the knowledge that is already possessed. There may be qualitative differences between people in their ability to make such connections; but what is more important is the variation between people in the kinds of knowledge which they can absorb. The normal process of building up structures of knowledge creates patterns into which certain kinds of external knowledge will easily fit; but because knowledge is constructed in domains that are limited by the criteria of similarity that are employed, consciously or more often unconsciously, these patterns are typically incompatible with other kinds of external knowledge, which may simply make no sense, or may not even be noticed. Even when acceptance appears to be straightforward, knowledge may be modified in transmission. (If we think of codified knowledge, we should recognise that each brain develops its own code.) My former colleague Frank Bradbury, who as participant and manager had developed a deep knowledge of innovation processes, insisted that innovations were never simply adopted but always adapted, because there were always differences between the originator’s and the adopter’s systems: he was accordingly critical, more than 35 years ago, of the common practice which treated innovation and diffusion as separate topics.

The principle may be generalised. Economics has plenty of examples, of which I will take one that is particularly relevant to this paper. Standard economics worked for many years with three factors of production, land, labour and capital. Gradually economists became increasingly conscious of the differences in workers’ skills, and one way of dealing with this was to extend the notion of capital from machines to humans. This extension carried with it the standard ways of analysing capital, as an undifferentiated quantity, augmented by investment which balanced the prospective return against the interest rate. Unfortunately, because capital theory generally ignored the combination of substitutability and complementarity between units of physical capital discussed earlier, little attention was paid to the extreme heterogeneity of human capital, and the importance of ordered relationships between people in order to make the best use of it.

For practitioners of a discipline focussed on price theory, Marshall’s suggestion that organisation might be treated as a factor of production, was both inadmissible and superfluous; the analytical method of economics was not suited to systems that were selectively connected. Marshall’s deep interest in the organisation of economic activities reflected the critical importance of the development and effective co-ordination of differentiated skills in his theory of economic development, which had effectively vanished as a significant topic in the twentieth century. It is, I believe, no accident that endogenous growth theorists have not revived this interest in the effects of organisation on the rate and direction of the growth of knowledge. Nor was Marshall’s view that parents’ willingness to invest in children depended more on their ability and willingness to look into the future than on the rate of interest the kind of thought that was congenial to most economists.

People who have recognised the advantages of looking to other people as valuable sources of knowledge, and of incorporating external knowledge with their own, are likely to be receptive to the idea of joining, on appropriate terms, an organisation which appears to offer a context in which they can apply their skills and knowledge and acquire additional skills and knowledge which are compatible with it. If this requires accepting, in Simon’s (1982, 2, p. 345) words, ‘a social prescription of some,
but not all, of the premises that enter into an individual’s choice of behaviors’, that is no more than they do when not functioning as members of an organisation. (We may excuse the adjective ‘social’ as a convenient shorthand.) Barnard (1938, p. 163) pointed out that whether any communication is authoritative is decided by the recipient, not the originator. We could hardly manage our lives if we were unwilling to accept the authority of many people who have no means of enforcing acceptance, and indeed we often seek authority; so we should not be surprised at the widespread acceptance of authority in a well-functioning organisation – much of it not the authority of formal superiors. As Knight (1921, p. 269) points out, joining an organisation allows us to benefit from a division of labour in uncertainty bearing by which ‘the confident and venturesome … “insure” the doubtful and timid’. The gain in comfort may suppress opportunism; more positively by setting bounds to uncertainty it may encourage people, as members of an organisation, to take decisions which they would have found too troublesome outside that organisation.

The location of capabilities

We have argued that the capabilities of an organisation lie within the members of that organisation, but with two important provisos. First, some of the most distinctive individual skills and knowledge are likely to have been developed within that organisation and significantly influenced by its activities. Second, among the skills of its members are the knowledge, substantially automatic, of how to act in ways that complement the activities of other members; and much of this knowledge is not immediately accessible to newcomers – or even, as Barnard observes, to people moving to new environments within the same organisation – and of uncertain, and sometimes negative, value within other organisations. At least this is true for an organisation that is functioning effectively; we should not overlook the possibility that an organisation may provide a context in which people develop skills and practices which reduce performance.

However, this argument is incomplete. It is, I believe, a fundamental principle that no theory of the firm can be adequate which does not encompass the relationships between members of the firm and those outside the firm. Sometimes these relationships may be considered as exchanges in which the firm offers inducements to attract the contributions that will support it – from suppliers, customers, investors, banks, local government, and so on (a perspective associated with Simon), or more dramatically as relationships in which members of the firm attempt to manage their dependency on resources that are subject to external influence or control (Pfeffer and Salancik 1978). For present purposes it is appropriate to focus on the connections that members of a firm make to selected outsiders, often but not always members of other firms, in order to establish context-specific combinations of knowledge and skills. Having approached these connections from a basic understanding of individual characteristics, we can not only appreciate the force of Marshall’s proposition that every firm needs both an internal and an external organisation but understand that this is fundamentally a proposition about the needs of individuals within the firm.

It is natural to think of combinations of different but complementary knowledge and skills, but remembering that we are thinking of developing knowledge and developing new uses for knowledge, for which there are no demonstrably correct procedures despite the implicit claims that are regularly made, we may also consider as
complementary the variety of experiments, both natural and artificial, which is the natural product of differences in focus, perceptions, and personal linkages between individuals, often associated with their location in different firms. Firms have an interest in the success of their rivals, because these successes may be a source of knowledge; and some members of a firm may be particularly aware of this. Returning once more to the history of Du Pont, we find the company experiencing repeated problems with the dyeing of successive artificial fibres, and those working on these problems gaining repeated comfort from their established arrangements, including personal contact, for the exchange of information with ICI. The source of comfort was that ICI, like Du Pont (and other chemical companies) had a substantial research programme in dyes; and because it was a separate company its researchers had different ideas (Hounshell and Smith). Amalgamation, had that been conceivable, would have reduced this comfort, because it would have reduced variety. It is common to claim that a proposed merger will enhance capabilities; it can rather easily destroy them.

From firm-specific linkages we can pass to the networks of connections within clusters of firms which are undertaking similar activities, within clusters of firms which are undertaking complementary activities, within the combined clusters that constitute an industrial district, and at national level. It is worth recalling that Marshall (1919), concerned about the prospects for the British economy, sought to discover what could be learnt from the formal and informal organisation of industry in France, Germany and the United States, and presented his findings in three chapters to which he gave titles which summarise in very few words three different national systems of innovation: individuality and refinement in production, science in the service of industry, and multiform standardisation. (Does anyone have any difficulty in matching country and description?) It may be possible to extract value from membership in a network, but the prime and logically prior reason for membership is to create value out of the connections, by generating and combining differentiated knowledge.

**Strategy and uncertainty**

That the strategy of a firm should be based on its comparative advantages is an apparently simple proposition. However, its application is not straightforward; and it certainly cannot be done by deducing an appropriate set of actions from capabilities. In thinking about strategy, or indeed about the functioning of any economy, we must not forget the pervasiveness of uncertainty – which is a precondition of novelty, in business as in science. Uncertainty presents problems and the potential for success, extending into a future which cannot be predicted but which may be imagined. I suggest that this implies two guiding principles for thinking about capability-based strategy. The first is that the task is not to extract rent from a stable configuration but to manage a process in real time; and the second is that what has to be managed is the development as well as the application of capabilities, which are ultimately the knowledge and skills of particular individuals who are interacting with each other in particular contexts.

Development and application alike depend on making new connections; and the fundamental comparative advantage of the human species is that it is equipped with brains that are extraordinarily efficient at making connections. However, there is no
way in which the managers of a firm, or indeed any individual, can programme the making of the most appropriate connections. What can plausibly be attempted by either is the creation of a system and a context that seems likely to facilitate it. It seems even more obvious now than thirty years ago that to deal successfully with the problems and potentials of uncertainty the pattern of relationships within a firm should constitute an imperfectly specified contract (Loasby 1976). We all know that imperfectly specified contracts can lead to incentive problems; but a fully specified contract cannot match the requirements of uncertainty. Business strategy, like military strategy, is misconceived if it is represented in game-theoretic terms as a complete sequence of conditional actions; Simon’s language of premises and procedures is more appropriate.

Differences in the value placed on capabilities, often arising from differences between individuals in the connections that they imagine from any resource, are commonplace. That there should be such differences obviously implies that in retrospect it will often become clear that mistakes have been made and resources inefficiently allocated; but the imposition of supposedly rational choices is itself an inefficient response to uncertainty. In Simon’s (1992, p. 21) words, ‘Any direction you proceed in has a very high *a priori* probability of being wrong; so it is good if other people are exploring in other directions’. Because the specific contribution of a formal organisation is its capacity to achieve coherence between individuals with differing kinds of knowledge and skills, it is to be expected that any organisation will be able to tolerate only a rather limited amount of variety; in order to achieve the variety that is an essential ingredient of the evolution of knowledge it is therefore desirable to have multiple organisations, which have some resistance to industry models of conformity. In an economy of any size, national champions are to be avoided.

One consequence of uncertainty is that, contrary to what is sometimes asserted, it is quite possible for a particular resource to be simultaneously a source of potential advantage and a tradeable asset; a potential buyer may have in mind a different connection, or place a different value on the same connection. This certainly applies to individuals who appear to have some distinctive ability. Therefore although in principle the value of a resource, or a structure of resources, may be assigned by a Mengerian imputation from its imagined uses, any such imputation must be a conjecture, and there may be many conjectures and so many valuations. Differences in valuation, related to differences in circumstances and in the imagination of alternative possibilities, are invoked by Penrose to explain the sale of businesses which are not firms.

A final observation. This paper has been investigating the conditions for success. It does not, and cannot, provide the basis for any recipe for success. (As a consolation we should remember, as Frank Knight (1921) pointed out, that any publicly-available and demonstrably correct recipe would extinguish the prospect of profit.) In conditions of uncertainty and change, most new ideas will not work, most new skills will have no useful application. An economic system is a multiform cluster of selectively connected organisations, arrangements and alliances which may organise discovery by guided trial and error, for which the guidelines themselves are necessarily fallible. We have not yet discovered any better way of organising discovery than through as combination of differentiation of focus, variation within each differentiated activity, selective reintegration of what has been differentiated,
and selection pressures which are tolerant of experimentation but not of persistence in
apparent error. The formulation and application of strategy is an experimental
procedure.

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